INNOVATIVE ENERGY TECHNOLOGY SYSTEMS AND ENVIRONMENTAL CONCERNS: A SUSTAINABLE APPROACH
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Integrated Approach for Ground Water Prospect Zonation in Chikkanayakanahalli Sub Watershed of Tumkur District, Karnataka using Geoinformatics

Bharath Kumar L
Dept. of Geology, Central Uni of Karnataka. Kadaganchi-585311

Govindaraju
Dept. of Applied Geology Kuvempu University. Shankaraghatta-577451

Jaya kumar P D
Dept. of Applied Geology Kuvempu University, Shankaraghatta-577451

Abstract

Groundwater is a most important natural resource of the earth and is required for drinking, irrigation and industrialization. It is essential to maintain a proper balance between the groundwater quantity and its exploitation. A possible solution for such problems is micro level planning, and use of standard methodology for assessing the groundwater. The surface hydrological features like topography, geomorphology, drainage and surface water bodies play important role in groundwater replenishment. Remote sensing is an excellent tool for hydrologists in understanding the "perplexing" problems of groundwater exploration. The various thematic layers generated using remote sensing data like Lithology/structural, geomorphology, land use/land cover, lineament can be integrated with slope, drainage density and other collateral data in a Geographic Information system (GIS) framework and analyzed using a model developed with logical conditions to derive at groundwater zones as well as artificial recharge sites. Integration of thematic layers, we derive five different ground water prospect zones like Very Good, Good, Moderate, Poor and Very Poor ground water prospect zones and proposed four types of zones for construction of suitable water harvesting structures like vegetative check, boulder check, rubble check and check dam for judicious utilization of groundwater resources coupled with proper water management.

1. Introduction

Groundwater is a most important natural resource of the earth. It is essential to maintain a proper balance between the groundwater quantity and its exploitation. Otherwise, it leads to large-scale decline of groundwater levels, which ultimately cause a serious problem for sustainable agricultural production. 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 (Biswas Arkoprovo et. al. 2012). The movement of groundwater controlled mainly by porosity and permeability of the surface and underlying Lithology. The same Lithology forming different geomorphic units will have variable porosity and permeability thereby causing changes in the potential of groundwater

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(Deepika et.al. 2013). Satellite remote sensing data provides an opportunity systematic analysis of various landforms/lineaments due to the synoptic and multi-spectral coverage of a terrain. Investigation of remotely sensed data for drainage patterns, Lithology, geomorphologic units and lineament characteristics of terrain are integrated way facilities and effective evaluation of ground water potential zones (Obi Reddy et.al. 2000). All the controlling parameters are rarely been studied together because of non-availability of data. Hence, a systematic study of these factors leads to better delineation of prospective zones. Ground truth verification done through detailed hydro-geological and geophysical investigations. Delineation of pertinent area in the composite map is one of the most desired tasks for groundwater development, for construction of artificial recharge structure and for surface water storage by water impounding structure. Ground water prospects zonation means identifying and mapping the prospective ground water zones in an area by qualitative assessment of the controlling and indicative parameters (Srivastava et. al. 2012). The main aim of the study is to Prepare ground water prospects map for Chikkanayakanahalli sub watershed by integrating thematic layers to understand ground water potentiality of the area and to manage water resources using muti-temporal satellite data products, Aster DEM and GIS techniques. The ground water prospect map of Chikkanayakanahalli sub watershed corresponding to survey of India top map on 1:50,000 scale covering all the habitations to show a) Perspective zones for ground water occurrence and b) Tentative locations for constructing recharge structures.

2. Study area

The study area Chikkanayakanahalli sub watershed of Chikkanayakanahalli taluk in Tumkur district, lies between latitudes $13^0$22'07''-13^o32'37''N and longitudes 76^0 35' 51''-76^0 41' 14'' E in survey of India toposheet of 57 C/10 & C/11 of 1:50,000 scale (Fig.1), which covers an area about 89.397 sq km with 17 villages in the study area.

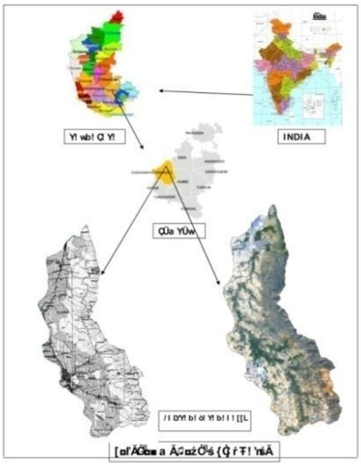

Fig. 1: Location map of Chikkanayakanahalli Sub watershed.

