IDENTIFICATION OF GROUNDWATER POTENTIAL ZONES USING ARCGIS 10.1

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Abstract- A case study was conducted to find out the groundwater potential zones in Dodahalla Watershed, Belagavi and Karnataka, India with an aerial of 320.20 km². The thematic maps such as geomorphology, land use / land cover, slope, soil, lithology and drainage map were generated for the study area. The groundwater potential zones are generated by overlaying all the thematic maps in terms of weighted overlay method using the spatial analysis tool in ArcGIS 10.1. During weighted overlay analysis the ranking has been given for each individual parameters of each thematic map and weights were assigned according to the influence such as geomorphology-25%, land use / landcover-20%, slope-15%, soil-20%, lithology-10% and drainage-10% and the potential zones were identified in terms of good, moderate, poor, very poor zones with an area 0.346469 km², 273.6149km², 43.2184km² and 1.208018km² respectively.

I. INTRODUCTION

Water, the most existing resource on the earth, which is also essential for life. While all the water present on the earth is not good for consumption, its quality takes the first feature for making it consumable. Ground water is the ‘God gift’ natural source for living things for their life survive. Ground water is a precious and the most widely distributed resource of the earth and unlike any other mineral resource, it gets its annual replenishment from the meteoric precipitation. The world’s total water resources are estimated at 1.37 * 109 million ha-m. Of these global water resources about 97.2% is salt water mainly in oceans, and only 2.8% is available as fresh water at any time on the planet earth. Out of this 2.8%, about 2.2% is available as surface water and 0.6% as ground water. Even out of this 2.2% of surface water, 2.15% is fresh water in glaciers and icecaps and only of the order of 0.01% is available in lakes and reservoirs, and 0.0001% in streams; the remaining being in other forms -0.001% as water vapors in atmosphere, and 0.002% as soil moisture in the top 0.6m. Out of 0.6% of stored ground water, only about 0.3% can be economically extracted with the present drilling technology, the remaining being unavailable as it is situated below a depth of 800m (H M Raghunath, 2006).

Groundwater resources are an important natural resource for its use in domestic, agriculture, and industries purposes. There has been a tremendous increase in the demand for groundwater due to increase in population, advanced irrigation practices and industrial usages. Groundwater is a significant natural resource in present day, but of limited use due to frequent failures in monsoon, undependable surface water, and rapid urbanization and industrialization have created a major risk to this valuable resource (Ramamoorthy, et al., 2015).

The occurrence of groundwater at any place on the earth is not a matter of chance but a consequence of the interaction of the climatic, geological, hydrological, physiographical and ecological factors. Groundwater exploration operation is essentially a hydro geological and geophysical inference operation and is dependent on the correct interpretation of the hydrological indicators and evidences (Biswa Arkoprovo, et al., 2012).

Geographical Information system, also called geo-based information system (GIS), is relatively new technology. It is a very powerful tool for processing, analyzing and integrating spatial data sets. ArcGIS deals with information on location patterns of features and their attributes. It can be considered a higher order computer coded map which permits storage, selective dedicated manipulation, display and output of spatial information. GIS has become a standard, indispensable, tool for handling spatial information for the exploration, development and management of the Earth’s resources.

Consequently, integration of remote sensing (RS) and geographic information system (GIS) has proven to be efficient, rapid and cost effective technique producing valuable data on geology, geomorphology, lineaments and slope as well as a systematic integration of these data for exploration and delineation of groundwater potentials zones (Olotuyin A. Fashae, et al., 2014). With the advent of remote sensing and Geographic Information System (GIS) technologies, the mappings of groundwater potential zones within each geological unit have become an easy procedure (Naveenkumar, et al., 2015).
MATERIAL AND METHODS

Study area
The Ramdurg and Gokak taluka is located in the Belagavi district of Karnataka state having geographical area of 1215.42 km$^2$ and 1543.08 km$^2$ (CGWB, 2007). It is economically backward and located in the eastern part of Belagavi district. The river Malaprabha flows in this taluka from west to east, which provides water to 30 villages of taluk for irrigation. Dodahalla watershed falls in between the Ramdurg and Gokak taluka. Since the water quality of this study area is very poor as per Mines and Geology department and also exploitation of ground water is more in this particular watershed (CGWB, 2007). Also, average stage of development is more in Ramdurga and Gokak (CGWB, 2007). These reasons have initiated to take up this study area.

Dodahalla watershed falls in Ghataprabha basin. The watershed lies at latitude of 16°03’ to 16°16’ N and longitude 75°04’ to 75°16’ E with an aerial extent of 320.20 km$^2$ shown in Fig.1.

Spatial data
Geomorphology map, Land use/Land cover map, Slope map, Soil map, Lithology map, and Drainage map were used in the analysis.

Physiographic characteristics

Geomorphology
The types of geomorphology parameters were found to be plains, hills and plateaus, River/stream and piedmont zone respectively.

