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Groundwater Investigation of Upper Kabini Watershed Using Remote Sensing and GIS Technique, HD Kote Taluk, Mysuru District

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Abstract

Water is one of the main natural resources that is essential for human's daily life domestic, industrial agriculture and other like fields. This needs periodic assessing and monitoring of water resources for its sustainability. Mapping and integration of lithology, geomorphology, drainage lineament, soil types slope pattern, land use/land cover and other related features was carried out in Southern tip of Karnataka State using GIS techniques to assess the groundwater prospect zones. The present study aims to predict the good, moderate, poor and very poor groundwater prospects zones using water level measured in available dug/bore wells of the study area collected during the year 2017. Each lithological units and geomorphological landforms are mapped during limited field visits and digitized using visual image interpretation and Digital Image Processing (DIP) on Satellite Remote Sensing data through Arc GIS software. The final results highlight the potentiality of GIS application in mapping of groundwater prospect zones.

Keywords: Ground water; Remote sensing; GIS; Digital Image Processing (DIP)

Introduction

Investigation on Groundwater potential zones are carried out by a number of researchers around the world, and it was found that the involved factors in determining the groundwater potential zones were different, and hence the results vary. According to the study of Teeuw, thrust is on the study of lineaments for groundwater exploration [1]. In general the problem of groundwater exploration is attempted not only with lineament studies but also factors like drainage density, geomorphology, geology, slope, land-use, rainfall intensity and soil texture [2],[6] are considered. The derived results are found to be available satisfactory field survey and it varies from one region to another because of different geo-environmental conditions.

Exploitation of groundwater in the study area is done through construction of dug wells, dug-cum-bore wells and bore wells. However, recharging of groundwater table is curtailed by frequent dry seasons and failure of monsoons. The minimum depth of the water table in the study area is up to 5 m in favorable localities adjoining rivers, canal system and abutting tanks, whereas the water table in remote areas are found at greater depth, up to 50-60 m resulting in acute water shortage. Exploitation of groundwater resources has increased in the past decades, leading to the over-consumption of groundwater, which eventually decreased groundwater levels, water exhaustion, water pollution and deterioration of water quality.

Integration of remote sensing with GIS for preparing various thematic layers, such as lithology, drainage density, lineament density, rainfall, slope pattern, soil types and land use with assigned weightage in a spatial domain will support the identification of potential groundwater zones. Therefore, the present study focuses on the identification of groundwater potential zones in upper Kabini watershed, using the advanced technology of remote sensing and GIS for the planning, utilization, administration, and management of groundwater resources. Kabini is one of the rivers situated in H D Kote Taluk, Mysuru District. The Kabini river is the main tributary of Kaveri river which originates from Kerala. The investigation of groundwater of upper Kabini watershed can be analysed by remote sensing and GIS technique. It is a rapid, cost effective and time saving tool, whereas remote sensing plays an indispensable role in acquiring information about the area. It detects and monitors the delineation of groundwater.

In the past, several researchers (from India and abroad) have used geoinformatic techniques for the delineation of groundwater potential zone with successful results [7], [9]. In these studies, the commonly used thematic layers are lithology, geomorphology, drainage pattern, lineament density, soil and topographic slope. On the other hand, some researchers have integrated geoinformatic techniques to delineate groundwater potential zones [10]. The studies carried out in India on ground water mainly focuses on hard-rock terrains. Remote sensing data combined with geographical information system (GIS) technique is very efficient in identification of groundwater potential zones of any region. The study reveals that the integration of thematic maps prepared from conventional and remote sensing techniques using GIS gives more accurate results. Groundwater is available when the infiltration of water beneath the earth surface is more Groundwater table decreases, when the pumping rate is more than the rate of recharge. Hence, it can be concluded that areas of high withdrawal rates may lead to reduction of groundwater zones (Figure 1).