3. Materials and methodology

In order to prepare the groundwater prospect zones for the Chikkanayakanahalli sub

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watershed, different thematic maps on 1:50,000 scale were prepared from topographic map, IRS LISS III 2008 data and Spot image 2013 shown in Fig.2, these are updated with ground truth verification. Thematic maps like drainage and surface water bodies, contour, road network settlement, location, slope, land use/land cover, geomorphology, lithology and structural maps were prepared (Khan et.al. 2002).

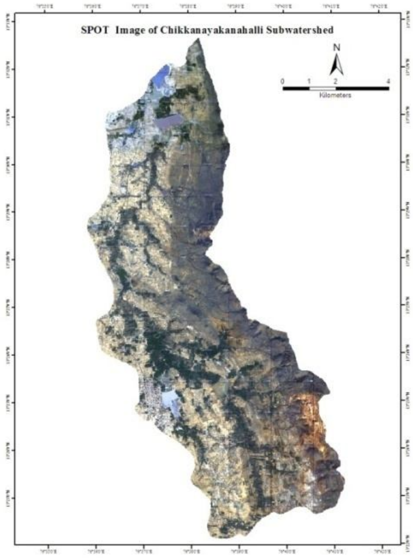
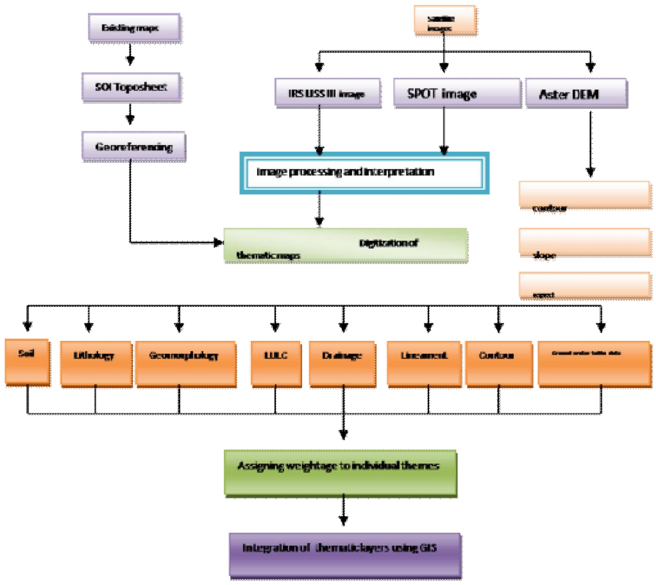


Fig. 2. SPOT image of Chikkanayakanahalli Sub watershed



4. Results and discussions

4.1 Slope Map

The study area shows seven categories of slope namely nearly level, gentle slope, very gentle slope, moderate slope, steep slope, moderately steep slope, very steep slope and strong slope as shown in Fig. 3. The major portion of the slope covered is nearly level, gentle and

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moderate with 36%, 27 % and 13% respectively. These are good zone for ground water potential.

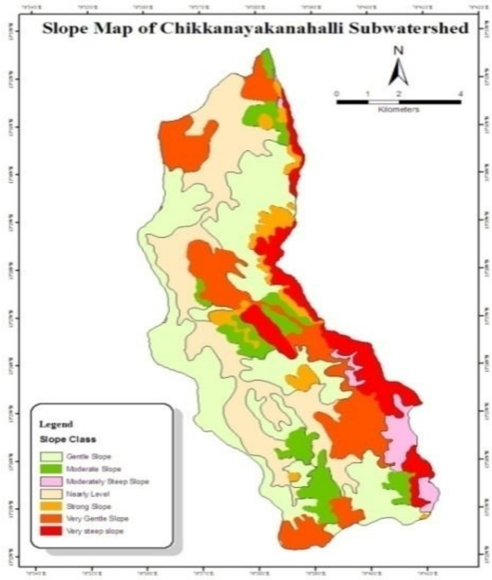

Fig. 3: Slope map of Study area.

4.2 Land use/Land cover Map

The current land use/land cover pattern of the study area consists of 17 villages and most of the area is covered by plantation (coconut, arecanut, banana, mango) with 22% and double crop (ragi, wheat, millet and rice) with 2% respectively. The degraded and scrub forest covered by 20% and 16% respectively. There are 6 major water bodies, 13 small tank and rocky outcrop in some area as shown in Fig. 4.

