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An analysis of artificial recharge zones using remote sensing and GIS in Agastheeswaram Taluk, Kanyakumari District(TN)

J.R.Julius,
Research Scholar
Hindustan University
Chennai, India

Dr.R.Angeline Prabhavathy,
Professor, Department of Civil Engineering
Hindustan University
Chennai, India

Dr. G.Ravikumar
Professor in Civil Engineering
A.C.Tech, Anna University
Chennai, India

***Abstract*— Ground Water, which is the important source for domestic and irrigation requirements, is depleting in many areas due to its large scale withdrawal for various sectors. Artificial Recharge such as Rainwater Harvesting are essential in order to improve ground water level and quality. Artificial techniques for recharge would be effective if they are chosen in accordance with site and soil conditions. GIS, which is a computer based tool, is commonly used for assessing, monitoring and conserving groundwater resources. Satellite data provides useful information on the factors influencing the movement of groundwater like geology, lineament, structures, soils, land use/ land cover etc. In the present study, an effort has been made to identify suitable recharge zones using advanced geospatial tools like remote sensing and GIS.**

Index terms –GIS, Geology, Geomorphology, Lineament, Groundwater Potential, Recharge Zonation

1. INTRODUCTION

Shortage of water for industrial and domestic use and even for drinking purpose is a cause of concern throughout the world particularly in developing and underdeveloped countries. To manage with these crises, it has become important to divert surface runoff into the ground and allow recharging artificially. The artificial recharge projects are zone specific, the replication of the technique is based on the concerned topographical, hydro geological, land use and socioeconomic environment of the area. Due to the advancement in spatial, spectral and temporal capabilities of remote sensing technique, it has become an efficient tool in assessing, monitoring and conserving groundwater resources. Satellite data provide useful information on the factors like geology, geomorphology, land use, lineaments etc controlling the occurrence and movement of groundwater. The purpose of this study is to collect ancillary data and to generate different thematic maps from satellite data and to create a feasible method for identification of suitable sites for different artificial recharge structures with the help of GIS modeling.

2. STUDY AREA

The study area is bounded by Pazhayar watershed in the east and Hanuman Nathi watershed in the west of Agastheeswaram taluk and it lies between longitudes $77^{o}24'30"$ and $77^{o}24'33"$ E and latitudes $8^{o}10'30"$ N and is situated in the southern part of the Kanyakumari District of Tamil Nadu state. This area is covered in SOI toposheets mapped on 1:50000 scale and area is spread across 278.75 sq.km. Climate of the area is sub tropical with alternating dry and wet seasons. The average annual rainfall in the area is 900 cm and about 80 % of the rain precipitates during monsoon period. The annual temperature variation is between 35^{0} C maximum and 25^{0} C minimum.

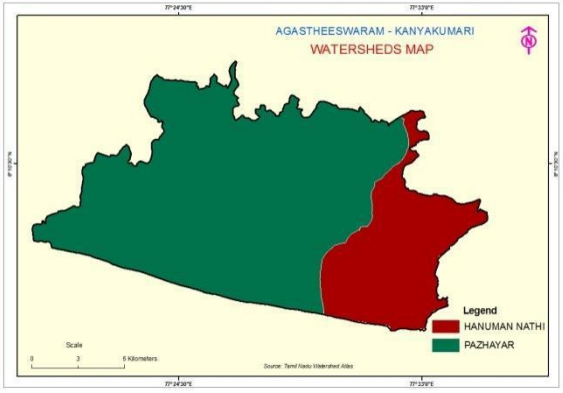

Fig.1 Watershed map of the study area

3.DATA USED AND METHODOLOGY

In the present study IRS LISS III sensor satellite data and SOI toposheets on 1:50000 scale were used for base map generation and other thematic maps. Secondary data on hydrogeology, well data, recharge conditions, depth of bore wells, aquifer depth were collected from state ground water board, Tharamani, Chennai. Geological mapping was done by referring Geological map published by Geological survey of India. Rainfall data was received from Indian Meteorological Department Chennai. Suitable recharge zones are identified in GIS platform by using various parameters.

4. RESULTS AND DISCUSSION

In rising technology paradigm, GIS has emerged as powerful tool which has potential to arrange complex spatial environment with tabular relationships. The emphasis is on developing digital spatial database, using the data sets derived from precise navigation and imaging satellites, digitization of maps and transactional databases. GIS provides an extremely useful technology for integrating data on spatially distributed resources generated from the satellite data, topographical maps and field observations. These maps were analysed and modeled for identifying recharge zones in Arc GIS software.