Methodology

The Indian Remote Sensing Satellite (IRS), Linear Image Self-Scanning (LISS) III of geocoded False Colour Composites (FCC), generated from the bands 2, 3 and 4 on a 1:50,000 scale, was used for the present study.

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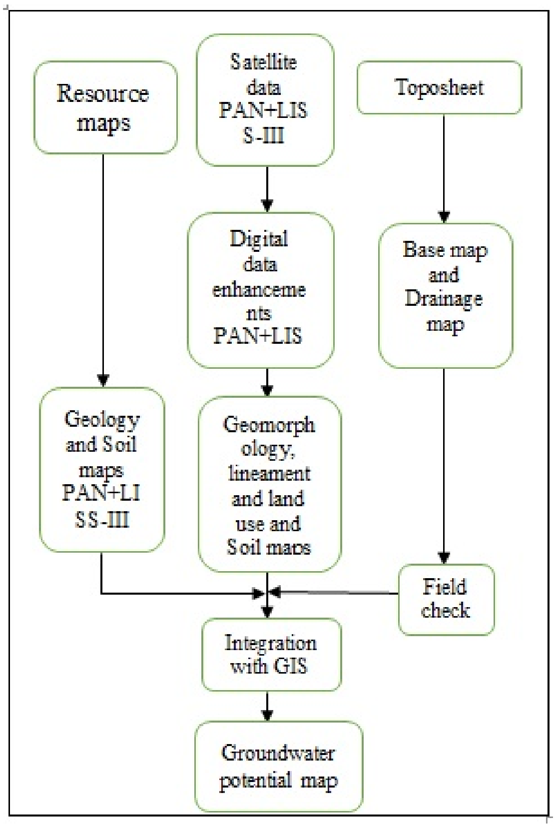

Figure1: Flow chart showing the methodology adopted for of Upper Kabini Ground Water occurrences.

The Survey of India toposheet maps on a scale of 1:50,000 equal to the corresponding imagery were used for the preparation of thematic maps. The imagery was visually interpreted to delineate geomorphologic units and land use/land cover with the help of standard characteristic image interpretation elements like tone, texture, shape, size, pattern, and association. Methodology employed is summarized in the flow chart in Figure 1. It involves digital image processing using ERDAS 8.7 software and visual interpretation of IRS PAN-LISS-III data for the extraction of lithology, drainage, lineament, geomorphology, land use/land cover and soils as well as field studies. All data were integrated in a Geographic Information System (GIS) using Arc GIS 9.2 software and analyzed to assess the groundwater controlling features. 9.2 software and analyzed to assess the groundwater controlling features.

Rain fall data of Upper Kabini

Mysore district receives an average rainfall of 776.7 mm. There are 53 rainy days in the district on an average about 50% of annual rainfall occurs during the southwest monsoon period (Figure 2). The rainfall generally decreases from west to east. The coefficient of variation is around 30% in the west to above 35% in the east, indicative of consistent rainfall in the west as compared to the east. The pre monsoon rainfall is more consistent than the post-monsoon rainfall. The southwest monsoon had been normal from 1994 onwards till 1999, excessive during 2012 and deficient thereafter. The northwest monsoon is much better comparatively being excessive to normal during the recent past. Over all on an annual basis, there are more normal to excessive rainfall years than deficient once. While during 2014 and 2016, the district received excess rainfall. During, 2010, 2011, 2012, it was normal and thereafter only during 2006 and upto till date rainfall is normal. The average minimum and maximum temperatures vary from 34 to 21.4°C in April to 16.4 to 28.5°C in January. Relative humidity ranges from 21 to 84%.

Study area

Heggadadevanakote (H D Kote) taluk is situated in the southwestern part of Mysore district. It is located between 11° 44'18" and 12° 17'24" North latitudes and 76° 06'29" and 76° 32'21" East longitudes covering an area of 975.73 sq km (Figures 3). This taluk has five hoblis namely Kasaba, Hampapura, Saraguru, Kandhalikke and Antharasanthe. The climate is sub humid to semiarid tropical. The mean annual rainfall is 904 mm occurring in 59 rainy days. The major crops grown are cotton, ragi and paddy in the study area.

