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Research Paper

WATER RESOURCES PLANNING AND MANAGEMENT POSSIBILITIES IN CHAMARAJANAGAR TALUK, CHAMARAJANAGAR DISTRICT, KARNATAKA, INDIA

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Any unplanned development and utilization of water resources with result in water scarcity. In many parts of the developing world. Such a situation exists. In order to do proper planning and management of water resources, it is necessary to conduct detailed analyses of the factors, which influence the water availability and its uses. In the present study, a comprehensive analysis have been undertaken for proper utilization of water resources in Chamarajanagar Taluk, which has been identified as one of the drought hit districts of Karnataka, in India. The factors analysed in this work are, surface and groundwater availability, land use, cropping pattern, recharge potential of soils and the rainfall pattern in typical areas of Taluk. It is observed that the problem of water scarcity is mainly due to the lack of irrigation planning and management. Hence, a modified cropping pattern is suggested by taking into consideration of all available water resources and other conditions.

Keywords: Water planning, Drought, Soil, Rainfall pattern, Water scarcity irrigation planning

INTRODUCTION

Chamarajanagar district is located in the southern part of the Karnataka state, in India. Chamarajanagar Taluk is located adjoining to the southern border of a Taluk of TamilNadu State. To the west, it is bound by Gundalpet and Nanjangud Taluks and to the north is T.Narasipur Taluk and to the east is Yelandur Taluk. This Taluk comprises of 5 Hobli's namely Chamarajanagara (kasaba), Haradanahalli, Harve, Santhemaralli, Chandakavadi and it comprises of 42 Gramapanchayath (GP) which are the micro units of District development. The main river draining through this Taluk is "Suvarnavathi". It is also known as "Honnu Holy". It flows via Ramasamudra and Alur towns and flow towards Yelandur town. The Suvarnavathi is a tributary of river Cauvery which is known as "Chikka Holay". It is the only surface water resource available for the residents of Chamarajanagar town. The growing pressure on land and water resources due to population explosion is a serious concern

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to water resources engineers and scientists. To meet the water needs, it is necessary to find out several alternative ways and means for harvesting the water which runs off from the land. To achieve this, there is a need to analyse the hydrological parameters such as rainfall characteristics, land use changes, surface and groundwater availability and crop water requirement. Various studies have been carried out for different parts of district by, State and Central Groundwater Departments. However, systematic and comprehensive studies with respect to surface and groundwater availability are not available. Therefore, the present study is an attempt to assess the total water resources in Chamarajanagar Taluk, which is now declared as one of the drought prone districts. This study is mainly based on the field investigation and information collected through local farmers. Land use map of the district was prepared using 1995 IRS-1A-LISS-II data and is compared with the present land use condition through ground truth verification. Further, to understand the available water resources in the district, surface water availability (basin wise), groundwater potential and the crop water requirement were also estimated. The methodology adopted has been presented with promising results obtained in this work.

STUDY AREA

Chamarajanagar Taluk, Chamarajanagar district of Karnataka comes under the semi-arid climate zone. It lies between 11°40'00''N 12°15'00''N Latitudes and 76°40'00''E-77°15'00''E Longitude with a geographical area of 1235.9 sq. kms covering 190 villages coming under the Survey of India (SOI) toposheet nos. 57D/12, 57D/16,57H/4, 58A/9, 58A/13, 58A/14, 58E/1, 58E/2, 58E/5, on a scale of 1:50,000. The study area falls in southern dry-agro-climatic zone. The study area is accessible by good motorable roads and is very well connected from Mysore to Chamarajanagar broad gauge railways with a length of 60 Km (from Bangalore 157 Km) (Figure 1). The study area experiences a fairly hot summer and cold winter. March to May are the summer months/season, June to September are monsoon months/season, October to December are post monsoon months/season as well as January to February are winter months/season. The mean maximum temperature is 34 °C and the mean minimum temperature is 16.4 °C. The average annual rainfall is 696 mm. The Physiography of Karnataka state has been classified into four Plateaus. They are, Northern Karnataka Plateau, Central Karnataka Plateau, Southern Karnataka Plateau and Karnataka Coastal Region. The Physiographic setting of the study area belongs to the Southern Karnataka plateau, partly maidan, plain, undulating and mountainous region. The average elevation of the study area is 656 m, Above Mean Sea Level (AMSL).