Land use/land cover
Four types of land use pattern were identified in the entire study area, which includes agricultural land, water bodies, wastelands and built-up land.

Soil
Two type of soil are present in entire study area. Major portion is cover with clayey soil and less area cover with loamy soil.

Lithology
Lithology is a very important aspect in predicting groundwater potential zones (Biswa Arkoprovo, et al., 2012). There are six types of lithological formation falling in study area, they are: Argillite, Quartzite, Conglomerate, Dolomite, Arenite and Limestone.

Slope
Slope always plays a crucial role in groundwater potential mapping (Biswa Arkoprovo, et al., 2012). The area is dividing into six ranges which are varying from 0-35%.

METHODOLOGY

The methodology adopted to generate Groundwater potential mapping is shown in Fig. 2.

Preparation of thematic maps
The following maps were scanned; geo-referenced and supervised classified the study area using ArcGIS 10.1. The thematic maps include- 1. Geomorphology map 2. Slope map 3. Soil map 4. Lithology map 5. Land use/Land cover map 6. Drainage map.

GIS database development
The features of the study area such as soil type, slope map, land use pattern and drainage pattern, Geomorphology and lithology were obtained and all the thematic maps are subjected to supervised classification and attributes were generated for each thematic map. Generated thematic maps are overlay using weighted overlay method in spatial analyst tools.

Assessment of groundwater potential zones
The groundwater potential zones were obtained by overlaying all the thematic maps in terms of weighted overlay methods using the spatial analysis tool in ArcGIS 10.1. During the weighted overlay analysis, the ranking has been given for each individual zone.
parameters of each thematic map and the weightage were assigned according to the influence of the different parameters. Weightages are given in the order of 1 to 5. Higher weightage i.e., 5 (five) is given to higher influence for groundwater recharge and lower weightage i.e., 1 (one) for less recharging area which is presented in Table 1.

Table 1 Rank and Weightage of different parameters for ground water potential zones

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Criteria</th>
<th>Weights (%)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Geomorphology</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>Land use/Land cover</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Soil</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>Slope (%)</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>Drainage</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Lithology</td>
<td>10</td>
</tr>
</tbody>
</table>

RESULT AND DISCUSSIONS

Initial the maps collected were geo-referenced and supervised classification was adopted to prepare different thematic maps using ArcGIS 10.1

Soil group
Study area consists mainly two type of soil in that clayey is predominant soil group, followed by loamy soil group. Based on the two types of soil group the study area consists of moderate clayey soil infiltration and runoff less which is shown in Fig.3.

Land use/Land cover
Land use/land cover map which is shown in Fig.4. There are four types of land use patterns identified in the entire study area. Viz., agricultural land, water bodies, wastelands and built-up land. Agriculture land is predominant land use type in the study area.

Geomorphology
There are four types of geomorphologic features were found in the study area namely plains, hills and plateaus, river/stream and piedmont zone. The maximum area is covered with plains, hills and plateaus. Geomorphology map is shown in Fig.5.

Slope
Slope is the one of the characteristic of the terrain. Lower slope values indicate the terrain is flat and higher slope values indicate the steep terrain. Percentage of slope was found to be 0 to 35%. More than 60% of the area falls in 10% slope group. Slope Map is shown in Fig.6.
Lithological

Entire area is cover with sedimentary rock formation. This again classified to six groups in that undifferentiated flows and dolomite, limestone and argillite rocks are the predominant lithological types in the study area, lithology map shown in Fig.7.

Drainage

A drainage basin is a natural unit draining runoff water to a common point. Drainage network helps in delineation of watershed. Drainage density and type of drainage gives information related to runoff, infiltration relief and permeability (M.L.Waikar, et al., 2014). The study area is third order basin joining the rivers, tributaries based on topography depicted in Fig.7.

Groundwater potential mapping

All the thematic maps were converted into grid (raster format) and superimposed by weighted overly method (rank and weight wise thematic maps and integrated with one another through ArcGIS). Ground water potential zones which are shown in Fig.9.

Table 2.2. Groundwater potential zones of study area

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Potential zones</th>
<th>Area (km²)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Good</td>
<td>0.346469</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
<td>273.6149</td>
</tr>
<tr>
<td>3</td>
<td>Poor</td>
<td>43.21841</td>
</tr>
<tr>
<td>4</td>
<td>Very poor</td>
<td>1.208018</td>
</tr>
</tbody>
</table>
CONCLUSION

In the present study, GIS technique has been successfully adopted and used for the evaluation of groundwater potential zones of the Dodahalla watershed. Use of weighted overlay method was found to be very useful in mapping groundwater potential zones of the study area. In the present case, four categories of groundwater potential zones have been identified by the above said method with the help of GIS. The four categories are: Good, Moderate, Poor and Very poor. From the resulted map we can conclude that the Maximum groundwater potential zone lies in the Moderate zone. From this study, it is suggested to change of agricultural pattern as the present agricultural pattern fails due to the lack of water availability.

REFERENCES


