Mapping of Groundwater Potential Zones in the Kuzhithuraiyar Sub Basin of Kodayar River, Kanniyakumari District, Tamilnadu: Using Analytic Hierarchy Process (AHP) and GIS

Athsha Great Raxana. R*, Venkateswaran. S

Department of Geology, Periyar University, Salem-11, Tamil Nadu, India, athshagreat@gmail.com*

Abstract. Groundwater plays a very important role for all living beings. It is decisive to have a scientific understanding of groundwater management since, with careful use and replenishment, groundwater may help solve issues. The distribution of groundwater tables, slope, landform, drainage pattern, lithology, topography, geological structure, fracturing density, opening and connectivity of fractures, secondary porosity, and landuse landcover all affect the occurrence and efficiency of groundwater in an aquifer system. An essential tool for assessing, tracking and protecting groundwater resources is the integration of geospatial techniques such as Remote Sensing and Geographic Information System for the identification of groundwater potential zones. This study aims to find the groundwater potential zones using Analytical Hierarchy Process (AHP) and managing the resources by creating different thematic layers such as rainfall, geology, geomorphology, drainage density, soil, slope, lineament and landuse landcover (LULC) of the Kuzhithuraiyar sub basin of the Kodayar river in Tamilnadu using the application of geospatial technologies. The thematic maps for all the thematic layers have been prepared using tools such as Interpolation, contour lines, Classification in ArcGIS 10.8. Theme weight and class rank were assigned to different thematic layers in weighed overlay analysis. The results were validated through field work and groundwater potential map was created. The groundwater potential zonation mapping was done by the overlay analysis in ArcGIS 10.8 software. The obtained map was classified into four categories namely very high groundwater potential zone, high groundwater potential zone, medium groundwater potential zone, medium groundwater potential zone and low groundwater potential zone. The North Eastern part of the basin is considered as low groundwater potential zone while the Southern portion has high groundwater potentiality. The low groundwater potential zone covers an area of 10.58 sq.km and high groundwater potential zone covers an area of about 388.37sq.km. This study will be helpful for useful groundwater management for different tenacities.

Keywords: ArcGIS 10.8, DEM, ENVI, thematic maps, AHP, Groundwater potentiality
Introduction

One of the most precious natural resources is groundwater, which is a major source of water for human beings, animals, agriculture, cities, farms, and factories. In both urban and rural environments, groundwater is a significant natural source of fresh water for the distribution of water for consumption (Fashae et al., 2014). It becomes a crucial source of water supply in both urban and rural areas of any country due to its constant availability and outstanding natural quality (Todd & Mays, 2004; Hussein, et al., 2017). In comparison to surface water sources, groundwater development is more accessible, relatively less expensive, quicker to develop if ideal sites are found, and less prone to pollution (Jha & Chowdary, 2007; Talabi & Tijani, 2011; Ahmed et al., 2013; Ahmed & Mansor, 2018). Today, groundwater resources provide significantly more than 50% of residential water for cities and 85% of water for rural areas. In India, irrigation accounts for around 92% of groundwater extraction (Kolanuvada et al., 2019; Bera A et al., 2020). With 230 km³ of yearly groundwater extractions, India is the world’s largest consumer of this resource (Arkoprovo et al., 2013). According to the NITI Aayog (2018) research, 0.6 million people in India are under moderate to severe water stress as a result of poor freshwater management and availability (Murmu et al., 2019).

