Geoinformatic Modeling of Groundwater Resource Mapping of Shear Zone Regions- A Case Study on Attur Valley, Tamil Nadu, India

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Abstract The general tendency of mapping groundwater resource using remote sensing and Geographic Information System (GIS) techniques involve assigning higher weightage to geomorphology. But this cannot be used as a thumb rule everywhere, especially an area where many ductile and brittle zones are prevalent. The influence of texture and structure of sheared rocks might play a control over retaining and permitting groundwater to flow. Attur valley is characterized by the presence of many shear zones and faults and hence the rocks are highly fissile within the shear zones. The present study tries to establish a new ranking and weightage scheme and hence a new spatial model for groundwater resource mapping in shear zone area like Attur Valley. This spatial model can be verified with field data such as water level data, pump test and resistivity data.

Keywords Shear zones · Groundwater resources · Attur valley · Geoinformatic modeling · Iso-resistivity · Pump test · Water level fluctuation method

Introduction

One of the best methodologies to locate and map the occurrence and distribution of groundwater has focused on the utility of high resolution satellite imagery to identify and delineate the surface features more accurately. Remote sensing method provides the efficient way of mapping of natural resources economically than those of the conventional methods and yield better results. Krishnamurthy and Srinivasan (1995); Ravindran and Jayaram (1997); Rao et al. (2004), Mohanty and Behera (2010); Sinha et al. (2012); Gumma and Paul Pavelic (2013) have used the satellite remote sensing data to define the spatial distribution of different groundwater prospect classes on the basis of geomorphology and other associated parameters. Sankar (2002); Rai et al.(2005); Lokesh et al. (2005) in their studies found that, identification of groundwater occurrences location using remote sensing data is based on indirect analysis of some directly observable terrain features like geological structures, geomorphology and their hydrologic characteristics. Bahuguna et al. (2003), in their studies found that lineaments play significant role in groundwater exploration particularly in hard rock terrain. On the basis of hydrogeomorphology, Vijith (2007) has delineated three categories of groundwater potential zones namely good, moderate and poor of Kottayam district, Kerala. Various thematic maps for delineating groundwater favorability zones are selected presuming that all the parameters have significant influence on the occurrence of groundwater (e.g., Rao and Jugran, 2003; Solomon and Friedrich, 2006) the number of thematic layers used depends on the availability of data in an area.

Groundwater prospecting based on mapping of landforms and lineaments is now very common using remote sensing data. Remote sensing serves as the preliminary inventory
method to understand the groundwater prospects/conditions and helps in delineating areas where further explorations need to be taken up through hydrogeological and geophysical methods.

This study is intended to evolve a comprehensive geoinformatic model from various thematic maps interpreted from different platforms for effectively demarcate groundwater potential zones. Moreover, proper understanding of nature of the terrain added with remote sensing technique may provide accurate result. The present study focuses the importance of rocks, lineaments and dykes along with geomorphology, slope, and landuse pattern.

**Study Area**

The study area is located in the central part of Tamil Nadu and geologically occupies a transition zone between Dharwar rocks and southern granulite rocks and covers an area of 9050sq. km. It covers under 581 series Survey of India toposheet of 1:50,000 scale numbering I/1, I/2, I/3, I/5, I/6, I/7, I/9, I/10, I/11, I/13, I/14, and I/15. Northern part of the study area is bounded by Shevaroyan, Chiteri and Kalayan hills and southern part is bounded by Kolli and Pachchais while the central part is a broad valley called Attur valley.

**Geology of the Study Area**

Geologically, the study area is covered predominantly by hard crystalline rocks belonging to precambrian period, and plio-
tocene laterite and recent alluvium are exposed in the eastern parts as shown in Fig. 1. The study area exposes vast areas of gneissic and granitic rocks named as ‘Peninsular gneiss’ which constitutes the basement for the deposition of the younger succession. They are typically migmatitic gneisses alternating with bands of hornblende biotite gneisses and granulites associated with the pre-existing mafic and ultramafic rocks. The charnockite group occupying the eastern and central parts of the Salem district includes charnockite, pyroxene granulite and banded magnetite quartzite. The charnockites in the Kolli malai and Shevaroy hills are altered to bauxite and laterite. A number of shear zones traverse E-W along the foothills of the Shevaroys –Chiteri –Kalayan and Kolli-Pachchais hills characterized by the presence of sheared charnockites mostly pseudotachylites. Pyroxene granulite bands associated with magnetite quartzites occurs as inter-banded sequence with charnockite and form good marker in deciphering the structure of the area as seen around Attur. The Satyamangalam group of rocks equivalent to Archaean of Dharwar comprises fuchsite quartzite and amphibolites occur in a linear zone surrounding the Sankari granitic dome.