Roads are dense in the settlement area. Different types of roads in the taluk are national highway, metalled, un-metalled, footpath and cart tracks. Except national highway, metalled and other roads are mud roads. They are linking both villages and agricultural fields. National cart tracks pass through the agricultural land highway passes through the taluk and links Mysore and Kerala. Most of the footpaths and cart tracks pass through the agricultural lands.

Base map

Roads are dense in the settlement area. Different types of roads in the taluk are national highway, metalled, un-metalled, footpath and cart tracks. Except national highway, metalled and other roads are mud roads.

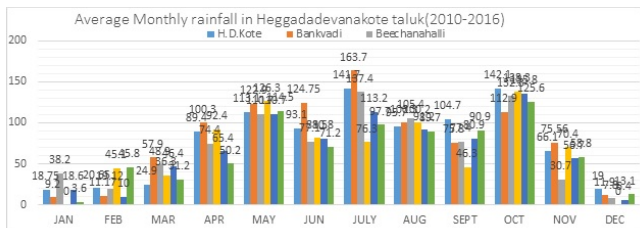

Figure 2: Rain Fall data of Upper Kabini Watershed.

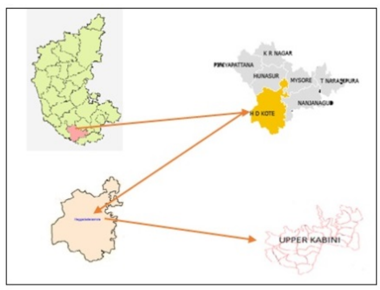

Figure 3: Study Area of Upper Kabini Watershed.

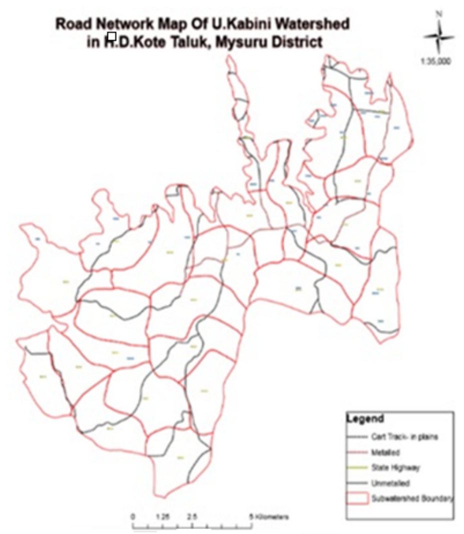

Figure 4: Base Map of Upper Kabini Watershed.

They are linking both villages and agricultural fields. National cart tracks pass through the agricultural land highway passes through the taluk and links Mysore and Kerala. Most of the footpaths and cart tracks pass through the agricultural lands.

Lithology

Geologically, the taluk is composed of igneous and metamorphic rocks of Pre Cambrian age exposed at the surface or covered with a thin mantle of residual and transported soils. The rock types are Heggadadevanakote granite, schistose rocks belonging to sargur schist belt and peninsular gneiss [11-12] (Figures 5) Southern and northeast area consists of thin bands, lenses and elongated linear features of amphibolite schist, banded iron formation, metapelite, pyroxene granulite and metabasaltic rocks. Major part of the taluk is covered by Peninsular gneiss. Dolerite dykes are found in the north western part of the taluk trending in north west to southeast direction.

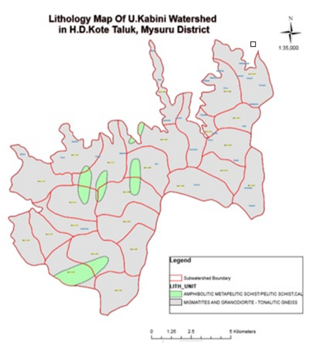

Figure 5: Lithological Map of Upper Kabini Watershed.