5. GEOLOGY OF THE AREA

Chamockite Group, Alluvium- Marine, Alluvium-Fluvial and Aeolian mainly constitute the geology of the area. The geological map is prepared by interpretation of satellite data and subsurface borehole data obtained from Department of Remote Sensing(Fig.2).

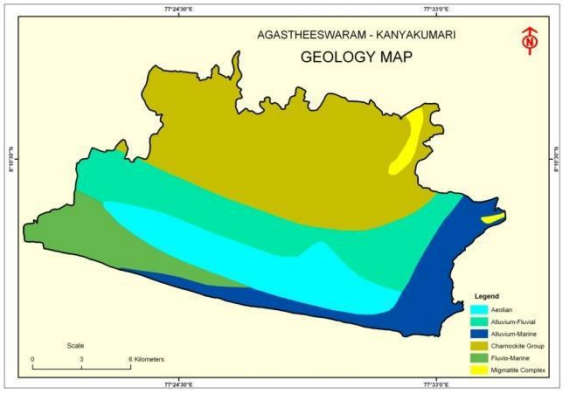

Fig. 2. Geology Map of Agastheeswaram Taluk, Kanyakumari District(TN)

6. LINEAMENTS

Lineaments are natural straight lines or curvilinear features that can be correlated to faults, fractures, joints, bedding traces and lithological contacts, unconformities etc. mapped from satellite remote sensing data(Fig/3). The study area is characterized by dominant NE-SE trend and ENE-WSW, E-W and NW-SE leaning sediments.

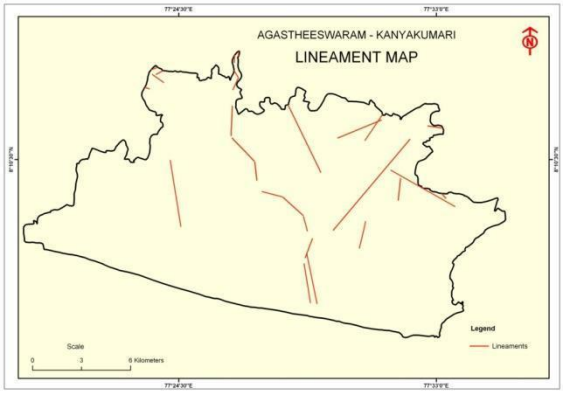

Fig. 3 Lineament map of Agastheeswaram Taluk, Kanyakumari District(TN)

7. GEOMORPHOLOGY OF THE AREA

Geomorphology of the area plays a very important role to control the ground water regime. The landforms features, types of the weathered material relief, slope, depth of watershed material and the overall assemblage of different landforms play a vital role in defining the groundwater system. On the basis of digital remote sensing, SOI toposheets, field visits and well data geomorphology of the area is mapped out (Fig.4). It comprises of coastal plain, denudational hills, Eolian plain, Pediplain and Structural Hills.

A coastal plain is a flat, low-lying piece of land next to the ocean. Coastal plains are separated from the rest of the interior by nearby landforms, such as mountains.This study area is predominantly covered by pediplain which is broad, relatively flat rock surface formed by the joining of several pediments. Pediplains are usually formed in arid or semi-arid climates and may have a thin veneer of sediments. It is postulated that the pediplain may be the last stage of landform evolution, the final result of the processes of erosion. Eolian plain is connected to wind activity in the study of geology, and specifically to the wind's ability to shape the surface of the Earth. Winds may erode, transport, and deposit materials, and are effective agents in regions with sparse vegetation and a large supply of unconsolidated sediments. Although water is a much more powerful eroding force than wind, eolian plain are important in arid environments such as deserts. Denudational hills are low relief hills mostly covered with vegetation. While pediments are concave surfaces developed at the junction of hills with the plains and exhibit undulating topography and are dissected.

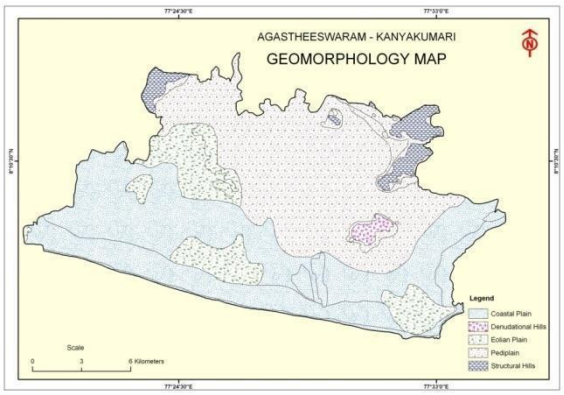

Fig. 4. Geomorphology map of Agastheeswaram Taluk, Kanyakumari District(TN)

8. LANDUSE/LANDCOVER

Landuse/Landcover mapping has been carried out by using satellite remote sensing data in association with ancillary data and field checks(Fig. 5). Land use and land cover informations are necessary for assessment of groundwater availability and its management. In the study area, a major part

accounts crop land followed by rural and urban land, that is the built-up area. Only few percentage of area is occupied by tanks and ponds.