**Structure and Tectonics**

The Southern granulite terrain has a complex evolutionary history from the early Archean to late Neoproterozoic (3,500 –550 Ma) with repeated multiple deformations, anatexis, intrusions and polyphase metamorphism (Bartlett et al., 1998; Bhaskar Rao et al., 2003). There exists a narrow transition zone along which the low-grade greenschist granite domain transforms to high-grade granulite facies rocks (Swaminath et al., 1976). The SGT is a mosaic of crustal blocks consisting of highland charnockite massifs separated from each other by a network of low-lying shear zones extending in different directions viz. NE–SW, E–W and NW–SE. The most prominent among the charnockite massifs are the Biligiri Rangan, the Shevroy, the Nilgiri and the Kodaitakanal hills and they constitute the northern massif (Nr-M). The most important shear zones of the region are the Moyar– Bhavani – Attur (MBASZ), the Palghat–Cauvery (PCSZ) and the Achankovil (AKSZ) shear zones. The MBASZ branches into several curvilinear shear zones in the NE–SW direction. A number of shear zones traverse E-W trending along the foothills of the Kolli- Pachchais hills and Shevaroy-Chiteri- Kalayan hills.

**Rainfall**

An analysis of rainfall pattern for the study area is done for over the period of 10 years. The average rainfall level of the region exceeds at some places like Shevaroy and northern part of Kalayan hills. The Attur valley receives rain from both northeast and south west monsoons. The average rainfall of the Salem region is 850mm. Yercaud received highest rainfall in the region averaging 1500mm from 1996 to 2006. At the same time Vazhapadi and Rasipuram recorded average rainfall of 750mm and the lowest in the study area. Overall the climate is good and is influenced by the monsoons.

**Methodology**

In the present study 9 themes have been selected on the basis of their merits pertaining to the study area. The themes like Geomorphology, lineament, landuse, structure and trendline were prepared from IRS IC LISS III data acquired on 19th February 2004 (P100/R67). Drainage map was prepared from Survey of India toposheets 58 I series of 1:50,000 scale. And district resource maps published by Geological Survey of India (scale 1:2,50,000 of year 1987) were used for lithology and slope map was derived from SRTM data. Lineament density, lineament frequency and lineament intersection map were derived from lineament map and drainage density map was prepared from drainage map. Since, the water bearing qualities depends upon the porosity of the rocks, the rocks in province like Salem which underwent multiple deformation
phases apart from the inherited porosity, higher weightage must be given to lithology. In crystalline terrains the geomorphology is mostly controlled by rock types. So, higher weightage was given to lithology prior to geomorphology followed by fractures related properties like lineament density, lineament frequency and lineament intersection (Table 1).

In this method, all vector GIS layers of the 9 terrain systems were used and weightages (Wi) were assigned on the basis of their possible influence and control over water resources of a region. Then for the each sub variable of 9 themes, scores were assigned (Sij). Then these scores (Sij) of the sub variables were multiplied with the corresponding weightage (Wi) of the terrain systems to work out the water potential zones weightages (Wi x Sij). For example, Wi for lithology layer is 10 and Sij for the fissile hornblende gneiss is 9. So the finally accrued water potential weightages (Wi x Sij) for the fissile hornblende gneiss is 90 (10 x 9). Similarly, for each sub variable of the 9 terrain systems water resource weightages were worked out and the corresponding weightages are assigned. In this method, the total weights of the final integrated map was derived as sum of the weights assigned to the different layers according to their suitability and finally a groundwater potential zone map was prepared (Fig. 3).