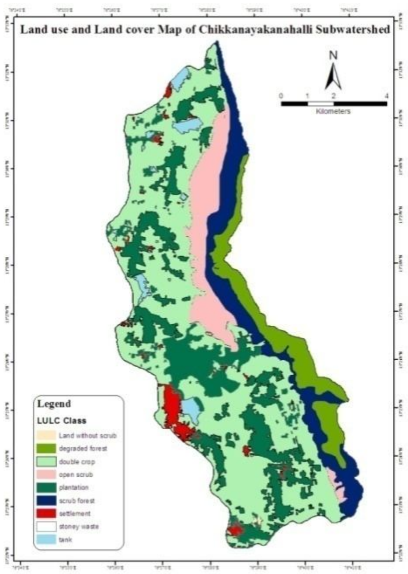

Fig. 4: Land use and land cover map.

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4.3 Soil Map

Soil map in the study area reveal four main soil classes, clayey skeletal, fine, dyke ridges, and loamy skeletal. Majority of the area covered with fine soil and clayey skeletal with 40% and 33 % respectively, Dyke ridges covered by 5% as shown in Fig. 5.

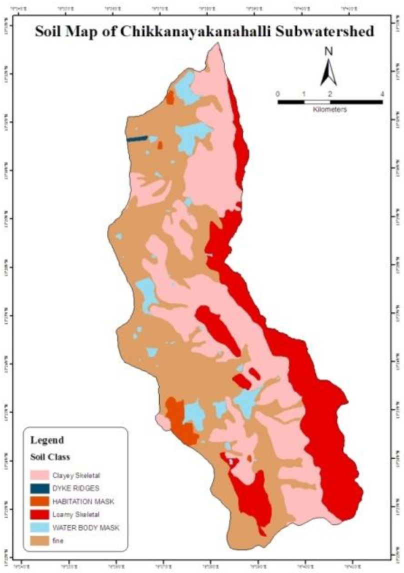

Fig. 5: Soil map of Study area

4.4 Geomorphology Map

The major geomorphologic features are Pediplain, structural hill, valley fill and pediment with 51%, 17%, 18% and 8% respectively as shown in Fig. 6. Valley fill, pediplain and pediments are very good to moderate, where as structural hill is having poor ground water potential zone (Pradeep K Jain, 1998).

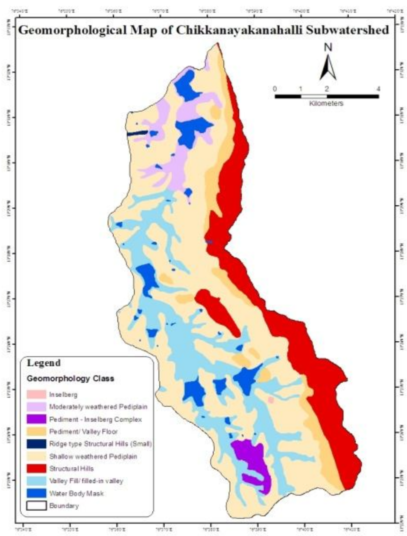

Fig. 6: Geomorphology map of Study area.

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4.5 Drainage Network and Water bodies Map

The drainage pattern show dentritic to sub dentritic drainage patterns, these are extracted from survey of India Toposheet and updated using satellite data as shown in Fig. 7.

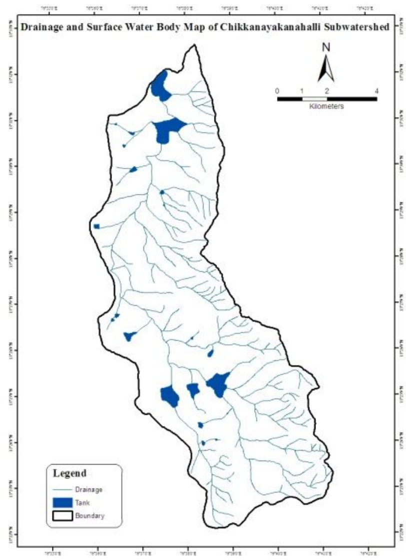

Fig. 7: Drainage and Surface water body map of Study area.

4.6 Lithology Map

Geologically the study area represents eight types of rock formations. Majority of area covered by Migmatites & Granodiorite-Tonalitic Gneiss, meta basalt/tuff and Maganese and Iron formation with 47%, 28% and13% respectively. Ferroginous/ Manganiferrous Chert, Ferruginous Chert/ BHQ/ BFQ, Greywacke/Argillite, Limestone, dolomite is less covered as shown in Fig. 8.