Water holding capacity of the area depends on the geo environmental factors such as rainfall, the only potential input source for replenishing groundwater; Drainage density, which regulates surface water infiltration via soil porosity as well as permeability; Lineament density regulates the flow of groundwater through geological breaks like faults or fracture systems and serves as conduits for groundwater storage (Krishnamurthy et al., 2000; Kanagaraj et al., 2019). The slope regulates the amount of surface water that seeps into aquifers; Permeability, which is directly related to the effective porosity of the soil and regulates the hydraulic conductivity of the aquifer material (Punmia & Jain, 2005). Land use and land cover affect how quickly surface runoff, infiltration, and groundwater are used. These factors include vegetation, water bodies, settlements, woods, etc.; Geology sheds light on the underlying rock strata, and the porosity of a rock dictates how well water may permeate it; Geomorphological features give information on the surface landforms; undulations and sinks control surface water flow, and the texture of the soil dictates how well it can be infiltrated. The aforementioned data is utilised to determine the groundwater potential zones and has been accounted for by numerous scientists (Nagarajan & Singh, 2009; Dar et al., 2010; Oh et al., 2011; Magesh 2012; Bagyaraj et al., 2013; Nag & Ghosh, 2013; Kumar et al., 2014; Manap et al., 2014; Elmahdy & Mohamed, 2014; Nampak et al., 2014; Rahmati et al., 2015; Kaliraj et al., 2015; Selvam et al., 2015; Rahmati et al., 2016; Senanayake et al., 2016; Yeh et al., 2016; Selvarani et al., 2016).

Combining Remote Sensing (RS) and Geographic Information Systems (GIS) has proven to be a successful, quick, and affordable method for producing valuable data on geology, geomorphology, lineaments, slope, as well as a methodical combining of these data for exploring and defining groundwater potential zones (Prasad, et al., 2008; Fashae, et al., 2014). GIS is a potentially efficient technique for handling massive amounts of geographical data and can be applied in a variety of sectors, including groundwater potential zone delineation and water resource management (Fashae, et al., 2014). Therefore the current study’s objective is to identify groundwater potential zones utilizing geospatial approaches and several impacting elements, and to validate the findings through field validations. This study concentrates on Geological, Geomorphological, Drainage density, Rainfall, Slope, Lineament and Landuse and landcover characteristics of the Kuzhithuraiyar sub basin.

Study area

The study area is located at the South Western tip of the Indian Peninsula (Fig. 1). During the pre monsoon period the water level in the Alluvium ranges from 1.49m to 16.14 m bgl, in charnockite water ranges from 2.48 to 10.04 m bgl, in the garnet sillimanite graphite gneiss water ranges from 2.34 to 10.61 m bgl, in garnet biotite gneiss the water level

Ключові слова: ArcGIS 10.8, DEM, ENVI, тематичні карти, AHP, потенціал підземних вод
ranges from 4.74 to 15.22 m bgl on the other hand during post monsoon the water level in the Alluvium ranges from 0.44 to 12.95 m bgl, in charnockite water ranges from 1.97 to 7.24 m bgl, in the garnet sillimanite graphite gneiss water ranges from 1.25 to 8.98 m, in garnet biotite gneiss the water level ranges from 3.93 to 13.68 m bgl (CGWB 2012).

Materials and Methods

Data collection

The factors such as geomorphology, geology, lineaments, land use, land cover, and drainage that influence and alter the occurrence, and movement of groundwater were quantified using satellite data and GIS methods. Maps of geology and geomorphology were collected from the Geological Survey of India’s Bhukosh site Geoscientific Data. The lineament map was obtained using a thematic service of the Indian Geo-Platform of the ISRO (Bhuvan) portal. LANDSAT imagery was downloaded from the United States Geological Survey (USGS) website and digitized using ENVI to create LULC maps. The United States Geological Survey (USGS) portal’s SRTM Digital Elevation Model data was used to create a slope map. Toposheets were taken from the Survey of India portal to create the drainage map. Using the rainfall data published by the Water Resources Organization, Tamil Nadu, India, an isohyetal map was created. ArcGIS 10.8 software was used to digitize and produce all of the theme maps. Groundwater Recharge Potential Zones were found by overlaying all the thematic maps.

Generation of thematic maps

Rainfall

The average annual rainfall of the past five years from 2017 to 2021 was obtained from Public Works Department (PWD). The monthly rainfall data were calculated and converted to annual rainfall data. The average annual rainfall data were used to prepare an isohyetal map using spline tool and contour tool in ArcGIS 10.8 at a contour interval of 10mm.

