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Original Research Paper

Groundwater Development Studies Using Remote Sensing and GIS Techniques in Drought Prone area of Chamarajanagar District, Karnataka, India

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ABSTARCT

While water supply is a crucial issue, there is an evidence to suggest that the quality of groundwater supplies is also under threat in recent years. This is the result of salinisation and increasing trend of groundwater exploitation and heterogeneous terrain condition of hard rock area posing major problem in groundwater exploration. Groundwater exploitation has been on the rise in Chamarajanagar district, Karnataka. Competing demands have grown in face of perennial water shortages, a situation which has been exaggerated by drought condition in the past decade. Integrated and environmentally sustainable development strategies have become inevitable for micro-level planning these days. Geographic Information System (GIS) was used for spatial analysis and integration. Geomedia Professional 5.1 GIS software was adopted in this process. The ranked maps were spatially integrated and the district area was divided into very good, good, moderate and low groundwater potential zones. Aquifer thickness map was generated by intersection of well inventory, sub-surface geological, geophysical and groundwater potential data. Based on aquifer thickness, aquifer was categorized into deep aquifer, shallow aquifer and moderately deep aquifer. By combining groundwater potential zone and aquifer thickness, the watershed area was reclassified into eleven priority zones, recommended for different agricultural practices, groundwater development and management of aquifer recharge.

INTRODUCTION

Increasing population and modern industrial and agricultural activities not only create more demand for groundwaters, but are also pollute them by releasing untreated wastes. There in an increase of researches not only on groundwater resources, but also on locating groundwater of good quality for human consumption (Change et.al 2002). Integrated studies using remote sensing and GIS based groundwater development study are very useful for processing and interpretation of groundwater development studies in Chamarajanagar district, Karnataka, India.

STUDY AREA

The study area consists of four taluks of which Kollegal, Chamarajanagar, Gundlupet and Yelandur fall under hilly terrains, which are part of Eastern Ghats. The study area is 5686 sq km located between 11°30'-12°15' latitude and 76°30' -77°15'longitude (Fig. 1). The area is accessible by good roads and is very well connected by Mysore to Chamarajanagar railway line. The total population is 7,68,198. The main occupation is agriculture and marketing, and the farmers are dependent upon canal irrigation and at places by groundwater. There are 29 rain gauge stations and the area receives an average annual rainfall 822 mm.

Data used and methodology: Field studies were conducted and corrections were made accordingly to maps of geology, lineaments and hydrogeomorphology using remote sensing data in combination with available toposheets, geological maps, field data on fracture orientation, and water table elevation data were used for this integrated approach. Generated outputs are: drainage, drainage density, micro watershed, density and structural maps from satellite data; geology map from GSI data (1969). These parameters were found to be significant towards evolving the management priorities. Ranks and weightages were assigned for each parameter depending on their influence on the movement and storage of groundwater. (Eastman 1995). Geographic information system was used for the spatial analysis and integration. Geomedia Professional 5.1 GIS software was adopted in this process. The IRS ID LISS III satellite data dated May 22, 2003, acquired form National Remote Sensing Agency (NRSA), was used for the study. Histogram equalization, FCC, Principal Component Analysis (PCA), supervised classification (maximum likelihood) and band ratioing were performed and used for preparation of various thematic maps