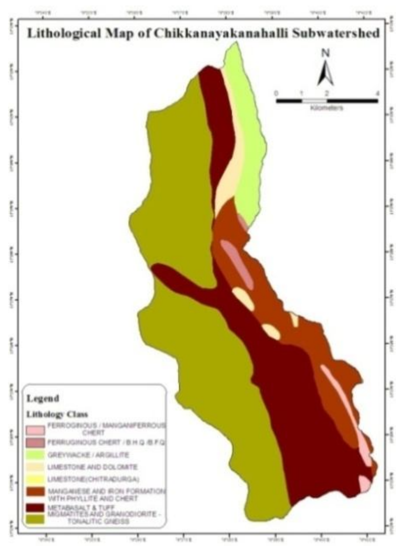

Fig. 8: Lithology map of Study area.

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4.7 Lineament map

The mapping and interpretation of lineaments needs to be done with care and with a proper understanding of its applications and limitations. This is not always the case. Here, an attempt made to map the drainage lineaments for groundwater potentiality assessment. In the study area, the third and fourth order streams are linear and potential zone for ground water, hence, which is used in integration of thematic layer to delineate the ground water potential zonation (Pradeep K Jain, 1998) as shown in the figure-9.

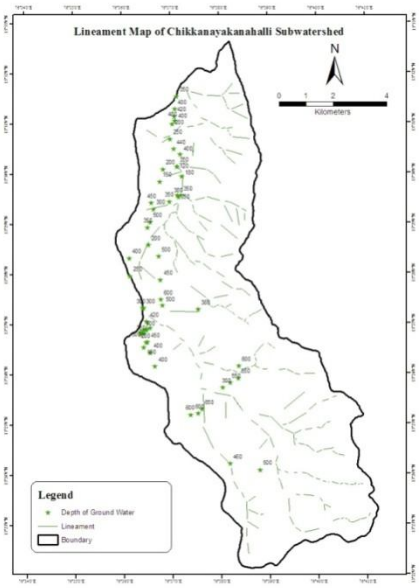

Fig. 9: Lineament map of Study area.

4.8 Ground water contour map

Ground water contour map of the Chikkanayakanahalli sub watershed area of Tumkur district prepared based on the bore well information collected during field visit for ten years. The average ten year ground water contour map shown in Fig. 10.

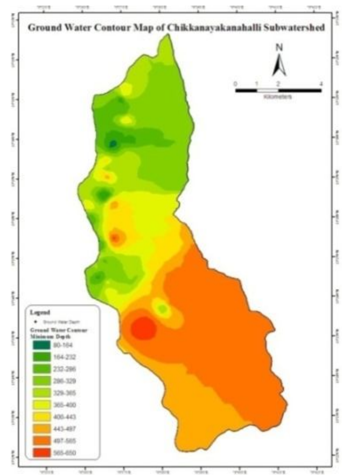

Fig. 10: Ground water contour map of Study area

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4.9. Ground water potential zonation

To demarcate ground water potential zones, all the thematic layer are integrated and ranks were assigned based on their influence on ground water potential as shown in Table 1 (Jyoti sarup et.al. 2011). Based on the criteria, map has classified into poor, moderate good, very good and excellent zones as shown in Fig. 11.

Table 1. Criteria Adapted for the Preparation of Ground Water Prospect Map of Study Area

LU/LC	Slope (%)	Soil	Geo morphology	GW-Contours	Surface Contours	Lithology	Weightage / Rank
Agricultural land-Double crop area Agricultural land-Plantation	0-1	Fine	Valley Fill PPM	120-180 181-230	720-790	MGTG Meta Basalt	**"Very Good (5)"**
Agricultural land-Plantation Open scrub	1-3 3-5	Clayee skeletal Loamy-Skeletal	PPM PPS	231-300 301-365	800-860	Meta Basalt Limestone	**"Good (4)"**
Open scrub Land without scrub	5-10 10-15	Clayey-Skeletal Loamy-Skeletal	Pediment PPM PPS	366-420 420-497	870-930	Limestone BHQ/BFQ	**"Moderate (3)"**
Degraded forest Scrub forest Wasteland	10-15 15-35	Clayey-Skeletal Loamy-Skeletal	Pediment PPS	498-550 550-575	930-1000	Mn and Iron formation with Phyllite And Chert Argillite	**"Poor (2)"**
Wasteland Stony waste	3 5-50	Loamy skeletal	PIC Structural hill	576-600 600-650	1010-1060	Ferruginous /Manganese-Iron-Chert	**"Very Poor (1)"**