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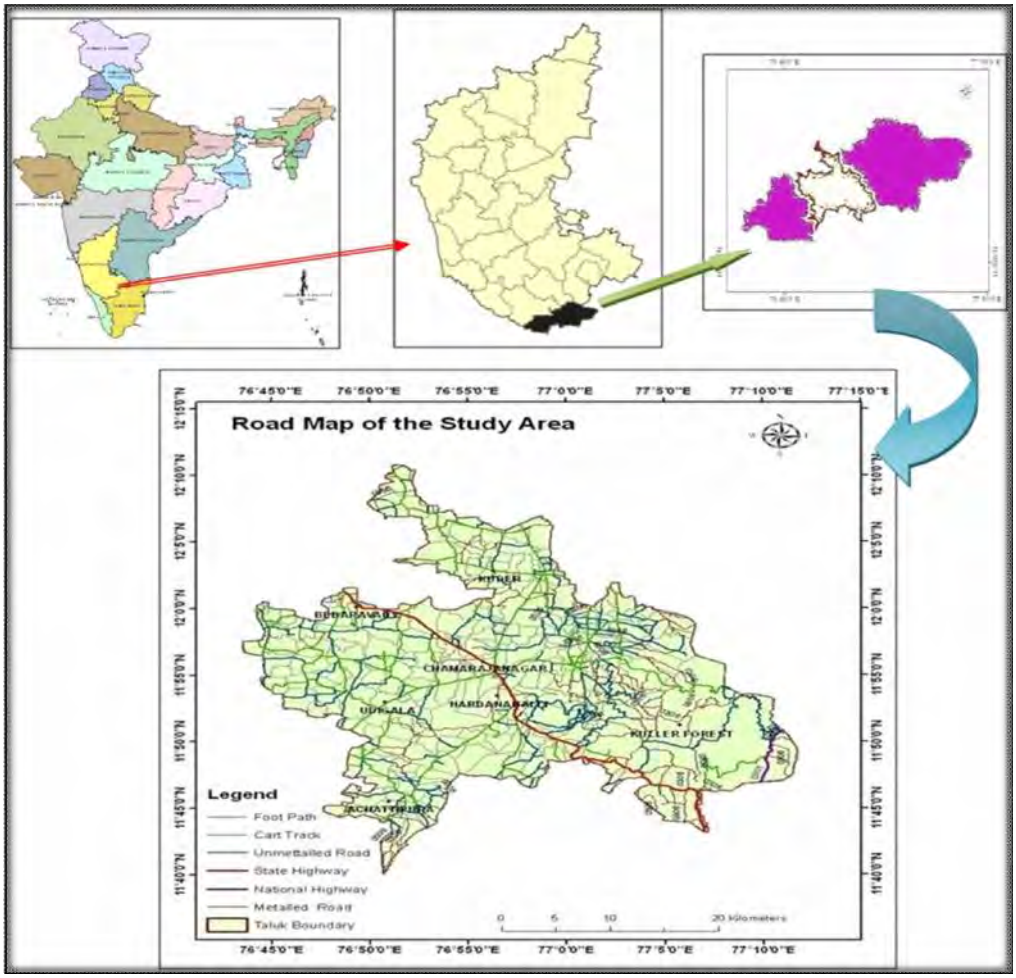
Figure 1: Location of the Study Area