Geology

A map of geology at a scale of 1:50000 were collected from the Geological Survey of India’s Bhukosh site Geoscientific Data and the Geology of the study area was extracted using ArcGIS10.8.

Geomorphology

Geomorphology map was collected from the Geological Survey of India’s Bhukosh site Geoscientific Data and was extracted using ArcGIS 10.8.

Drainage density

Runoff will be higher and infiltration capacity will be lower if the drainage density is higher (Prasad, et al. 2008; Thomas, et al. 2012; Raxana & Venkateswaran, 2023). The drainage map was obtained by tracing the drainage networks in the toposheets using ArcGIS 10.8. Drainage density was calculated using the ratio between the stream length and basin length. The results were divided into four classes low, medium,
high and very high based on their drainage density. The results were computed in ArcGIS 10.8 software and spatial distribution map was developed.

**Soil**

Soil map was obtained from National Bureau of Soil Survey and Land Use planning. The obtained map was digitized using ArcGIS 10.8.

**Slope**

One important component influencing surface water infiltration into the subsurface and determining whether groundwater recharge is appropriate is slope (Kumar, et al., 2022). The slope map was extracted from Digital Elevation Model (DEM) obtained through United States Geological Survey (USGS) and digitized using ArcGIS 10.8.

**Lineament**

The lineament map obtained through Indian Geo-Platform of the ISRO (Bhuvan) portal was digitized using ArcGIS 10.8.

**Land use land cover**

The satellite image of LANDSAT 8-9 OLI/TIRS Sensor of 30m resolution acquired on March 22, 2022 obtained through United States Geological Earth Explorer (USGS) was used for creating Landuse Landcover map. Supervised classification method with Maximum Likelihood classification technique was used for the landuse landcover classification.

**AHP Technique using multi-IF factor**

In this study major groundwater influencing factors such as Rainfall, Geology, Geomorphology, Drainage density, Soil, Slope Lineament density, and, Landuse landcover are related with each other. Each factor has given score according to their influence on groundwater. Weight was assigned according to the major and minor relationship that is 1.0 and 0.5 respectively (Shaban et al., 2006 and Yeh et al., 2009). The proposed score of each influencing factors were calculated by using the formula 1.

Proposed score of each influencing factor: $$\frac{A + B}{2(A+B)} \times 100$$  (1)

where: A – the major effect

B – the minor effect

All the influencing factors were subjected to weightage overlay analysis in ArcGIS 10.8 and the Groundwater recharge potential zone were identified.

**Results and discussion**

**Multi-IF analysis**

In the year 1990 Saaty first suggested AHP method to identify probable groundwater recharge zones (Saaty, 1990). Weights were assigned during the weighted overlay analysis in accordance with the multi-IF of each individual parameter of each thematic map and the hydro-geological environment of the study area (Shaban et al., 2006; Yeh et al., 2009; Adham et al., 2010; Singh et al., 2011; Magesh et al., 2012; Gunma and Pavelic, 2012; Selvam et al., 2015b; Selvam 2015a; Samson and Elangovan 2015; Ghosh Prasanta Kumar et al., 2016). Weightage is given based on the goal of this study which is groundwater potential zone. All the criteria for the present goal are related to each other. The direct relationship factor which affects the groundwater potentiality is assigned as 1 and indirect relationship factor is assigned as 0.5. The relative weightage for each factors are shown in the Table 1. The reclassified influencing factors were sub divided into sub factors (Table 2).

**Rainfall**

The maximum rainfall of the Kuzhithuraiyar sub basin is 1170mm and minimum rainfall is 672.5mm with an average of 1000.5mm (Fig.2). The region experiences both South West (June to September) and North East monsoon (October to Mid of December). The rainfall distribution map implies that the NNW region experiences the highest rainfall followed by SSW, SSE and NE region receives the lowest rainfall. The precipitation trend is from the center of the basin towards the North West direction. The area is divided into five classes namely Low rainfall, Moderate rainfall, high rainfall and very high rainfall. About 16.84 sq.km receives low rainfall, 231.89 sq.km receives moderate rainfall, 208.99 sq.km receives high rainfall and 279.93 sq.km receives very high rainfall.