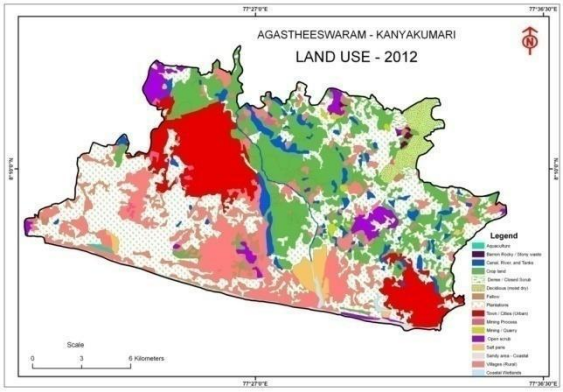

Fig. 5. Geomorphology map of Agastheeswaram Taluk, Kanyakumari District(TN)

9. SLOPE

Contribution of rainfall to stream flow, duration of overland flow, subsurface flow, infilteration, groundwater reservoir, depth to the water table, pattern of landuse/landcover and feasibility of geotechnical constructions for storage and artificial recharge are mainly controlled by slope. In the study area, a majority of area is characterised by very steep slope followed by moderate slope (5-10%). Only lesser area is represented by nearly level to gentle slope (0-50%), as shown in fig. 6.

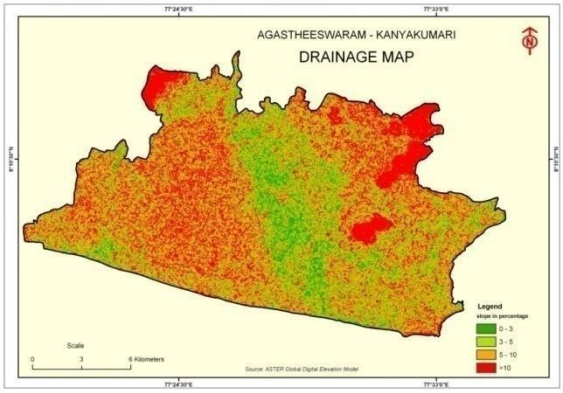

Fig. 6. Drainage map of Agastheeswaram Taluk, Kanyakumari District(TN)

10. GROUNDWATER POTENTIAL OF THE AREA

Groundwater potential of any area is synchronized by rainfall, landuse, landcover, geomorphology, water use and geological parameters like type of rock, stratigraphy, porosity, permeability, lineament, joints and fractures in the rock, depth to wate table, type of aquifer, direction of subsurface flow, soil texture, soil structure, depth of weathering, water holding capacity, soil moisture etc.,

In the present study, ground water potential zone map is generated through GIS and verified with well yield data in the field (Fig. 7). In Agastheeswaram taluk of Kanyakumari District three potential zone viz. Good, Moderate and Poor have been identified. Good potential zones are influenced by coastal plains. This area has good recharge conditions. Only a fraction of the total area contribute to moderate recharge zone. A majority of the study area is occupied with poor ground water recharge zone. Low potential zone is mainy a rocky terrain dominated by pediment zone and builtup area.

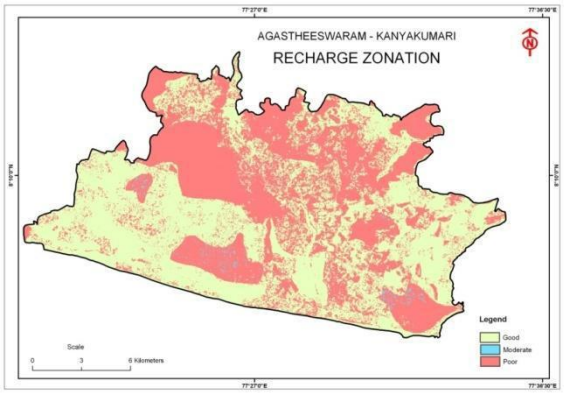

Fig. 7. Potential recharge zones of the study area

11. GIS BASED PROJECTIONS OF ARTIFICIAL RECHARGE ZONES

Artificial techniques for recharge would be effective if they are chosen in accordance with the site and soil conditions. In the present study, suitable recharge structures such as percolation tanks, check dams, roof top harvesting and contour bunds are proposed based on drainage morphology in the areas demarcated as favorable for artificial recharge for Pazhayar and Hanuman Nathi watershed (Fig. 8).