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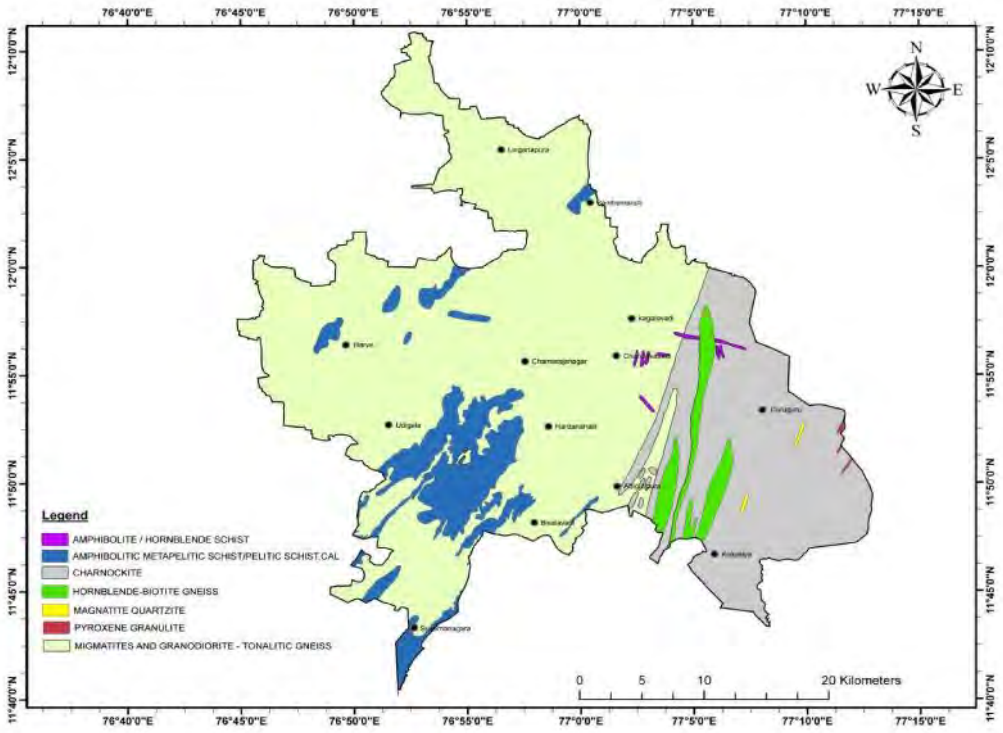
GEOLOGY OF THE AREA

Geologically, this region belongs to the Proterozoic basin of southern Karnataka. The area is underlain by hard rocks consisting of peninsular gneiss, ultramafics, hornblende-biotite gneiss, charnockites and intruded by dolerite dykes of Proterozoic era. Biotite granitie is the wide spread formation of the study area (Figure. 2).

Gneiss

Peninsular gneiss comprises of migmatites, gneisses and granitoids. In stratigraphic units, the peninsular gneiss is shown as the Archean types situated above the Saragur group. Ramakrishnan *et al.* (1976) divided these into three major components namely: (1) The macro layered trimodal gneiss, with alternating amphibolites and ultramafics, (2) Migmatites of various structural types, and (3) Homophanous granitoids. The gneiss of the Chamarajanagar Taluk fits into type one of Ramakrishnan *et al.* (1976). These rocks strike N10°E-S10°W to N30°E to S30°W with varying easterly dips of 60° to 80°. The pink and grey granites basic enclaves, aplite, pegmatite, epidote and quartz veins and dolerite dykes frequently traverse the study area. The grey gneisses noticed in the valley region are highly weathered, fractured and fissured up to an

Figure 2: Lithology of Chamarajnagar Taluk



average depth of 6 to 10 m, whereas the pink gneisses are massive and do not show much tectonic disturbance.

Charnockites

The Charnockite is similar to granite which includes many different types, as felsic, which are rich in quartz and microcline and mafic which contain full of pyroxene and olivine. The study area forms of north eastern and south eastern extension of the massifs of Tamilnadu and Kerala. The charnockites have N-S trends with easterly dips at 70^{o} to 80^{o}.These rocks have undergone regional metamorphism which effected the rocks are progressively, increased in intensity from North to South. Pichamuthu (1953) was of the opinion that the retrogressive metamorphism was effective during this period. The rocks are intermediate corresponding mineralogically to norites, quartz-norites and diorites.

