CONSERVE WATER - SAVE LIFE

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

GROUND WATER INFORMATION BOOKLET
RAICHUR DISTRICT, KARNATAKA

SOUTH WESTERN REGION
BANGALORE
JULY 2013

सुशील गुप्ता
अध्यक्ष
केन्द्रीय भूमि जल बोर्ड,
जल संसाधन मंत्रालय,
भारत सरकार,
भूजल भवन, एन एच. - 4,
फरीदाबाद.

Sushil Gupta
Chairman
Central Ground Water Board,
Ministry of Water Resources,
Government of India,
Bhujal Bhawan, NH-IV,
Faridabad.

FOREWORD

Groundwater is an essential component of the environment and economy. It sustains the flow in our rivers and plays an important role in maintaining the fragile ecosystems. The groundwater dependence of agrarian states like Karnataka is high. Recent studies indicate that 26 percent of the area of Karnataka State is under over exploited category and number of blocks is under critical category. In view of the growing concerns of sustainability of ground water sources, immediate attention is required to augment groundwater resources in stressed areas. Irrigated agriculture in the state is putting additional stress on the groundwater system and needs proper management of the resources.

Central Ground Water Board is providing all technical input for effective management of ground water resources in the state. The groundwater scenario compiled on administrative divisions gives a better perspective for planning various ground water management measures by local administrative bodies. With this objective, Central Ground Water Board is publishing the revised groundwater information booklet for all the districts of the state.

I do appreciate the efforts of Dr. K.Md.Najeeb, Regional Director and his fleet of dedicated Scientists of South Western Region, Bangalore for bringing out this booklet. I am sure these brochures will provide a portrait of the groundwater resources in each district for planning effective management measures by the administrators, planners and the stake holders.

Sushil Gupta
CHAIRMAN

FOREWORD

Ground water contributes about eighty percent of the drinking water requirements in the rural areas, fifty percent of the urban water requirements and more than fifty percent of the irrigation requirements of the nation. Central Ground Water Board has decided to bring out district level ground water information booklets highlighting the ground water scenario, its resource potential, quality aspects, recharge-discharge relationship etc., for all the districts of the country. As part of this, Central Ground Water Board, South Western Region, Bangalore is preparing such booklets for all the 30 districts of Karnataka State, of which six of the districts fall under farmers' distress category.

The Raichur district Ground Water Information Booklet has been prepared based on the information available and data collected from various State and Central Government organisations by several hydro-scientists of Central Ground Water Board with utmost care and dedication. This booklet has been prepared by Shri **G.Krishnamurthy, Scientist-C**, under the guidance of Dr. K. Md. Najeeb, Regional Director, Central Ground Water Board, South Western Region, Bangalore. The figures were prepared by S/Sri. H.P.Jayaprakash, Scientist-C, Dr. Anathkumar Ars, Assistant Hydrogeologist, and J. Sivaramakrishnan, Assistant Hydrogeologist. The efforts Sri. S.S.Hegde, Scientist 'C', Report Processing Section, in finalising and bringing out the report in this format is commendable.

I take this opportunity to congratulate them for the diligent and careful compilation of this booklet, which will certainly serve as a guiding document for further work and help the planners, administrators, hydrogeologists and engineers to plan the water resources management in a better way in the district.