Figure 6: Drainage Map of Upper Kabini Watershed.

Description	Area (km^2)
Sub watershed boundary	975.73
Amphibolitic metapelitic schist/pelitic schist, Cal	91.98
Migmatites and granodiorite-tonalitic gneiss	883.75

Table 1: Table showing the Litho Cover in percentage of the study area.

Drainage map

The drainage pattern of the taluk is sub parallel and dendritic. Due to high density of drainage, surface runoff is more than infiltration. Gneissic terrain has more fractures resulting in first order drains less conspicuous, whereas the third order drains are more conspicuous. Gneissic terrain comprises of areas with surface water impounded in the form of ponds, lakes and reservoirs (Tables 2 and 3). In addition, streams, rivers and canals are also present (Figure 6).

Sub-watershed	Stream order			
	Ist order	IInd order	IIIrd order	IVth order
4B3E6F1a	7	3	-	-
4B3E6F1b	5	2	1	-
4B3E6F1c	6	1	5	-
4B3E6F1d	6	3	1	-
4B3E6F1e	4	5	-	-
4B3E6H1a	3	1	-	-
4B3E6H1b	6	3	1	-
4B3E6H1c	5	2	1	-
4B3E6H1d	7	3	5	-
4B3E6H1e	11	5	-	-
4B3E6H1f	2	-	-	-
4B3E6F2a	8	6	-	-
4B3E6F2b	5	4	1	-

4B3E6F2c	8	3	-	-
4B3E6F2d	5	-	-	-
4B3E6F2e	7	3	-	-
4B3E6H2a	16	8	2	-
4B3E6H2b	10	6	2	-
4B3E6H2c	1	-	2	1
4B3E6H2d	5	3	2	-
4B3E6H2e	8	3	2	-
4B3E6H2f	7	1	-	-
4B3E6H2g	4	2	-	-
4B3E6H2h	8	4	-	-

Table 2: Stream Order of the Study Area.

		Stream length			
	Area (km^2)	Ist order	IInd order	IIIrd order	IVth order
4B3E6F1a	39.55	2.78	2.7	-	-
4B3E6F1b	36.8	3.27	2.65	0.62	-
4B3E6F1c	39.46	2.93	1.9	1.89	-
4B3E6F1d	37.96	2.36	2.67	1.59	-
4B3E6F1e	39.78	2.05	1.67	-	-
4B3E6H1a	38.27	3.48	4.83	-	-
4B3E6H1b	40.31	2.51	2.34	1.28	
4B3E6H1c	42.5	3.29	4.57	4.39	-
4B3E6H1d	44.22	2.5	2.82	1.46	-
4B3E6H1e	46.06	1.73	0.83	-	-
4B3E6H1f	47.73	0.7	-	-	-
4B3E6F2a	42.54	3.05	2.07	-	-
4B3E6F2b	40.58	2.1	2.81	0.69	-
4B3E6F2c	43.25	2.23	1.47	-	-
4B3E6F2d	45.68	2.15	-	-	-
4B3E6F2e	45.52	1.37	3.17	-	-
4B3E6H2a	43.94	1.86	2.15	1.92	-
4B3E6H2b	42.89	2.23	1.68	1.89	-
4B3E6H2c	43.62	2.92	-	3.85	2.74
4B3E6H2d	45.5	0.99	2.75	1.9	-
4B3E6H2e	48.23	1.48	1.42	2.12	-
4B3E6H2f	47	1.93	3.65	-	-
4B3E6H2g	48.47	3.14	1.51	-	-
4B3E6H2h	48.82	1.89	1.92	-	-

Table 3: Stream Length of the Study Area.

Slope

Slope is the rise or fall in height per unit horizontal distance in a direction depending upon meteorological parameter, runoff, lithology, climate, geological structure. Steep slopes act as a high runoff zone, whereas gentle slope encourage more infiltration and groundwater recharge (CGWB 2009). Slope is an important feature for flow of surface water (Figure 7) (Table 4).