**Geology**

Geology plays a vital role in the groundwater conditions of the area (Rajaveni SP et al., 2017). Nine different types of Geology are found in the study area which includes Garnet biotite graphite gneiss (315.74 sq.km), Garnet biotite gneiss (305.43 sq.km), Charnockite (84.18 sq.km), sand silt with clay partings (8.75 sq.km), sandstone with clay intercalations (8.11 sq.km), granite (6.89 sq.km), Gabbro (3.33 sq.km) and sand silt with clay (0.62 sq.km) Spatial distribution of the different types of Geological units/ rock types are shown in Figure. 3. Metamorphic rocks cover the major portion of the basin followed by unconsolidated sediments/ sedimentary rocks and igneous rocks. Sedimentary rocks are good source of water because they have high porosity and permeability whereas metamorphic and igneous rocks are permeable only when they are weathered and fractured. Gneissic rock of this area have lineament which is responsible for good groundwater po-
tentuality. By nature Charnockite formation have low infiltration whereas alluvium deposits have high infiltration rate (Kanagaraj et al., 2019).

**Hydrogeomorphic units**

The study area is divided into five geomorphological units namely Alluvial plain, Coastal plain, Denudational hills, Pediplain and Structural Hills. The spatial distribution of different geomorphic units are structural hills covers an area of 466.29 sq.km, Pediplain covers an area of 264.71 sq.km, Denudational hills covers an area of 5.34 sq.km, Coastal plain covers an area of 1.21 sq.km and Alluvial plain covers an area of 0.09 sq.km (Fig. 4). The structural hills have slight to no chance of having ground water because most of the rain that falls on them runs off as surface runoff. At the base of mountain ranges, as water and wind slowly erode and disintegrate rock surfaces, they generate a succession of pediments. These
pediments gently slope outward, until they join with one another to form a single huge plain, or pediplain. Alluvial plain are found adjacent to the river where periodic inundation happens and it is composed of unconsolidated sediments. Coastal plains are low lying area adjacent to sea. The significant hydrogeomorphic units are Alluvial plain, coastal plain, denudational hills and pediplains which covers an areal extent of 271.36 sq.km.

Drainage pattern

The tributaries unite the main river at acute angle which means less than 90 degree and looks like branches of trees hence, it is identified as dendritic and sub- dendritic drainage pattern. The drainage density (Fig.5) of the sub basin ranges from 1.35 to 3.47km/ km². The low drainage density is found in SW and SE portion of the sub basin. Moderate drainage texture is found in hilly terrain Northern direction of the basin.

Fig. 4. Geomorphology map of Kuzhithuraiyar Sub basin

Fig. 5. Drainage density map of Kuzhithuraiyar Sub basin
whereas Eastern portion shows high drainage density. High drainage density indicates low infiltration of water whereas low drainage density indicates high infiltration of water. Therefore, the downstream portions have high infiltration than upstream region.

**Soil**

The characteristics that define groundwater infiltration and quality are heavily influenced by soils, which can both positively or negatively impact groundwater recharge. The study area is mostly covered by reserved forest which is 374.77 sq.km followed by inceptisol 203.4 sq.km, Alfisols 106.44 sq.km, Hill soil 30.65 sq.km and entisols 22.39 sq.km (Fig.6). Inceptisols are soils with textures finer than loamy sand. Alfisols form in loamy parent materials that are not too sandy or too clayey under semiarid to humid areas. Entisols are sandy, mineral soils with low levels of organic matter, natural fertility, and water-holding capacity (Weil, & Brady, 2016). Hill soils have sand as dominant particle in it. Infiltration rate will be high for sandy soil than clayey soil due to high porosity and permeability of sand and high porosity and absence of permeability in clay.