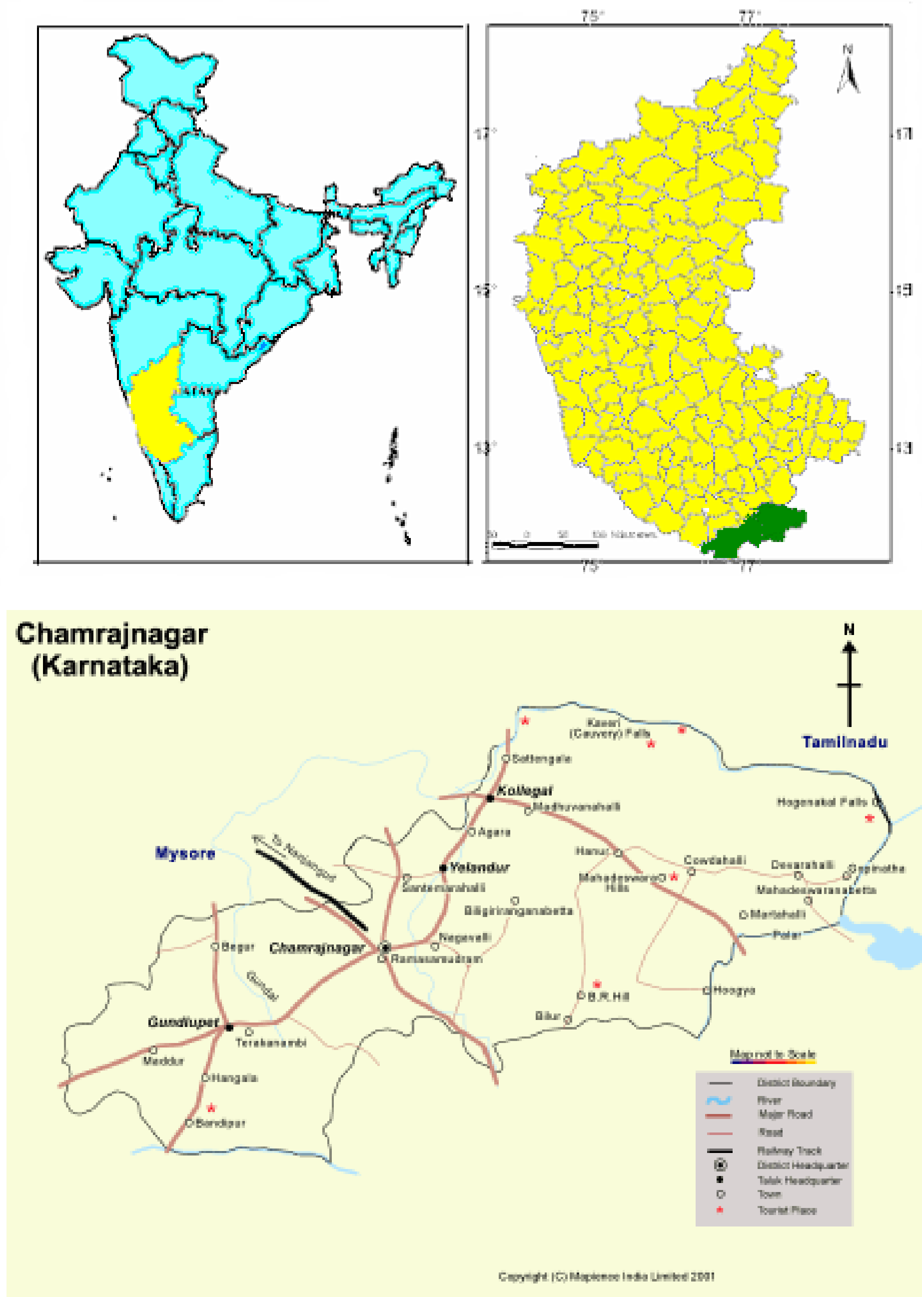

Fig.1: Location map of the study area.

like hydrogeomo-rphology, lineament, structural, and land use/land cover map.

Land use/land cover mapping: The land use/land cover study was made elaborately using the FCC. In this context, the SOI topo map and field knowledge were used and different land use/land cover features were interpreted with the help of specific tonal and textural characteristics of the features. The study area consists of fallow land, open scrub, dry crop, barren hills, reservoir, river, scrub land, settlement, tanks (with or without water) and wet crop.

