GIS for the assessment of potential groundwater zone in Thiruvallur block, Tamilnadu, India

Ramamoorthy.P¹ Mahalingam² Logeswari .M³
¹University of Madras ²Institute of Water Studies ³Mailam Engineering College

Abstract—Groundwater plays a major role in the agricultural activities. In Tamilnadu majority of people depend on groundwater for irrigation and domestic use. The demand of water has increased in the last few years and has lead to water scarcity. Remote sensing and GIS techniques is found to be very effective tool for delineate potential groundwater zones. Thiruvallur block of Thiruvallur district in Tamil Nadu is taken to assess ground water potential as a case study. This paper describes the ground water scenario of the area assessed by integrating the thematic information on geology, geomorphology, rainfall, soils, lineament etc.

Key words: GIS, Thiruvallur, Soil, Groundwater, Rainfall, Geology

I. INTRODUCTION

Water plays a vital role in the development of any activity in the country. The uses of water are manifold for developing domestic water supplies for communities, for bathing and recreation for irrigation and agriculture, for fisheries for industrial purposes, for navigation and for power development. There are two major sources of water, namely surface and groundwater source. The efficiency of groundwater is high compared to surface water, but groundwater resources have not properly developed through exploration. The occurrence of groundwater in the hard rock terrain is confined to secondary permeable structures, i.e. fractures and weathered zone and in upper unconsolidated materials(Ramamoorthy P, 2014).GIS and remote sensing tools are widely used for the management of various natural resources (Dar et al., 2010); Krishna Kumar et al., 2011; Magesh et al.,2011a,b). Delineating the potential groundwater zones using remote sensing and GIS is an effective tool. In recent years, extensive use of satellite data along with conventional maps and rectified ground truth data, has made it easier to establish the base line information for groundwater potential zones (Tiwari and Rai, 1996; Das et al., 1997; Thomas et al., 1999; Harinarayana et al., 2000; Muralidhar et al., 2000; Chowdhury et al., 2010). Remote sensing not only provides a wide-range scale of the space-time distribution of observations, but also saves time and money (Murthy, 2000; Leblanc et al., 2003; Tweed et al., 2007). In addition it is widely used to characterize the earth surface (such as lineaments, drainage patterns and lithology) as well as to examine the groundwater recharge zones (Sener et al., 2005).

GIS is one of the most important tool for integrating and analyzing to represent spatial information and data base of any resource which could be easily used for planning of resource development, environmental protection, scientific researches and investigations (Subagunasekar et al., 2012).

II. STUDY AREA

The study area Thiruvallur block is located in the middle portion of the Thiruvallur district. It is bounded in the East by Villivakkam, Ellapumur and Poonamallee blocks north by Kadambathur block and south by Poondi block. The total aerial extent of the study area is 194.91 Sq.km (Fig:1). Geographically the study area is located in between 13°06’00”N to 13°16’00”N and 79°52’00”E to 80°06’00”E. and it falls in the Survey of India (SOI) topo sheets 66D &66C.

Fig. 1: Study area

III. METHODOLOGY

The base map of study area was prepared from SOI toposheets.ARC GIS was used to prepare various thematic maps such as Geology, Soil, Lineament, Geomorphology, landuse, water level etc. The all thematic layers were integrated and prepared potential ground water zone map by weighted overlay analysis method and classified as very good, good, moderate and poor zones.

IV. GEOLOGY

The Geology theme is derived from Geological Resource map of Thiruvallur district prepared by Geological Survey of India. Thiruvallur block is occupied by sedimentary formation. Rocks of Archaean, Proterozoic in the block. The hard rock formations are occupied in the west and southeastern side of the basin. Biotite Hornblende gneiss and Epidote hornblende gneiss occur in the north east part of the block (Fig:2).

V. SOILS

Soil is one of the natural resources, which is an important parameter to delineate potential groundwater zones. The soils of the Thiruvallur block have been derived from Soil Atlas prepared by Agricultural University, Coimbatore and shown in (Fig-3).The major soil types found in this area are (1)Inceptisols, (2) Alfisol, (3) Entisol and (4) Vertisol

VI. GEOMORPHOLOGY

Geomorphological study is one of the most importance aspects in the evaluation of water resources both surface and ground water. The hydro geomorphological unit such as flood plain, valley fill, buried pediment is good sources of
groundwater where as structural hills, pediment zone and
gullied land are poor recharge zones(Subagunasekar et
al.2012). Geomorphological land forms are identified from
IRS P6 LISS III 2006 satellite data for this block (Fig-4).
Flood plain, Low land, Alluvial plain, Buried channel,
Upland. Among the fluvial geomorphic units, flood plain,
buried channel, alluvial plain, and valley fill contribute more
ground water resources to the area.