Slope is the loss or gain in altitude per unit horizontal distance in a direction depending upon lithology, climate, meteorological parameter, run off, vegetation, geological structures and the process of denudation that can estimate runoff and erosion. Steep slopes act as a high runoff zones whereas gentle slope encourages more infiltration and ground water recharge. Slope is an essential aspect for surface water flow and has a bearing over the infiltration possibilities. The slope aspect information has been derived from sol top maps 1:35000 scale (20 m contour interval) using guidelines on slope categories(AIS & LUS,1990).The slope of the study area is classified into seven classes viz. nearly level (0-1%); very gently sloping (1-3%); gently sloping (3-5%); moderately sloping (5-10%); strongly sloping (10-15%); moderately steep to steep sloping (15-35%) and steep slopes (& gt;35%).

S. No.	Slope Category	Slope percentage	Area (km^2)	Percentage (%)
1	Nearly low	0-1	267.418	27.84
2	Very gently sloping	1-3	24.99	2.6
3	Gently sloping	3-5	127.358	13.26
4	Moderately sloping	5-10	276.38	28.78
5	Strongly Sloping	10-15	131.35	13.67
6	Moderately steep to steep sloping	15-35	77.7	8.09
7	Very steep sloping	>35	55.17	5.74
		Total	960.276	99.98

Table 4: Slope Percentage of the Study Area.

Lineament

Lineaments are natural linear structures like joints and fractures. Major lineaments are observed along third order drains that trend northwest and southeast direction. Minor and short lineaments are observed along the first and second order drains trending northeast (Table 5 and Figure 8).

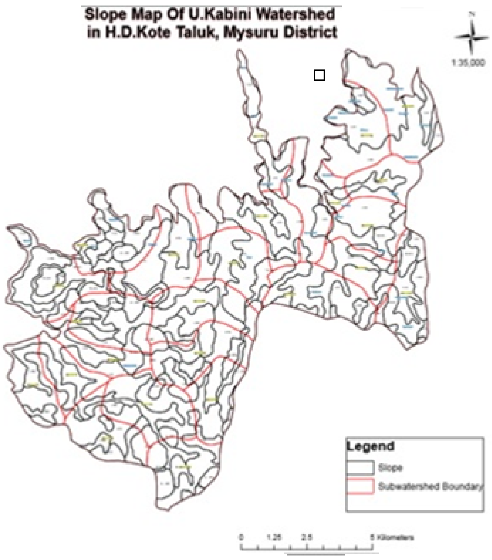

Figure 7: Slope Map of Upper Kabini Watershed.

Code	Lineaments Length (km)
4B3E6F1a	-
4B3E6F1b	41.43
4B3E6F1c	54.99
4B3E6F1d	6.31
4B3E6F1e	17.09
4B3E6H1a	57.91
4B3E6H1b	27.53
4B3E6H1c	28.06
4B3E6H1d	49.71

Table 5: Lineaments length calculated of the study area.

Geomorphology

The taluk is mainly divided into Pedi plain, pediments and hills (Table 6 and Figure 9). The entire terrain is gently sloping towards northeast. Hills are observed in south and southwestern part of the taluk. Dyke ridges are exposed in north-western part trending northwest-southeast direction and serves as a barrier for groundwater flow. The Structural Hills (SH) and Denudational Hills (DH) are observed in the south western part. There are few inselbergs (1) and dyke ridges (DR). The weathering of soil is very deep ranging from 2 to 3 m in the valley regions. In the Pedi Plain Shallow (PPS) regions, the depth of weathering is few meters. The upper or elevated land mass is exposed with rock outcrops and demarcated as pediment (PD). The reserved forest area is not surveyed (NSA).

Figure 8: Geomorphology Length Calculated of the Study Area.