Assignment of Weightages (Wi) and Scores (Sij) to Terrain Systems

Lithology

As discussed in the methodology, first the weightages (Wi) were assigned to the 9 terrain parameters as shown in Table 1. In the present study, the maximum weightage of 10 was
Table 1 Scores and weightages for different themes

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Themes &amp; Wi</th>
<th>Classes and score (Sij) - [Wi x Sij]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>LITHOLOGY (10)</td>
<td>Fluvial sediments (sand, silt, gravel, clay) laterite (10–100); Fissile hornblende biotite gneiss (9–90); Charnockite, hornblende biotite gneiss, epidote hornblende gneiss, siderite-ankerite gneiss (8–80); Amphibolite, pyroxenite, dunite, peridotite, pink migmatite, carbonatite, calc granulite and limestone (5–50); Garnetiferous gabbro, pyroxene granulite (4–40); Syenite, granite, Ginge granite, granite / granulite (Tindivanam) (3–30); Magnetite-quartzite, pegmatite, basic dyke (2–20);</td>
</tr>
<tr>
<td>2.</td>
<td>GEOMORPHOLOGY (9)</td>
<td>Alluvial fill (10–90); Bajada (9–81); Intermontane valley (8–72); Fracture valley fill, pediplain deep (7–63); Penepal moderate (6–54); Penepal shallow / buried pediment (5–45); Hilltop weathered / dissected plateau / moderately buried pediment (4–36); Undissected plateau, fracture valley barren, pediment/ pediment-inselberg (3–27); Residual hills (2–18); Linear ridge / dyke, structural hills, rocky slope / cliffs (1–9);</td>
</tr>
<tr>
<td>3.</td>
<td>L1 (8)</td>
<td>Very high&gt;60 (10–80); High 60–45 (8–64); Moderate 45–30 (6–48); Low 30–15 (4–32); Very low 0–15 (2–16);</td>
</tr>
<tr>
<td>4.</td>
<td>LF(8)</td>
<td>Very high&gt;20 (10–80); High 20–15 (8–64); Moderate 15–10 (6–48); Low 10–5 (4–32); Very low 0–5 (2–16);</td>
</tr>
<tr>
<td>5.</td>
<td>LD(8)</td>
<td>Very high&gt;30,000 (10–80); High 30,000–20,000 (8–64); Moderate 20,000–10,000 (6–48); Low 10,000–5,000 (4–32); Very low 0–5,000 (2–16);</td>
</tr>
<tr>
<td>6.</td>
<td>BS &amp; TL (7)</td>
<td>Structural basin (10–70); Open fold (8–56); Trend line (6–42);</td>
</tr>
<tr>
<td>7.</td>
<td>SLOPE (8)</td>
<td>Gentle slope (10–60); Moderate slope (8–48); Steep slope (6–36); Very Steep slope (4–24);</td>
</tr>
<tr>
<td>8.</td>
<td>DD (5)</td>
<td>Very low&lt;5,000 (10–50); Low 5,000–5,000 (8–40); Moderate 20,000–10,000 (6–30); High 30,000–20,000 (4–20); Very high&gt;30,000 (2–10);</td>
</tr>
<tr>
<td>9.</td>
<td>LANDUSE – LAND COVER (4)</td>
<td>River, river island, river bed vegetation, river/sandy area, reservoirs, water lakes/ponds, tanks (10–40); Crop Land in Forest, Crop land (8–32); Deciduous forest, plantations, Grassland/degraded, Forest plantations (6–24); Mining process, abandoned quarries, wastelands-with/without scrub, gullied/ravenous land, built-up, built-up/villages (rural) (4–16); Barren rocky/ stony waste (2–8);</td>
</tr>
</tbody>
</table>

assigned to the lithology, as the rock assemblage of Salem province is unique which includes brittle charnockite, mafic granulite, hornblende biotite gneiss, amphibolites and so on. These rocks differ from each other, in water resource aspect by porosity as they are intensely sheared and foliated in nature.

The secondary porosity is the essential character of crystalline aquifers where the response to shearing varies from rock to rock and hence their water holding properties. Based on this conception higher score of 9 was assigned to fissile hornblende gneiss next to fluvial younger sediments (Fig. 1, Table 1). Charnockite, hornblende, biotite gneiss, epidote hornblende gneiss, siderite-ankerite gneiss are relatively less porous than fissile hornblende gneiss and hence lower value of 8. Similarly rocks are ranked according to their merit of water holding properties and hence the weighted lithology GIS map was prepared.