**Slope**

The research region is made up of three different types of landforms: uplands with hills, middle lands with plains and valleys, and low lands with the coastal belt. The slope controls the rate of surface water infiltration and runoff; flat surfaces can hold and drain water inside the ground, which can improve groundwater recharge; steep slopes increase runoff and limit surface water infiltration into the ground (Deepa, 2016). The slope of the basin is divided into seven classes such as flat (0-2 degrees), very gentle (2-4 degrees), gentle (4-8 degrees), moderate (8-16 degrees), moderately steep (16-30 degrees), steep (30-50 degrees) and very steep (>50 degrees). South Western portion of the basin is nearly flat and gentle while the other portions of the basin are moderately steep to very steep (Fig. 7).

**Lineament**

A zone with considerable groundwater potential is indicated by a high lineament-length density, which implies a high secondary porosity (Yeh et al., 2009; Shah & Lone, 2019). The lineament density map is shown in the Fig. 8. Maximum lineament density and intersection of lineament regions are better potential for groundwater occurrence because they are more amenable to infiltration and recharge (Bhuvaneswaran et al., 2015). Therefore, maximum lineament density is found across the major water body Perunchani Lake in the North Eastern part of the study area.

**Landuse and Landcover**

This study is based on Normalized Difference Vegetation Index (NDVI). It is divided into nine Landuse (LU) Landcover (LC) classes which include barren land, built-up land, crop land, dense forest, fallow land, grass land, open forest, shrub land and water bodies (Fig. 5). The classification was done using ENVI Software based on Maximum Likelihood
Fig. 7. Slope map of Kuzhithuraiyar Sub basin

Fig. 8. Lineament density map of Kuzhithuraiyar Sub basin

Classification (MLC). Light to medium red colour and fine to medium texture were used to identify crop land; medium to rough wood colour and texture were used to identify fallow land; and dark red colour and fine texture were used to identify plantations (Lone et al., 2013; Rajaveni et al., 2017). These are regarded as excellent potential groundwater prospect sites (Varughese et al., 2012; Rajaveni et al., 2017). Water bodies were shown in black tone and are for high groundwater potential zones (Chipman & Lillesand, 2007; Rajaveni et al., 2017). Forest plantings had an uneven form, a fine medium texture, and a light reddish brown tone (Kumar et al., 2008; Rajaveni, et al., 2017). Because groundwater is not being drawn from this property, even though forest regions may have significant groundwater recharge, their groundwater potential is poor (Magesh et al., 2012; Rajaveni, et al., 2017). Built-up land appeared as a pale blue white.
with fine texture and a regular shape and size, while wasteland was distinguished by a light to dark bluish tone and coarse texture (Lillesand et al., 2007; Rajaveeni et al., 2017). This study indicates that the Northern portion is of open forests, dense forest, shrub land, grass land, fallow land, barren land, water bodies, built-up land, while the southern portion is of fallow land, grass land, built-up land and water bodies.

**Weightage analysis of the Groundwater influencing factors using AHP**

In the year 1990 Saaty first suggested AHP method to identify probable groundwater recharge zones (Saaty, 1990). Weights were assigned during the weighted overlay analysis in accordance with the multi-IF of each individual parameter of each thematic map and the hydro-geological environment of the study area (Shaban et al., 2006; Yeh et al., 2009; Adham et al. 2010; Singh et al., 2011; Magesh et al., 2012; Gumma and Pavelic, 2012; Selvam et al., 2014, 2015a; Selvam et al., 2015b; Samson and Elangovan, 2015; Prasanta Kumar Ghosh et al., 2016). Weightage is given based on the goal of this study which is groundwater potential zone. All the criteria for the present goal are related to each other. The direct relationship factor which affects the groundwater potentiality is assigned as 1 and indirect relationship factor is assigned as 0.5. Rainfall is classified into four classes: low, moderate, high, and very high. In this case, low rainfall indirectly affects the groundwater potential. Hence, the relationship factor is assigned as 0.5, and the other three classes are considered direct factors, with the relationship factor as 1 for the other three parameters. Geology is classified into nine, where all the geological units have a direct influence on the groundwater potential, and hence each unit is assigned 1 as the relationship factor. Geomorphology is classified into five geomorphological units, in which structural hills are assigned 0.5 due to poor to nil groundwater potentiality. In terms of drainage density, low drainage density has a high infiltration capacity, so the relationship factor is assigned as 1 due to its direct influence on groundwater potentiality. In hilly soil, the infiltration rate will be higher for sandy soil than clayey soil due to the high porosity and permeability of sand and the high porosity and absence of permeability in clay. Hence, 1 is assigned as a relationship factor. Other soil types have indirect relationships; hence, the other three types are considered to be 0.5 each. 0° to 4° and 4° to 16° are considered 1 each, and 16° to 50° and more than 50° are considered 0.5 each. For very low and low lineament density, 0.5 is assigned, and for medium and high lineament density, 1 is assigned. Landuse landcover is classified into nine classes, where 0.5 has been assigned for two factors: built-up and barren land. The relative weightage for each factors are shown in the Table.1. The reclassified influencing factors were sub divided into sub factors (Table 2).