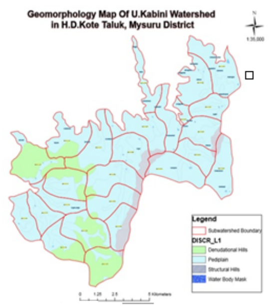

Figure 9: Geomorphology Map of Upper Kabini Watershed.

Description	Area (km^2)
Sub watershed boundary	975.73
Denudational hills	147.96
Pedi plain	759.91
Structural hills	57.85
Water body mask	10

Table 6: Geomorphology of Area Calculated of the Study Area.

LULC

An attempt has been made to identify the land use and land cover units in H D Kote taluk. Seven major classes have been identified at level 1. They are described below as regards their geographic distribution (Figure 10) and extent (Table 7).

Description	Area (km^2)
Sub watershed boundary	975.73
Agricultural land	313.4

Built-up-land	32.84
Forest	586.09
Others	35.86
Water bodies	7.54

Table 7: LULC of Area Calculated of the Study Area.

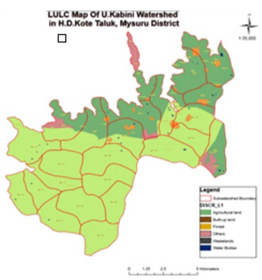

Figure 10: LULC map of upper kabini watershed.

Built-up land

The built-up area includes towns/cities, villages (residential and non-residential), industries, mining and quarrying areas. The geographical extent of the built-up area in the taluk is about 2399 ha.

Agriculture land

The agriculture land includes croplands, horticulture plantations, agri-horti-silvipasture and agro-horticulture which constitutes to about 68584 ha in the taluk.

Forest

Forests are the areas bearing an association predominantly of trees and other vegetation types (within the notified forest boundaries) capable of producing timber and other forest produce. They cover an area of about 71392 ha.

Waste lands

Waste land is described as degraded land which can be brought under vegetative cover with reasonable effort and which is currently under-utilized and/or land which is deteriorating for want of appropriate soil and water management or on account of natural causes. The various categories of waste lands are cultivable and non-cultivable. They cover an area of about 5975 ha in the taluk.

Others

This category includes tree grooves, bunds, canal dumps, roads, tank bunds, river island and grass islands. It has an area of about 2753 ha in the taluk.

Soil

Fifty-one soil series were identified and mapped in the taluk. The soils were mapped as phases of soil series. The soil phases are management units that indicate the problems and potentials associated with each soil phases 475 soil phases have been identified and mapped as phases of series. The soils in each map unit differ from place to place in their land and soil characteristics that affect management. The brief description of soil series and phases mapped are given. The soil map can be used for identifying the suitable areas for specific uses, viz., agriculture, horticulture, sericulture, agro-forestry, agri-horti-silvipasture etc., the standard soil map has been interpreted for various themes like soil available water capacity, soil depth, surface gravel, soil erosion, slope, land capability, land irrigability, soil salinity, land suitability for ragi.

Groundwater prospect

Based on different thematic maps, the groundwater prospects of the taluk are classified as excellent, very good, moderately good, slightly good, moderate, slightly moderate, poor, very poor and runoff zones (Figures 11 and 12). Yield of groundwater discharge is given both in gallons per hour (GPH) and in inches, and their areal extent is also given (Table 8). The area under forest is not surveyed (NSA). This taluk consists of gneissic terrain, due to which ground water potential zones are restricted along the fractures, joints and faults. Ground water potential zones are excellent along the river, very good and good in the canal and tank command areas, good to slightly good in the valley and poor to nil in pediments and rocky area. Elevated areas like hills serve as runoff zones.

Description	Area (km^2)
sub watershed boundary	975.73
Clayey	340.92
Fine	153.48
Fine loamy	377.89
Habitation mask	37.59
Loamy skeletal	56.23
Water body mask	9.62

Table 8: Soil of Area Calculated of the Study Area.