VII. LINEAMENT STUDY
The most obvious structural features that are important from
ground water point of view are the lineaments. In hard rock
terrains, lineaments represent areas and zones of faulting
and fracturing results in increased secondary porosity and
permeability. Lineaments provide the pathways for
groundwater movement and are hydro geologically very
important (Sankar et al., 2002). The ground water movement
is more along these lineaments. Ground water potential is
very good in the lineament intersection zones. For this area
lineaments are interpreted from IRS P6 LISS III 2006
satellite data. NNE-SSW NNW-SSE, NE-SE and E-W
trending lineaments were mapped. But, the lineament
intersections contribute to a considerable amount of ground
water storage in under ground fractured reservoirs (Fig-5).

A. Ground Water Occurrence
The occurrence of ground water depends on geological and
physiographical setting as well as on climatic conditions.
Further, the degree of structural deformation and weathering
of the geological formation control the distribution of
ground water both in vertical and lateral directions.
There are eight observation wells in this block. The 10 years
average pre monsoon water level data is furnished in Table-
1.1 Water level contours were generated by using GIS
software for Pre monsoon season.

B. Water Level
It is observed that the pre monsoon water level ranges
between 2 and 9 m bgl . The water level in the western
portion ranges from 5 to 6 m bgl. 3 to 5 m water level
variation is noticed in the north eastern part. In the some
patches of eastern part ground water level is in between 7
and 9m bgl(Fig-6).

<table>
<thead>
<tr>
<th>Well Location</th>
<th>LONG</th>
<th>LAT</th>
<th>Water level</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>79.867</td>
<td>13.029</td>
<td>2.34</td>
</tr>
<tr>
<td>L2</td>
<td>80.031</td>
<td>13.019</td>
<td>8.22</td>
</tr>
<tr>
<td>L3</td>
<td>80.081</td>
<td>13.294</td>
<td>5.49</td>
</tr>
<tr>
<td>L4</td>
<td>80.048</td>
<td>13.310</td>
<td>4.19</td>
</tr>
</tbody>
</table>
C. Evaluation of Ground water Potential using GIS

Using the GIS package, the specific application like map projection, geo referencing the spatial data, merging, mosaicking, data clipping, data updating, queries, attribute analysis, overlay analysis and integration analysis work done for generation of ground water potential zonation map.

The ground water potential zonation map was prepared by weighted overlay analysis using the thematic layers on Geomorphology, Geology, Lineament, Pre-Monsoon Water Level, soil by giving appropriate weightages.

<table>
<thead>
<tr>
<th>Layer Name</th>
<th>Category</th>
<th>Score for potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geomorphology</td>
<td>Flood plain</td>
<td>9</td>
</tr>
<tr>
<td>Wt. for Potential:17.49</td>
<td>Old river course</td>
<td>8</td>
</tr>
<tr>
<td>Geology</td>
<td>Paleo channel</td>
<td>6</td>
</tr>
<tr>
<td>Wt. for potential:9.17</td>
<td>Alluvium</td>
<td>5</td>
</tr>
<tr>
<td>Lineament</td>
<td>Paleo channel</td>
<td>4</td>
</tr>
<tr>
<td>Wt. for potential:16.43</td>
<td>Alluvium</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1.2: Shows Weights, classes and scores for map layers.

VIII. CONCLUSION

The study revealed that the usefulness of spatial data for assessment of groundwater potential zones of Thiruvallur block. Geomorphological units like flood plain, upland, buried channel, alluvial plain, etc were identified and their ground water potential was qualitatively assessed. Flood plains, old river course, etc are the favourable ground water potential zones. Fractures and lineaments contribute for delineation of groundwater potential are also studied. GIS layers were generated for selected themes and used for analysis for identifying the groundwater potential zones by assigning appropriate ranks on layers and weightages (Table 1.2) of the thematic data sets was given and integrated using overlay functions of GIS analysis. The north western portion of the study area (30%) falls on poor category of groundwater potential, the northern and southern portion falls on moderate zone the middle portion have good potential zones by 15% of the total study area. Artificial recharge structures should be constructed in the suitable locations by analyzing the various thematic layers for rainwater harvesting so as to increase the groundwater potential in the study area.

REFERENCES