Hornblende

Hornblende is the most abundant mineral in amphibolites. The diagnostic property of the area is the dark color of rocks (usually black). These rocks are important constituents in acid and intermediate igneous masses such as granite, diorite and also in metamorphic rocks such as gneiss and schist.

Dolerite Dykes

The dykes intrude relatively into the cool country rocks and frequently display a chilled margin with grain size becoming coarser towards the center where the rate of cooling is slow. If the dykes cooled very slowly, at greater depths, large crystals with form in dikes. The study area frequently noticed medium to coarse grained minerals in narrow to slightly wider dykes. They mainly oriented towords NW-SE, but some also trend in different directions. They normally play an important role in groundwater movement and storage. Groundwater potential zone maps are normally prepared keeping this as an important factor. Because, the upstream area of any dyke

Figure 3: Field Photographs of Chamarajanagar Taluk

normally stores more amount water, where the downstream of the dyke will be poorer in groundwater storage (Figure 3-field photographs of the area).

MATERIAL AND METHODOLOGY

For the assessment of surface water availability, a computer program developed by Majumdar (1986) was used. The groundwater potential of the catchment is estimated by groundwater fluctuation method, adopting the norms recommended by Ground Water Estimation Committee (1997). For this purpose, ground water fluctuation data were collected for observation wells in the district. Crop water requirement was calculated using standard methods. Estimation of soil hydrological properties is important, which will indicate the runoff potential of the region. For the estimation of infiltration, tests were conducted using double ring infiltrometer. Textural analyses were carried out for the soil samples of the area in the laboratory. Soil classification was done based on the textural analysis and runoff/recharge conditions.

RESULTS AND DISCUSSION

Land Use Pattern

Land and water resources are intimately interconnected and exert considerable influence in determining the various hydrological phenomena like infiltration, overland flow, evaporation, interception, etc. Furthermore, the land use and vegetal cover characteristics of a region, have a significant influence on the quality and quantity of runoff available from it. Details of the land utilization pattern followed in the district are shown in the Table 1.

Table 1: Land Use Pattern of Chamarajanagar Taluk

S. No.	Land Use Type	% of Area
1	Agriculture (Khariff)	12
2	Agriculture (Rabi)	31
3	Double crop	32
4	Barren land	8
5	Scrubs	8
6	Forest land	9
Total		**100**

To understand the land use changes over a period of 10 years, data have been collected from District Statistical Office, Mysore and also from Natural Resources Data Management Services (NRDMS), Mysore. A field survey has been carried out in the study area of Chamarajanagar Taluk to verify the changes and it is noted that there are quite lot of changes. One of the most significant observations is that, there is a reduction of 3-4% of the forest cover over a period of 10 years. Land degradation has taken place in some of the areas of these Taluks. As per the information provided by the Statistical department, there are no significant differences in agriculture land and it is almost constant in the last 10 years. However, during field investigations, it is observed that, some of the agriculture land has been reclaimed for construction of houses. The reasons for such drastic changes are mainly due to water scarcity for aggriculture. To overcome this, the farmers should be educated and a proper cropping pattern should be followed irrespective of income generation in the short duration. Degraded lands are comparatively less in most of the taluks and attempts are ongoing to regenerate the forests on degraded land by adopting suitable types of plantation.

Soil Analysis

Based on the composition of the parent rock, the soils of the study area are grouped into four categories (Figure 4), namely, 1. Clay Soil (CS), 2. Sandy Clay Loam (SCL), 3. Sandy Loam (SL) and 4. Gravelly Loamy Sand (GLS) (Figure 4 and Table 2).