11.1 Percolation tanks

These structures are recommended in the favorable recharge zones to ensure more recharge especially in the non monsoon months. Similar types of percolation tanks are suggested wherever the highly favorable zones with suitable terrain conditions exist. Recharge through percolation tank will be efficient in these sectors because of adequate runoff and a conductive medium as indicated by water level fluctuation, geology and geomorphologic evidences. These types of structures are economical and play a major role in augmenting the yield of wells

11.2 Check dams

Check dams are small scale structures built across lower order streams in order to prevent runoff and detain the water to enhance infiltration into the subsurface. It is expected that the check dams would prevent the water from flowing down to join the higher order streams and instead permit the water to spread out round the lower order streams and recharge the aquifer. Wherever possible these dams are located close to lineaments so that infiltration to the sub surface is increased.

11.4 Rooftop rainwater harvesting

In the built up area, monsoon recharge can be harnessed to recharge the groundwater reservoir through rooftop rainwater harvesting during monsoon. In case of

rooftop rainwater harvesting all conditions except built-up land are redundant and not playing a key role.

11.5 Contour bunds

Contour bunds are constructed in relatively low rainfall areas particularly in the areas having light textured soils. They are essentially meant for storing rainwater received during a time at periodic recurrence interval. The major considerations are maximum depth of water to be impounded, design depth of flow over waste weir and desired free board.

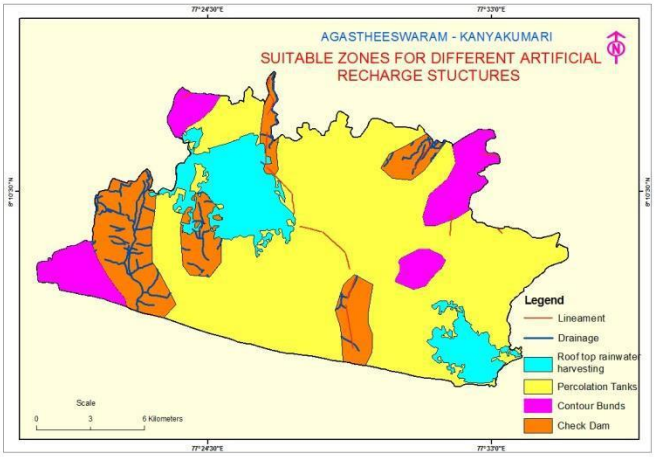

Fig.8 Sites suitable for different artificial recharge structures, Agastheeswarm taluk 12. CONCLUSION

As per the Zonation map, the check dams may be provided across the available streams, Roof top rainwater Harvesting in urban areas and percolation pond where runoff is high and the soil is having high recharge conditions.

This study demonstrates application of remote sensing and GIS techniques in the identification of site specific watershed management technique to enhance the groundwater potential in an area. The role of GIS and remote sensing for groundwater potential zonation and conservation is being fully realized only since the last decade. The current multi-parametric approach using GIS and remote sensing is holistic in nature and will reduce especially the time and cost especially of identifying suitable site specific recharge structures on a regional as well as local scale, thus enabling quick decision making for water management.

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Authors Profile

J.R.Julius received the **B.E.** degree in Civil engineering from the Mepco Schlenk Engineering College, Sivakasi, Madhurai Kamaraj University, Madhurai, India, in 1991, **M.E.** in Hydrology and Water Resources engineering in Anna University, Chennai, India, in 1993. Currently doing Ph.D. in Hindustan University, Chennai, India. His research interest includes Water Resources Engineering and Rainwater Harvesting.

Dr.R.Angeline Prabhavathy is the Dean, School of Building Sciences, Hindustan Institute of Technology and Science, Hindustan University. She completed her B.E in Civil Engineering from Thiagarajar College of Engineering Madurai in 1984. She did her Post Graduation in Soil Mechanics and Foundation Engineering from College of Engineering, Anna University in 1994. She did her research in the area of Cold-formed Steel Beam to Column Connections with hollow sections as well as concrete infilled sections. She obtained the Doctorate in the field of Civil Engineering from Anna University in 2004. She has published nine papers in international journals, four papers in national journals and 26 papers in Conferences.

Dr.G.Ravikumar received the **B.E., M.E. and Ph.D.** degree in Civil engineering from Guindy Engineering College, Anna University, Chennai, India. Currently he is a Professor of Civil Engineering in A.C.Tech, Anna University. His research interest includes Water Resources Engg, Rain Water Harvesting and Drought Assessment. He also serves as the Director of Centre for Entrepreneurship Development in Anna University.