Bangalore
July 2013

Dr.K.Md.Najeeb
Regional Director

RAICHUR DISTRICT AT A GALANCE

Sl. No.	ITEMS	Statistics
1	**GENERAL INFORMATION**	
	i) Geographical area (sq.km)	8383
	ii) Administrative Divisions	
	a) Number of Taluks	05
	b) Number of panchayats / Villages	164/884
	iii) Population (As per 2001Census)	16,69762
	iv) Average Annual Rainfall (mm)-2009	681
2	**GEOMORPHOLOGY**	
	Major physiographic units	**Three** – Northern rugged plateau, southern plains & Valley fills
	Major Drainages	**Two** – Krishna and Tungabhadra
3	**LAND USE (sq.km)**	
	a) Forest area	181.67
	b) Net area sown	5814.13
	c) Cultivable area	6256.21
4	**MAJOR SOIL TYPES**	**Four**: Mixed red and black soils, Medium black soils, Deep black soils and Red sandy soils
5	**AREA UNDER PRINCIPAL CROPS (sq.km)**	6681
6	**IRRIGATION BY DIFFERENT SOURCES (sq.km)**	
	Dug wells	222.39
	Bore wells	143.11
	Tanks/Ponds	10.14
	Canals	1231.27
	Other sources	28.20
	Net Irrigated area	1642.11
7	**NUMBER OF GROUND WATER MONITORING WELLS OF CGWB** (As on 31.03.2013)	
	No of Dug wells	54
	No of Piezometers	11
8	**PREDOMINANT GEOLOGICAL FORMATIONS**	Peninsular Gneissic complex
9	**HYDROGEOLOGY**	
	Major water bearing formation	Weathered/ fractured granitic gneiss
	Pre-monsoon Depth to water level range During-2011	0.65-10.70 (mbgl)
	Post-monsoon Depth to water level range During-2011	0.05-11.00 (mbgl)

	Long term water level trend in 10years (January 2002 to 1December 2011 In m/year)	30 Rising trends : range between 0.005 and 0.578 m/year. 6 Falling trends : range between 0.009 to 0.22 m/year
10	**GROUND WATER EXPLORATION BY CGWB** (As on 31.3.2013)	
	No of wells drilled (EW, OW) Depth range (m)	42-EW; 36-OW 09.3 - 100 mbgl
	Discharge (litres per second)	0.1- 9.0
	Storativity (S)	$1.77x10^{-2}$ to $9.1x10^{-5}$
	Transmissivity (m^2 /day)	1.60-500
11	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than the permissible limit (e.g.EC, F, As, Fe)	Higher concentrations of Fluoride, nitrate and EC values are observed on local scale.
12	**DYNAMIC GROUND WATER RESOURCES** (2004) IN MCM	
	Annual Replenishable Ground water Resources	820.95
	Net Annual Ground Water Draft	262.82
	Projected Demand for Domestic and industrial uses up to 2025	42.44
	Stage of Ground Water Development	48%
13	**AWARENESS AND TRANING ACTIVITY**	
	Water Management Training Programme- Date: 21,22 September-2005 Place: Raichur No. of participants: 28	One
14	**EFFORTS OF ARITIFICIAL RECHARGE & RAINWATER HARVESTING**	
	Projects completed by CGWB	Nil
	Projects under technical guidance of CGWB	One
15	**GROUND WATER CONTROL REGULATION**	
	OE Area in %	24
	Critical area in %	Nil
	No of Blocks notified	Nil
16	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Irregular and deficit rainfall; traditional farming and irrigation methods, unscientific develop-pment of groundwater, Brackishness of groundwater, soil salinity and water-logging in canal command areas, Fluoride etc.

RAICHUR DISTRICT

1. INTRODUCTION

1.1 General

Raichur district is situated in northeastern part of Karnataka state. It falls in the Northern Maidan region, between 15º 33'- 16º 34' North latitudes and 76º 14'- 77º 36' East longitudes. It lies between the two major rivers namely the Krishna and the Tungabhadra. The district is bounded on the north by Gulbarga, on the east by the Mahbubnagar district of Andhra Pradesh. Administrative divisions of the district are shown in Fig.1.

1.2 Location

Raichur town is the district Headquarters. The district has a total geographical area of 8,383 sq kms and is divided into five taluks for administrative convenience. The population of the district as per the 2001 Census is 1924773 with a density of population of 245 / sq.km (table 1). The district has witnessed a growth rate of 23.5% during the last decade.

1.3 Drainage

Raichur district forms part of Krishna catchment in northern part, while southern part forms the Lower Tungabhardra catchment area. The two important rivers in the district are the Krishna and the Thungabadra, which form the northern and southern boundary of the district respectively and are perennial in nature. River Bhima is an important tributary of the river Krishna. The drainage pattern is highly dendritic in nature (Fig.2). The drainage pattern in the area has been altered due to the irrigation practices in the area.