Clayey Soil

Clayey soil is essentially composed of Silicates, mica, iron and aluminum hydrous-oxide minerals. These are the most common minerals found in clay deposits in addition to quartz and carbonate. Clay is composed of millions of clay particles which are 0.002 millimeters (0.0000787 inches) in diameter or smaller. Clay soils are heavy to dig and cultivate, drain slowly after rain, warm up slowly when summer approaches, leading to delayed plant growth and 'workability' hold water well and rich in plant nutrients. Clay soil is formed after years of rock disintegration and weathering.

Sandy Clay Loam (SCL)

Sandy clay loam (SCL) is a soil texture of gritty soil. SCL can have 74 to 80% of sand and 20 to 35% of clay.

Sandy Soil/Loam

Sandy soil has biggest size particles which determine the degree of aeration and drainage. The sandy soil texture is gritty, granular and it's consists rock and mineral particles are very small.

Figure 4: Soil Map of the Area

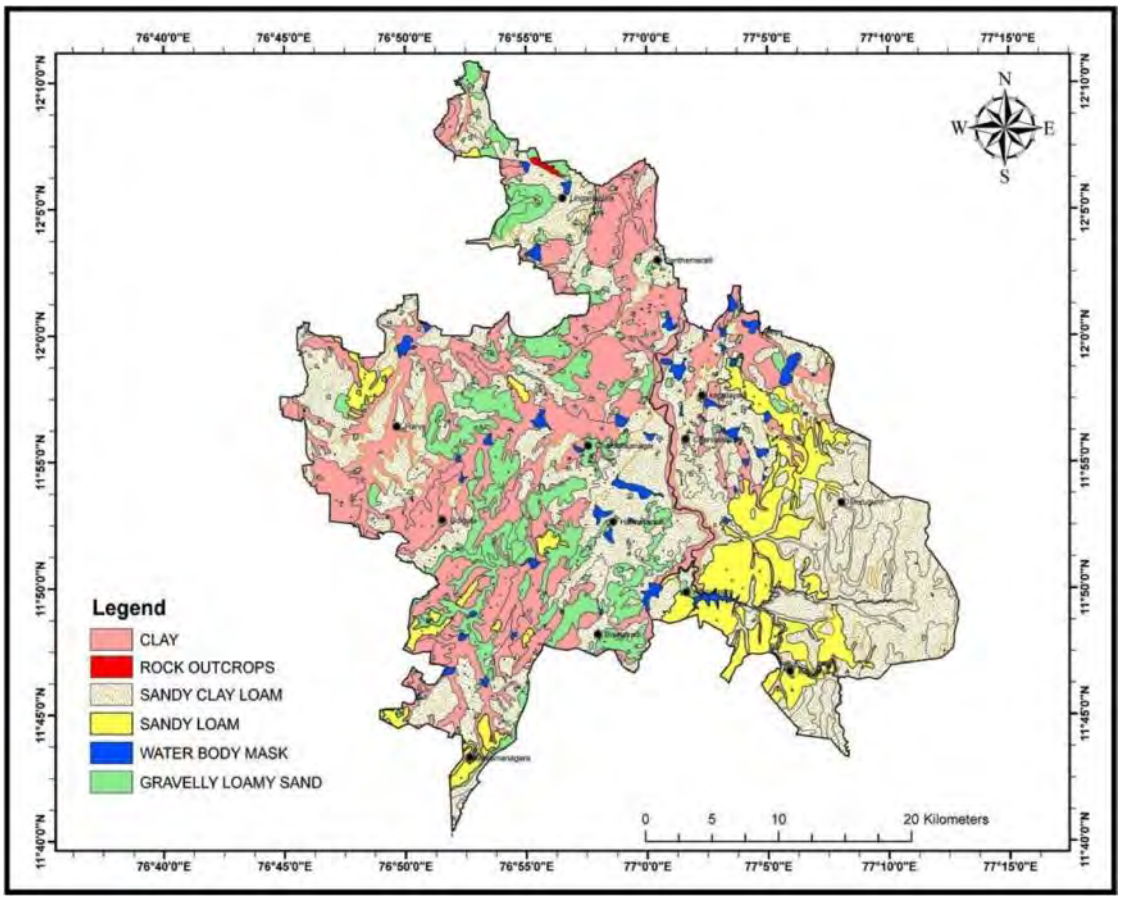


Table 2: Infiltration Values for Chamarajanagar Taluk

Locations	Soil Texture	Infiltration Rate cm/hr	Runoff Potential
Devalapur	Heavy loam	1.6	High
Yadapur	Heavy loam	1.2 – 6.6	Medium-High
Bisalvadi	Heavy-Med loam	1.8 – 4.8	Medium
Yanaganahalli	Light-Med loam	4.2 – 9.0	Low
Kagalavady	Medium loam	0.6 – 13.2	Low-High
Yedayur	Light loam	2 – 4	Low-Med
Harve	Light-Medium loam	1.8 – 20.4	Medium
Chamarajanagar	Light-Heavy loam	0.9 – 12.6	Low-High
Masagapur	Med-Heavy loam	0.5 – 5.4	Low-Med
Bedarapur	Light-Heavy loam	5.4 – 13.8	Med-High

The soil is formed by disintegration and weathering of rock such as granite, quartz. Sandy soil is easier to cultivate if it is rich in organic material but then it allows drainage more than is needed, thus resulting in over-drainage and dehydration of the plants in summer. It warms very fast in the spring season.

Gravelly Loamy Sand

Gravel soil has better drainage than clay and holds more water than sandy soil. The soil thickness of 100 cms and the infiltration rate 1.0 to 1.2 cm/hrs these also could be classified in a similar manner as these of red loam sand on size and texture.