![Fig. 9. Landuse Landcover map of Kuzhithuraiyar Sub basin](image)
Table 1. Relative weight of each factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>Proposed score of each influencing factor</th>
<th>Minor effect (B)</th>
<th>A+B</th>
<th>Major effect (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall</td>
<td></td>
<td>0.5</td>
<td>3.5</td>
<td>1+1+1</td>
</tr>
<tr>
<td>Geology</td>
<td></td>
<td>9</td>
<td>9</td>
<td>1+1+1+1+1+1+1+1+1</td>
</tr>
<tr>
<td>Geomorphology</td>
<td></td>
<td>0.5</td>
<td>4.5</td>
<td>1+1+1+1</td>
</tr>
<tr>
<td>Drainage density</td>
<td></td>
<td>0.5+0.5+0.5</td>
<td>2.5</td>
<td>1</td>
</tr>
<tr>
<td>Soil</td>
<td></td>
<td>0.5+0.5+0.5</td>
<td>2.5</td>
<td>1</td>
</tr>
<tr>
<td>Slope</td>
<td></td>
<td>0.5+0.5</td>
<td>4</td>
<td>1+1</td>
</tr>
<tr>
<td>Lineament density</td>
<td></td>
<td>0.5+0.5</td>
<td>3</td>
<td>1+1</td>
</tr>
<tr>
<td>Landuse landcover</td>
<td></td>
<td>0.5+0.5</td>
<td>8</td>
<td>1+1+1+1+1+1+1+1+1</td>
</tr>
</tbody>
</table>

\[ \sum (A + B) = 37 \]

Table 2. Theme weight and class rank assigned to different thematic layers in weighed overlay analysis

<table>
<thead>
<tr>
<th>Geo-environmental factors</th>
<th>Classes</th>
<th>Proposed score of each influencing factor</th>
<th>Individual rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall</td>
<td>High</td>
<td>9.5</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td></td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>Very low</td>
<td></td>
<td>1.2</td>
</tr>
<tr>
<td>Geology</td>
<td>Charnockite</td>
<td>17.2</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Clayey sand</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Gabbro</td>
<td></td>
<td>19.4</td>
</tr>
<tr>
<td></td>
<td>Garnet Biotite gneiss</td>
<td></td>
<td>18.3</td>
</tr>
<tr>
<td></td>
<td>Garnet biotite graphite gneiss</td>
<td>24.3</td>
<td>16.1</td>
</tr>
<tr>
<td></td>
<td>Granite</td>
<td></td>
<td>20.5</td>
</tr>
<tr>
<td></td>
<td>Sand, silt with clay partings</td>
<td></td>
<td>22.6</td>
</tr>
<tr>
<td></td>
<td>Sand silt with clay</td>
<td></td>
<td>24.7</td>
</tr>
<tr>
<td>Geomorphology</td>
<td>Alluvial plain</td>
<td>12.2</td>
<td>9.2</td>
</tr>
<tr>
<td></td>
<td>Coastal Plain</td>
<td></td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>Denudational Hills</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Pediplain</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Drainage density</td>
<td>Very low</td>
<td>6.8</td>
<td>6.8</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td></td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>Soil</td>
<td>Alfisols</td>
<td>6.8</td>
<td>6.8</td>
</tr>
<tr>
<td></td>
<td>Entisols</td>
<td></td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td>Hill Soil</td>
<td></td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>Inceptisols</td>
<td></td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>Reserved Forest</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Slope</td>
<td>Flat</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Gently Slope</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Sloping</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Moderately steep</td>
<td>10.8</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Steep</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Very Steep</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Lineament density</td>
<td>Very low</td>
<td>8.2</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
<td>6.1</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td></td>
<td>4.09</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td>2.08</td>
</tr>
<tr>
<td>Landuse landcover</td>
<td>Barren land</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Built-up land</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Crop land</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Dense forest</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Fallow land</td>
<td>21.6</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Grass land</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Open forest</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Shrub land</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Water body</td>
<td></td>
<td>22</td>
</tr>
</tbody>
</table>
Field validation