Geology

Authors like Chakraborty and Paul (2004), Shankar and Mohan (2005), Kumar et al., (2006), Trivedi et al., (2006), Thakur and Raghuwanshi (2008) have used hydrogeomorphology as criteria for delineating water potential zones. The study area has a dominant rocky terrain, which is manifested by hills and undulating surface. Hence, the geomorphology was assigned weightage (Wi) 9.

More than ten distinct geomorphologic units have been identified and delineated from the study area (Fig. 2). They include structural hills, escarpment/cliff, residual mounds, denudational slope, pediment, fracture valley and valley fill, etc. The distribution and extent of these geomorphic zones are varying from place to place. Highest score was assigned to alluvial fill followed by bajada, intermontane valley and fracture valley fills (Table 1). Linear ridges, dykes, inselberg were assigned low scores owing to lesser chances to hold water. From this, the weighted geomorphology GIS map is prepared.

Lineament

Lineaments like joints, fractures and faults are hydrogeologically very important and may provide the pathways for groundwater movement (Sankar, 2002). Presence of lineaments may act as a conduit for ground water movement which results in increased secondary porosity and therefore, can serve as groundwater prospective zones. The extension of large lineaments representing a shear zone or a major fault may extend subsurface from a hilly terrain to an alluvial terrain. It may form a productive groundwater reserve. Similarly intersection of lineaments can also be the probable sites of groundwater accumulation. Therefore, areas with high lineament density may have important groundwater prospects even in hilly regions which otherwise have zero groundwater prospects. So, weightage (Wi) value of 8 was assigned to
Lineament derived features like lineament density (LD), lineament frequency (LF) and lineament intersections (LI).

Lineament Density Ramasamy et al., (2001) have done fracture pattern modeling for hard rock aquifer system of central
Tamil Nadu in which they studied the fracture density and their influence over groundwater. In the present study, lineament density map was prepared by measuring the total length of the lineaments on a 5x5 sq.km grid. Then the measured values are assigned to respective centers of grids. The values are ranging from 5000m to 30000m per grid. The values are grouped into 5 classes and scores are assigned to each class. Highest score of 10 is assigned to highest lineament density and minimum to lowest lineament density (Table 1). An isoline map is prepared from the reclassified grid values as weighted lineament density map. Weighted lineament frequency map is prepared by counting the number of lineaments per 5x5 sq.km grid with corresponding weighted values (Table 1). Weighted lineament intersection map is prepared by counting the number of intersections of lineaments on the 5x5 sq.km grid with corresponding weighted values (Table 1).

Buffered Structure and Trendline (BS&T)

The compositional banding in the rocks as well as the linearity developed during shearing, dykes, mafic granulites and banded magnetite quartzite were traced as trendlines and they are qualified enough to control water flow and damming of ground water. So, 250m buffer zone is taken as a terrain parameter and assigned the weightage value 7 (Table 1) in the preparation of weighted, buffered structure and trendline map.

Slope

Slope plays a key role in groundwater occurrence as infiltration is inversely related to slope. A break in the slope (i.e. steep slope followed by gentler slope) generally promotes an appreciable groundwater infiltration. Steeper the slope, greater will be the runoff and thus, lesser is the favorability for groundwater recharge. SRTM data is used for the estimation of slope in degrees. The identified slope category varies from 1° to 56° in the study area and were classified into four classes like, 0° to 3° (gentle), 3°001” to 20° (moderate), 20°001” to 40° (steep) and >40 (very steep). Weightage scores were assigned and their total weighted values for each slope have been calculated (Table 1) and the corresponding weighted slope map is prepared.

Drainage Density (DD)

Drainage channels created using SOI topographic maps represent channels along which surface runoff moves down slope. The area of very high drainage density represents more closeness of drainage lines and vice-versa. Groundwater prospects are found to be poor in the very high drainage density areas as major part of the water poured over them during rainfall is lost as surface runoff with little infiltration to meet groundwater. On the contrary low drainage density areas permit more infiltration and recharge to the groundwater and therefore have more potential for groundwater (Mondal et al., 2007). Weightage scores of the total weightage for each drainage density are given in Table 1 and weighted drainage density map is prepared.

Land Use/Land Cover

For the identification and interpretation of land use pattern of the area, the standard methods of visual interpretation are adopted and the various land use classes delineated includes barren land, barren rock, built-up land, cleared area, cropland, grassland, natural vegetation, plantations, and water bodies. The weightage scores are assigned to each landuse and land cover category (Table 1) and the corresponding weighted landuse and land cover map has been prepared.