Generally, it is expected that the rate of infiltration in heavy loam is less when compared to the medium and light loam soil. However, in certain cases, depending upon the land condition and land use pattern, the infiltration rate shows a varying trend. It can be seen that the runoff potential is on the higher side, which reduces the retention of water. This allows water to drain off quickly causing lesser recharge.

Rainfall and Climate

Rainfall is a crucial agroclimatological factor in the seasonally arid parts of the world and its analysis is an important perquisite for agricultural planning in India. All of the natural conditions, rainfall should be regarded as the fundamentals so for as progress of the society is concerned. The Chamarajanagar taluk is moist during the winter and rainy season and comes under semiarid area. There are 8 rain gauge stations in this Taluk. The Taluk is receives an average annual rainfall 696 mm. About 37% of the annual rainfall is received during the SW monsoon (June-September), 36% during the post monsoon or NE monsoon (October-December), 27% during the Pre-monsoon (January-May) period. The analysis of rainfall, for the above period, indicates that though SW monsoon is more predominant, substantial rainfall is received during the Post monsoon or NE monsoon period. Hence, it can be seen that a fairly uniform distribution of rainfall during different seasons and good number of Rainy seasons will help the rain fed agriculture in the Taluk (Source: Department of Statistics &

Table 3: Taluk Fits into Zone VI

Zone	Name	Taluks
VI	Southern dry zone	Kollegal, Yelandur, Chamarajanagar, Gundalpet, Nanjangud, Mysore, T.N.pura, Malavalli, Maddur, Nagamangala.
VII	Southern transitional zone	H.DKote, Hunsur, Periyapatna, Arakalagud, Holenarasipur, Alur, Hassan, Belur

Source: Jagannathan et al. (1991)

Economics, Government of Karnataka, Chamarajanagar, 2011-2012). Average annual and monthly rainfall data are shown in Table 4. Based on the rainfall distribution, soil types and cropping pattern Jagannathan *et al.* (1991) has divided into 10 climatic zones. Based on which Chamarajanagar Taluk fits into zone VI (Table 3).

Water Level Fluctuation

Average Water level fluctuation was computed from ten years water level data for each geomorphic unit. It is observed that the maximum water level fluctuation is seen in Pediplain area where as minimum is seen in pediment area (Table 5).