After the creation of thematic maps a field validation has been carried out. Global positioning System (GPS) was used to compare the thematic maps with the real-world environment. The comparison with the real world environment gave better accuracy level.

Groundwater potential zone mapping

The groundwater potential zone was obtained by overlapping all the nine thematic maps in ArcGIS 10.8. The Groundwater recharge potential zone was divided into four classes viz., low, moderate, high and very high (Fig. 10). High groundwater potential covers 388.37 sq.km of the area followed by Moderate groundwater potential zone covers an area of 186.82 sq.km, Very high groundwater potentiality covers an area of 151.88 sq.km and low groundwater potential zone covers an area of 10.58 sq.km.

Conclusion

From this study it is evident that the downstream portion of the sub basin is potential for good groundwater resources. The geology and geomorphology of the area shows that the South Western portion has unconsolidated sediments such as sand silt with clay partings, Clayey sand and sand silt with clay, sedimentary rock such as sandstone with clay intercalations and pediplain, patches of structural hills, alluvial plain and coastal plain which are capable of holding sufficient amount of groundwater. While comparing the rock units and geomorphological units other regions such as igneous and metamorphic rocks, structural hills, denudational hills, Northern portion is not capable of holding more water. The upland regions have steep slope than the plains. Even though the North Eastern corner of the study area is of heavy rainfall it has medium groundwater potentiality due to high degree of slope, high drainage density, absence of lineament and hard and compact rocks. The upstream of the river is having least groundwater potentiality due to the presence of igneous and metamorphic rocks combined with steep slope and high drainage density. The downstream regions are lowlands with gentle slope to nearly flat lands and less drainage density where the water can get more residence time than the uplands. The very high groundwater potential zone is found around the water bodies such as lower Kodayar, Chittar-I, Chittar-II and Perunchani lakes followed by high groundwater potential regions along the downstream, medium groundwater potential zone is found in the hilly Northern terrain and near the South Western portion and low potential zone is found as small patches in the South Western portion. As per the groundwater potentiality theme rank assigned for the North Eastern potion has less groundwater potentiality with rank 4 followed by South Western region rank 3, and both North West and South East portion has good potentiality with Rank 1. The greater portion of the study area shows high groundwater potentiality. Fieldwork was carried
out to validate the results. In order to ensure long-term sustainability, concerned decision makers can create an effective groundwater utilization plan for the research region. This empirical approach successfully suggests prospective locations for groundwater zones while employing remote sensing and GIS to explore potential groundwater zones.

References


Acknowledgment

My profound gratitude goes out to the Department of Geology. DST-FIST Sponsored, for giving me an opportunity to do my research with the financial assistance of a Periyar University University Research Fellowship (URF).


Samson S, Elangovan K (2015) Delineation of groundwater recharge potential zones in Namakkal District, Tamilnadu, India using remote sensing and GIS. J In-