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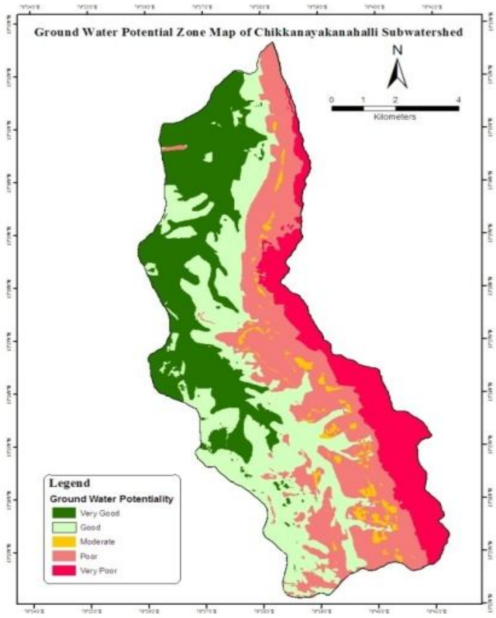

Fig. 11: Groundwater Prospects Map of the study area

4.10 Water resource action plan

The weights for the different themes assigned based on their water resource potentiality and different features of each theme are also assigned weights according to their relative influence on potentiality. Based on this evaluation of different features of a given themes were analyzed and suggested action plan as proposing various water harvesting structures like vegetative check, boulder check, rubble check and check dam as shown in the Fig12 and Table.2 for sustainable development of water resources.

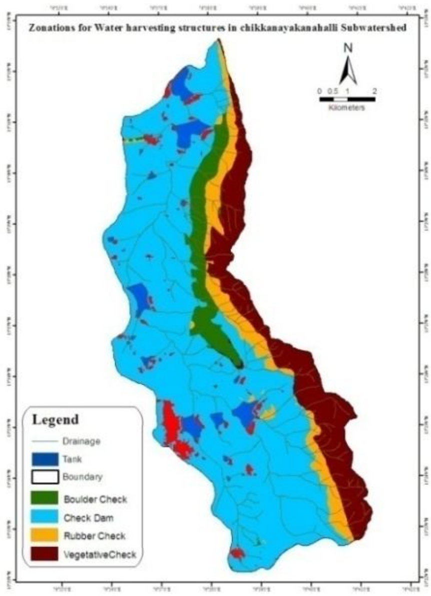

Fig. 12: Water harvesting structure map.

Table 2: Criteria adopted for water harvesting structures

Geomorphology	Slope	LULC	Lithology	Recommendation
Moderately weathered/ moderately buried Pediplain	Very Gentle Slope	Plantation	MIGMATITES AND GRANODIORITE-TONALITIC GNEISS	check dam
PPM	Very Gentle Slope	Open scrub	MMTG	check dam
PPS	Gentle Slope	double crop	MMTG	check dam
Water Body Mask(**)	Gentle Slope	scrub forest	FERRUGINOUS CHERT / B.H.Q /B.F.Q	rubber check
Water Body Mask(**)	Strong Slope	degraded forest	FERRUGINOUS CHERT / B.H.Q /B.F.Q	rubber check
PPM	Nearly Level	open scrub	LIMESTONE AND DOLOMITE	boulder check
Pediment/ Valley Floor	Strong Slope	open scrub	LIMESTONE AND DOLOMITE	rubber check
PPS	Gentle Slope	open scrub	FERRUGINOUS CHERT / B.H.Q /B.F.Q	boulder check
Structural Hills	Very steep slope	plantation	METABASALT & TUFF	vegetative check
Structural Hills	Gentle Slope	degraded forest	GREYWACKE / ARGILLITE	vegetative check
Structural Hills	Gentle Slope	scrub forest	GREYWACKE / ARGILLITE	vegetative check

5. Conclusions

The results of this study demonstrated that the integrated RS and GIS based approach is a powerful tool for assessing the groundwater potentiality, based on which the suitable location for the groundwater withdrawals could be identified. The groundwater potential zonation map shows for the study area, into five ground water prospect zones as very good, good, moderate, poor and very poor and proposed four types of zones for construction of suitable water harvesting structures like vegetative check, boulder check, rubble check and check dam for judicious utilization of groundwater resources coupled with proper water management.

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