Categorization

Categorization of geomorphic units has been done, in this study area, based on the Stage of development and the long term trend of water level

Table 4: Rainfall Data of the Chamarajanagar Taluk (cm)

Name of the Station	Years	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total Annual
Udigala	2000-2012	0	10	18.52	26.52	47.63	14.16	37.28	24.46	36.56	54.6	27.63	16.1	**313.46**
Hardanahalli	2000-2012	19.9	20.23	34.46	70.45	82.46	34.67	69.7	70.56	107.39	171.26	56.67	24.21	**761.96**
Ummathur	2000-2012	0	0	71.16	89.71	80.7	67.43	54.3	77.34	130.15	107.07	50.78	19.48	**748.12**
Chamarajanagar	2000-2012	3.77	5.44	16.6	27.86	42.38	12.2	24.52	24.06	36.76	65.23	26.73	17.52	**303.07**
Suvarnavathi	2000-2012	12.63	9.04	6.09	22.71	27.44	25.73	21.9	22.32	35.52	74.67	30.4	11.4	**299.85**
Bendaravadi	2000-2012	9.2	12.52	73.58	64.55	120.18	110.16	125.26	63.77	82.27	88.96	42.61	14.65	**807.71**
Mukdahalli	2000-2012	17.2	6.53	29.26	64.75	88.75	58.35	66.05	81	61.76	133.46	89.15	38.76	**735.02**
Kagalavady	2000-2012	5	4.3	30.12	68.3	79.55	58.3	57.57	77.11	122.12	199.5	69.3	24.64	**795.86**
Kuder	2000-2012	0	2	40	78.9	78.26	58	63.99	99.52	113.93	175.94	58.74	14.12	**783.4**

Table 5: Water Level Data of Study Area for Year of 1998-2014 (WL Below Ground Level) Average

S. No.	Well Type	Name of the Station	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Average Water Level in Meter
1	Open well	Devalapur	3	3.5	3.8	3.6	3.5	3.4	3.7	3.5	3.3	2.3	2.1	2.5	5.25
2	OB well	Yadapur	10.25	10.7	11	11.8	12.2	11.6	11.3	11.5	11.2	10.6	8.9	9.3	10.9
3	OB well	Bisalvadi	16.56	17.3	18	17.4	16.6	16.8	18.1	17.6	16.9	16.4	10.8	15.3	16.5
4	Open well	Yanaganahalli	9	9.4	8.9	9.1	10.2	9.5	10.1	10.3	10.2	10.2	8.2	7.1	9.3
5	OB well	Kagalavady	19.05	21.4	20.6	23.3	21.5	22.1	24.1	19.1	19.8	20.8	18.7	18.7	20.8
6	OB well	Yedayur	20.06	20.8	21.6	22.2	23.1	23.5	23.5	23.3	24.2	21.1	18.6	18.7	21.7
7	DWLR	Harve	27	28.5	29.5	29.4	26.6	32.7	29.3	32.2	30.8	27.4	26.3	26.9	28.9
8	OB well	Chamarajanagar	14.56	15.1	16.1	16.5	16.6	16.5	16.7	16.2	16	14.6	13.9	13.9	15.5
9	OB well	Masagapur	24.71	25.1	26.3	26.6	25.7	25.8	31.5	28.1	31	25.7	22.9	22.6	26.3
10	DWLR	Bedarapur	32.45	32.2	34.2	34.5	35	37.2	36	37.9	35.7	36.9	34.6	33.1	34.9
11	Open well	Bisalvadi	5.7	5.7	4.5	3.8	5.7	4.6	5	5.5	5.1	6.7	6.2	6.4	5.4
12	DWLR	Atgulipur	17.88	17	17.8	18.5	20	20.4	21.3	22	20.9	20.7	18.6	18.3	19.4