Geoinformatic Modelling for Groundwater Potential Zones

Geospatial model has been built based on nine weighted GIS vector layers of the different terrain parameters which are simplified by dissolving with scores of different classes of each terrain parameters. This modelling is entirely based on the selection of more effective influential terrain parameters and assigning the weightage for each element of terrain parameters. The intersections of best elements of all terrain parameters provide the best loci of groundwater.

This model highlighted the importance of rock types and fractures in crystalline terrain with crisscrossing shear zones and faults. Further, the trend lines and structures are specifically prioritized to bring out the damming characters of linear ridges varying lithology within homogenized gneissic and charnockitic terrain.

All the 9 terrain parameters with their sub classes are unified one after the other and 2049 polygons are formed with scores ranging from 141 to 534. The values were classed into six categories viz. very high potential zone (>451), high potential zone (391–450), moderate potential zone (331–390), low potential zone (271–330), very low potential zone (211–270), and Poor zone (< 210). (Fig. 3).

Validations

The delineated groundwater potential zone map was validated by choosing Salem block as a study window, with a) iso-resistivity map of the area, b) minimal water level fluctuation and c) transmissivity, permeability and specific yield (TKS) of the aquifers derived from pump test. The
resistivity valleys can be taken as high water potential zones and similarly the resistivity hills may correspond to low water potential zones. TKS (transmissivity, permeability and specific yield) signifies the characters of holding, to permit the flow and yield thus indicating the water potential zones.

Iso-resistivity Method

Resistivity is one of the best geophysical methods widely used for groundwater exploration where the resistivity drops/changes/flats in the curves are taken as water potential zone and it can be used as a validation tool (Lahcen Zouhri et al., 2004). Since, the study area covers nearly 9000 sq.km the identification and further correlation of low resistivity values can be an ideal method using iso-resistivity value contours drawn for various depths (30m, 50m, 80m, 100m and 150m). At 30m depth resistivity valleys with 150 ohm contours are matching with high potential zone in the western side of Salem block and poor zones in the southern side (Fig. 4a). And 550m hill is observed in the eastern side which is again matching with high potential zone. The central smaller valleys are matching with high potential zone and moderate potential zone. Resistivity valleys with 100 ohm are recorded in the western side where it is coinciding with high potential zone (Fig. 4b) and the other valleys coinciding with moderate potential zone. At western side the valley coincides with high potential zone and on the central and southern side it matches with the moderate potential zone (Fig. 4c). Eastern side hill is matching with massive chamockite in the Uthumalai area. (Fig. 4d)

At 100m depth the valley are matching with very high potential zone in the western and central area where as southern side matches with moderate and low potential zone. The resistivity hills in the northern side and the southeastern side matches with massive chamockite. 150m depth iso-resistivity valley is found near Kandashramam and the hill at the western side matches with massive chamockite near Uthumalai.

Pump Test Method

The pump test well locations are plotted on the water potential map of Salem block in order to verify the spatial model with aquifer characteristics (Fig. 5). The available measured discharges of 25 pumping wells around Salem are taken and their location on water potential classes is correlated. There is a positive correlation between higher values of transmissivity, specific yield, permeability and higher water potential of an area (Shahid et al. 2000).

Specific Capacity

The specific capacity of the water bearing formations is very high in Kullapanaiakanar point II, Government engineering college and Veerapandi point I and they fall within high potential zone, moderate potential zone and low potential zone respectively. Veerapandi point II and Kullapanaiakanar point I are falling within high potential zone and moderate potential zone respectively. Elampillai shows specific capacity of 2.91 l/min/meter of draw down and falls within high potential zone (Fig. 5).

Permeability

The permeability is very high in Gajjalanaickanpatti and the value is 20.8513 m/day and it falls within high potential zone. All other locations have values less than 2 m/day and hence the bar chart was prepared excluding Gajjalanaickanpatti for conveniently representing low values. Kullapanaiakanar point II has the value of 1.655 m/day and it falls within high potential zone. It is considered that the permeability values above 0.041 m/day (1ft/day) are considered as good aquifer and the values will be more than 0.41 m/day for highly fractured rocks (Bear 1972). The values range from 0.00705 to 0.03749 m/day and all fall within low potential zone. The values above 0.11 m/day are falling within moderate and high potential zones.