Description	Area (km^2)
sub watershed boundary	975.73
Moderate	418.95
Moderate to poor	26.43
Poor	212.54
Poor to nil	210.3
Very good to good	95.07
Water body mask	9.62

Table 9: Groundwater Potential Zones of Area Calculated in Percent.

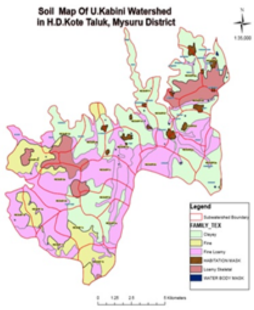

Figure 11: Soil Map of Upper Kabini watershed.

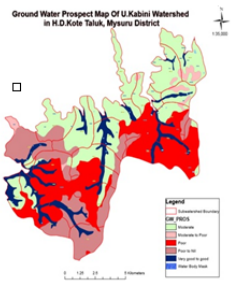

Figure 12: Groundwater Prospect Map of Upper Kabini Watershed.

Conclusion

Remote sensing and GIS techniques are proved to be powerful and most cost effective method for identification of ground water potential zones and mapping in the upper Kabini, H D Kote taluk.

Groundwater potential zones of the upper Kabini has been demarcated using various thematic maps such as, base map, lithological map, geological map, structural map, geomorphological and hydrological information were prepared from remote sensing and GIS techniques.

The area in divided into mainly four categories namely very low, medium and high recharge potential zones.

- Study indicates that the ground water recharge zone is located only in the pediplain area of the study region.
- Rain water is mainly responsible for the ground water recharge in study area.

References

1. Teeuw RM (1995) Groundwater Exploration Using Remote Sensing and a Low cost Geographic Infor Sys. Hydrogeo J 3: 21-30.
2. Chatterjee RS, Bhattacharya AK (1995) Delineation of the drainage pattern of a coal basin related inference using satellite remote sensing techniques. Asia Pacific Remote Sensing J 1:107-114.
3. Nagarajan M, Sujith Singh (2015) Assessment of groundwater potential zones using GIS technique. J Indian Soc Remote Sens 37: 69-77.
4. CGWB (1999) Hydrogeological conditions in Chamarajanagar district, Karnataka. Report of Central Ground Water Board, Ministry of Water Resources, South Western Region, India.
5. Shahid S, Nath SK, Roy J (2011) Groundwater potential modelling in a soft rock area using a GIS. Intern J Remote Sens 21: 1919-1924.
6. Jacob N, Saibaba J, Prasada RP (1999) Groundwater modeling for sustainable development using GIS techniques. Preconf Geoinform 264-267.
7. Krishnamurthy JN, Venkatesa K, Jayaraman V, Manivel M (2000) An approach to demarcate ground water potential zones through remote sensing and geographical information system. Intl J Remote Sens 17: 1867-1884.
8. Premchandra MR (1998) Groundwater quality in Gundulpet taluk of Chamarajnagar district. Mines Geo 4: 401.
9. Sridharan K, Manavalan P, Ramanjaneyula M (2002) An integrated approach to groundwater resource assessment. In: Intl. Conf. on Sustainable Development and Management of Groundwater Resources in Semi-arid Regions with special Reference to Hard Rocks, proceedings of the International Groundwater Conference.
10. Subhaschandra KC, Narayanachar G (1997) Structural features and groundwater occurrence in Gundal river subbasin, Mysore district. Mines Geo 345.
11. Janardhan AS, Srikantappa H, Ramachandra HM (1978) Sargur schist complex an Archaean high grade terrain in south India. In Developments in Precambrian Geology 1: 127-149.
12. Prakash Narasimha KN, Kobayashi S, Shoji T, Sasaki M, Sethumadhav MS (2009) XRD, EPMA AND FTIR studies on Garnet from Bettadabidu, Sargur area, Karnataka, India. J Appl Geochem 1: 1-11.