Figure 5: Groundwater Resource of Chamarajanagar Taluk-2015

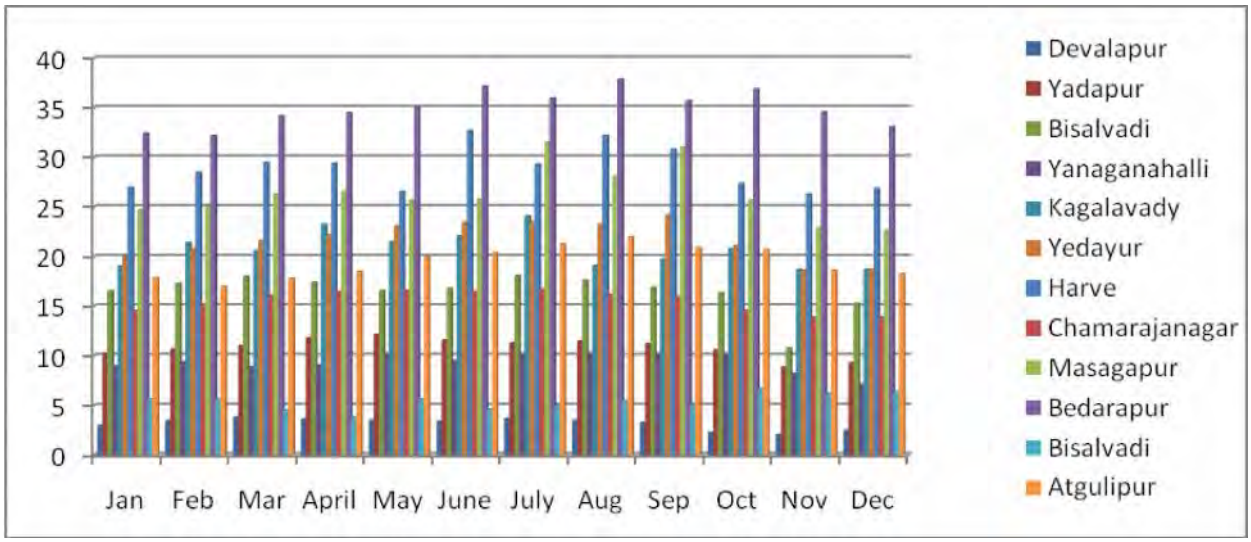


Table 6

Thematic Map	Related Features	Symbol	Recharge Prospect	Rank	Score
Geomorphology 20	Valley fills	VFS	Very good	4	80
	Pediplain Moderate	PPM	Good	3	60
	Pediplain shallow	PPS	Moderate	2	40
	Residual hills	RH	poor	1	20
	Structural hills	SH	poor	1	20
Slope 18	Nearly Level	0-1%	Very good	4	72
	Very Gentle slope	1-3%	good	3	54
	Gentle slope	3-5%	moderate	2	36
	Moderate slope	5-10%	poor	1	18
	Moderate to Steep	10-15%	poor	1	18
	Steep slope	15-35%	poor	1	18
	Very steep slope	>35%	poor	1	18
Geology/lithology 15	Migmatites and Granodiorite	…	Very good	4	60
	Amphibolite/Meta plitic schist	…	good	2	45
	Pyroxene Granulite	…	poor	1	15
	Granodiorite and granite	…	poor	1	15
	Charnockite	…	poor	1	15
	Amphibolite/Hornblende	…	moderate	3	30

fluctuation. Thus, the categorization of the taluk/ study area indicates that the entire Chamarajanagar taluk 97% area falls in safe category, where there is enough scope for further ground water development

CONCLUSION

Land use planning is a part of all agronomic practices. Agronomy needs the land use maps for various agricultural development. Water management, in drought prone areas, necessitates the application of new methods. Land use map clearly indicates that the situation of double crops is maximum in the Taluk, which may be taking plenty of water during non-rainy season. In addition to this, during Kharif percentage of agriculture is very less which should be increased especially in the catchment areas, in order to save water for Rabi season. From the soil characteristics, infiltration and hydraulic conductivity values, it may be presumed that the major part of the district is having high water potential. Rainfall trend also does not account for such a severe drought in the area. So, if proper steps are taken to improve the cropping pattern with optimal water application, the taluk may not face the so called situation known as 'drought'.

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