Lineament study: In crystalline terrain, occurrences of aquifers are intrinsically related with lineaments. In the present study, lineaments were interpreted from the satellite data and verified during ground check. After their demarcation, lineament density map was generated manually. Contouring and zonation of lineament density map had given lineament density zones (Rao 1995):

a. Poor (lineament density: 0-0.5 km/km^2)
b. Low (lineament density: 0.5-1 km/km^2)
c. Medium (lineament density: 1-2 km/km^2)
d. High (lineament density: 2-3 km/km^2)
e. Every high (lineament density : >3 km /km^2)

The very high and low lineament densities indicate very good and low groundwater potential zones respectively.

Hydrogeomorphological study: Hydrogeomorphology has an important role on the groundwater movement and occurrences. The hydrogeomorphological map (Fig. 2) showing different landforms was prepared from the FCC. The different categories of land forms are residual hills, alluvial fan, buried pediment, denuational hills, escarpment intermontane valley, piedmont slope and shallow pediment. Among these, piedmont slope, intermountain valley, buried pediment, and alluvial fan are the most favorable landforms for groundwater occurrence (Lillesand & Kiefer 1987).

Drainage and drainage density: Dendritic to sub-dendritic drainage pattern is observed in the study area, which implies more or less homogeneous lithology and structural controls. The sub-dendritic drainage pattern is mainly controlled by slope. The study area comes under Kabini river, which is a seventh order type of drainage. Drainae density plays an important role in groundwater study, and in the present study also it can indirectly give clue on groundwater potential. High and low drainage densities are observed in week, highly weathered materials and compact, hard rock terrains respectively. Drainage density map was prepared and categorized as:

a. Poor (drainage density: 0.0-0.5 km/km^2)
b. Very high (drainage density: >2 km/km^2).

Slope: Slope is an important parameter for integrated study and especially to decide land irrigability. Slope map was prepared form SOI toposheet on 1:50000 and categorized as:

a. Steep slope (slope amount: >35°)
b. Moderately steep slope (slope amount: 10°-35°)
c. Moderate slope (slope amount: 5°-10°)
d. Gentle slope (slope amount: 3°-5°)
e. Very gentle slope (slope amount: 0°-3°)

The gentle slope is mainly from east to west in the study area.

Rock and soil: The groundwater prospecting more specifically, water harvest planning is mostly restricted to soil cover area. Hence, small hills and barren rocky exposures were delineated with the help of satellite data (Krishna et al. 1982) and ground check; the rest was categorized as soil cover (Fig. 3).

RESULTS AND DISCUSSION

Ranking and weightage assignment: The occurrence and movement of groundwater in an area in controlled by various factors. Each parameter was assigned a rank and its each class was attributed weightage depending on its influence on the movement and storage of groundwater. This knowledge based ranking was done mainly based on the common logic aided by the data from geophysical, lithological,

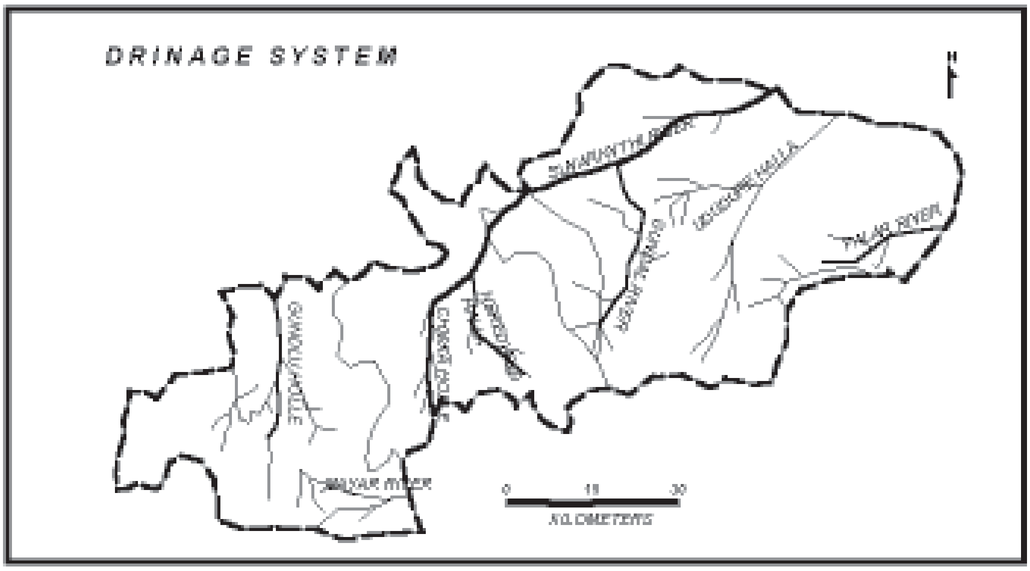

Fig. 2: Drainage area in the study area.