Transmissivity

The transmissivity values show best correlation to water potential zonation map. The values of transmissivity ranges from 0.23 sq.m/day to 37.48 sq.m/day and the values can be classed into three groups. The transmissivity data for 25 locations range from 0.23 sq.m/day to 6.21 sq.m/day and fall within low potential zone; the values with the range of 6.3 sq.m/day to 12.62 sq.m/day falls within moderate potential zone and the values ranging from 13.27 sq.m/day to 37.48 sq.m/day falls within high potential zone. The transmissivity trend of values coinciding with the classes of water potential zones signifies the validity of the model.

Water Level Fluctuation Method

The water level fluctuation is a direct dependant on rainfall, infiltration and pumping. In the area of fractured terrain, the fluctuation trend would be entirely controlled by the general structural orientation of the aquifers, landforms, topographic lows, structural basins and in fact the fractures. The minimum variation of waterlevel defines the groundwater potential zones. Chatterjee and Purohit (2009) have used water level
fluctuation method for groundwater resource estimation by studying long term water level trend. The good aquifer will reflect low fluctuation in water level and more fluctuation at the area where the water potential is moderate.

The waterlevel data for about maximum of 120 months have been analyzed for thirteen wells in Salem block. The standard deviation of the water level from the average water level was calculated and correlated for the water potential of the region. Higher the deviations lower the water potential. The location of the well in the identified classes of water potential zones signifies that standard deviation 5 and above falls within low potential zones and standard deviation 2 to 5 fall within medium potential zones above 1 to 2 falls within high potential zone (Table 2).

Results and Discussion

The shear zones are the epitome of more than deformation events which instill an induced change in the secondary porosity of rocks. Otherwise the area of high grade rocks like granulites would provide little chance for the storage and migration of water. The assignment of weightage in the remote sensing based studies requires a better understanding of the terrain terms of lithology and their structural imprints. So in the regions with crisscrossing shear zones, higher priority must be given to the rocks rather than geomorphology.

The Attur valley geology comprises of charnockites, hornblende biotite gneiss, mylonites, mafic granulites, banded iron formations, ultramafics and younger alluvium. Charnockites and mafic granulate and iron ores form the high topography whereas gneisses forms the fringe of charnockite and valleys and plains.
The study area is characterized by the presence of a major shear zone viz., Salem-Attur shear zone, Gangavalli shear zone and many minor shear zones. Structural trendlines are very prominent on the hills and banded
magnetite quartzite, dykes and mafic granulites are good markers of trendline. The tracing of trendline reveals major folds in Kalrayan hills, Chitteri hills, Pachchai hills, Kanjamalai and Mulliyakarai hills. Fissility of the rocks is due to multi-phased deformation which allows the free flow of ground water.

Table 2  Well Locations with no. of observations, average water level and

<table>
<thead>
<tr>
<th>Standard deviationS.No.</th>
<th>Village</th>
<th>Longitude</th>
<th>Latitude</th>
<th>No. of observations</th>
<th>Average water level (m)</th>
<th>S.D</th>
<th>Ground Water Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Elampillai</td>
<td>78.01</td>
<td>11.60</td>
<td>120</td>
<td>9.07</td>
<td>6.60</td>
<td>Low Potential Zone</td>
</tr>
<tr>
<td>2</td>
<td>Attayampatty</td>
<td>78.07</td>
<td>11.53</td>
<td>120</td>
<td>11.72</td>
<td>7.27</td>
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</tr>
<tr>
<td>3</td>
<td>Pethampatty</td>
<td>78.04</td>
<td>11.64</td>
<td>120</td>
<td>11.44</td>
<td>4.45</td>
<td>Moderate Potential Zone</td>
</tr>
<tr>
<td>4</td>
<td>Vedukathampatty</td>
<td>78.08</td>
<td>11.65</td>
<td>120</td>
<td>5.06</td>
<td>2.96</td>
<td>Moderate Potential Zone</td>
</tr>
<tr>
<td>5</td>
<td>Ariyanur</td>
<td>78.08</td>
<td>11.59</td>
<td>64</td>
<td>5.75</td>
<td>3.89</td>
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<tr>
<td>6</td>
<td>Nalikkalpatty</td>
<td>78.13</td>
<td>11.60</td>
<td>120</td>
<td>10.78</td>
<td>4.49</td>
<td>Moderate Potential Zone</td>
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<tr>
<td>7</td>
<td>Panamarathupatti</td>
<td>78.17</td>
<td>11.56</td>
<td>120</td>
<td>17.22</td>
<td>10.16</td>
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<td>8</td>
<td>Kamalapatty</td>
<td>78.29</td>
<td>11.59</td>
<td>120</td>
<td>15.29</td>
<td>5.09</td>
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<tr>
<td>9</td>
<td>Vellalakundam</td>
<td>78.33</td>
<td>11.63</td>
<td>120</td>
<td>11.93</td>
<td>3.33</td>
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<tr>
<td>10</td>
<td>Kannankurichy</td>
<td>78.19</td>
<td>11.70</td>
<td>83</td>
<td>4.70</td>
<td>2.09</td>
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<tr>
<td>11</td>
<td>Tekkampatti</td>
<td>78.11</td>
<td>11.75</td>
<td>113</td>
<td>8.96</td>
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</tr>
<tr>
<td>12</td>
<td>Karuppur</td>
<td>78.09</td>
<td>11.72</td>
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<td>6.44</td>
<td>2.48</td>
<td>Moderate Potential Zone</td>
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<tr>
<td>13</td>
<td>Omalur</td>
<td>78.05</td>
<td>11.75</td>
<td>113</td>
<td>4.708</td>
<td>1.25</td>
<td>High Potential Zone</td>
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</tbody>
</table>
The present geospatial model used 9 thematic maps viz. lithology, geomorphology, lineament intersection, lineament frequency, lineament density, buffered structure and trend line, slope, drainage density and landuse / land cover for vector overlay. The resultant polygons were 2049 and scores are ranging from 141 to 534. The water potential map was prepared by dissolving all the 2049 polygons into six polygons based on the percentage of scores.

The resultant model was validated with a) iso-resistivity map of the area, b) water level stability c) transmissivity, permeability and specific yield (TKS) of the aquifers derived from pump test. Correlation of resistivity valleys with high potential areas and resistivity hills for low potential areas were observed for various depths like 30 m, 50 m, 80 m, 100 m and 150 m.

The Salem block as a study window displayed better correlation with the high TKS values with high water potential zones and low TKS value with low potential zones. Higher TKS values correspond to the high potential zones in the study window. Transmissivity (T) values are showing natural class matching with that of water potential zones. The ‘T’ value ranges from 0.23 sq.m/day to 6.21 sq.m/day falls within low potential zone; the values from 6.3 sq.m/day to 12.62 sq.m/ day fall within moderate potential zone and the values ranging from 13.27 sq.m/day to 37.48 sq.m/day fall within high potential zone. The values of permeability (K) range from 0.00705 to 0.03749 m/day are falling within low potential zone. The values above 0.11 m/day are falling within moderate and high potential zones. The relation between specific capacity (S) and the water potential zones show a coarse relationship in the present study as the terrain is characterized by fissile rocks and fractures.

The water level fluctuation data for 13 wells provided yet another confirmation of the spatial model generated for the study area. The standard deviation of the water level significantly represents the range of oscillations of water level and it is observed that the standard deviation is less than 2 for high potential zones. The standard deviation 2 to 5 was observed for wells falling on the moderate potential zones and above 5 to 10 is falling on the low potential zones.

Conclusion

The present geospatial model has been propagated for mapping of groundwater resources in crystalline terrain with shear zones like Attur valley. The enigmatic geologic history of Salem region with many shear zones influences the migration and accumulation of groundwater. The present geospatial model has emphasized the importance of lithology especially shear rocks which have penetrative foliations, influences the flow of water and trendlines (mostly representing dykes, banded magnetite quartzite and mafic granulites) and structures for their undisputed role in damming the migrating water. Highest priority is given to lithology along with other terrain parameters and successfully validated with ground truth data like resistivity, pump test and water level. The resistivity and pump test data reveals the aquifer characters and their suitability to hold water and stability of water level indicates the inter-connectivitvity of the secondary pores and water potential of the region. Minimum the water level deviation higher the water potential. The general grouping of the standard deviation of water level fluctuation matches with different classes of water potential zones and thereby confirms the validity of the present model for shear zone regions like Attur valley.

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