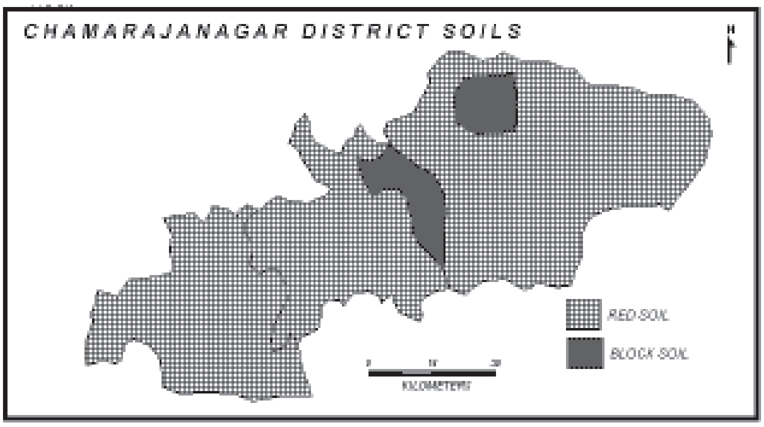

Fig. 3: Soil types in the study area.

subsurface geological and water level data. The final score or attribute of each unit of them is equal to product of the rank and weightage.

Demarcation of groundwater potential zone: In hard rock terrains, such as the present one, the occurrence of groundwater is mainly confined to certain zones only (Krishnamurthy & Jayaraman 1995). In order to delineate the groundwater potential zones, integrated terrain analysis was carried out using score based analysis. Thematic maps such as hydrogeomorphology, drainage density, lineament density, water level fluctuation and rock-soil contact were used for the spatial intersection/overlay analysis. After intersection, each polygon in the composite was evaluated with reference to the groundwater prospect based on the added values of scores of various themes. After integrations, the rocky area in the integrated map was eliminated by subtraction of rocky portion using rock-soil contact map, as this part was considered as a nil probable or poor groundwater prospect zone.

Aquifer type analysis: Aquifer thickness map was prepared from well inventory, sub surface geological, geophysical and groundwater potential data. Through integration of all these data, the depth of bed rock for different regions was assigned. Based on thickness of weathered and fractured zone, the aquifer thickness was reclassified into:

a. Deep aquifer zone (thickness: > 50 m)
b. Moderately deep aquifer zone (thickness: 20-5 m)
c. Shallow aquifer zone (thickness: < 20m)

In the final part of aquifer type analysis, the aquifer thickness map was spatially integrated with groundwater potential. Based on groundwater potentiality and aquifer type in the watershed area, recommendations were made for agricultural practices, groundwater development and management of aquifer recharge. For example, the priority zone IA possesses very good groundwater potentiality with deep aquifer condition (Subramanian & Selvan 2001). This area is recommended for major groundwater supply to villages. In addition, sustainable agriculture practices can be done though borewell. Construction of recharge wells is suitable mechanism for management of aquifer recharge in this zone (Todd 1980).

CONCLUSION

Remote sensing and GIS are very good tools for groundwater exploration. The study has given output of different groundwater potential zones. The aquifer type analysis has given good information for various developmental activities in drought prone areas like nature of groundwater development, type of agriculture practice and optimal aquifer management. The study was validated through existing dug well data; however, more yield data are required for precise validation. Further, detailed study is required to understand the controlling parameters of groundwater movement and occurrence in the study area.

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