Table 1. Taluk wise Area, Village and Population details

Sl. No.	**Taluk**	**Area (sq. km)**	**No. of villages**		**Population (as per 2001 census)**
			Inhabited	Uninhabited	
1	Devdurga	1508	173	15	222457
2	Lingsugur	1948	186	5	321042
3	Raichur	1535	147	13	330719
4	Manvi	1793	164	7	435380
5	Sindhanur	1599	160	13	360164
	Total	**8383**	**830**	**53**	**16,69762**

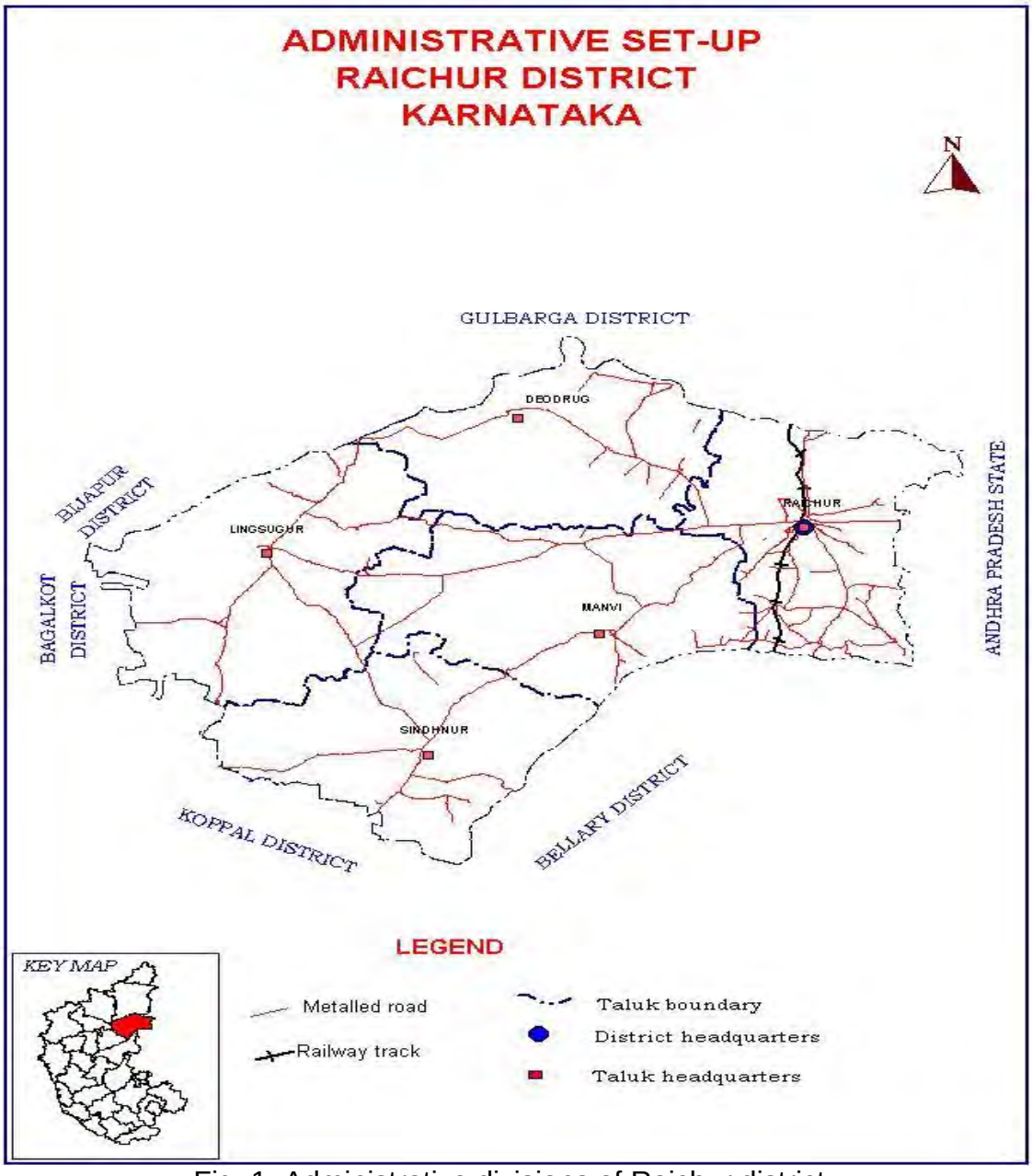

Fig. 1. Administrative divisions of Raichur district

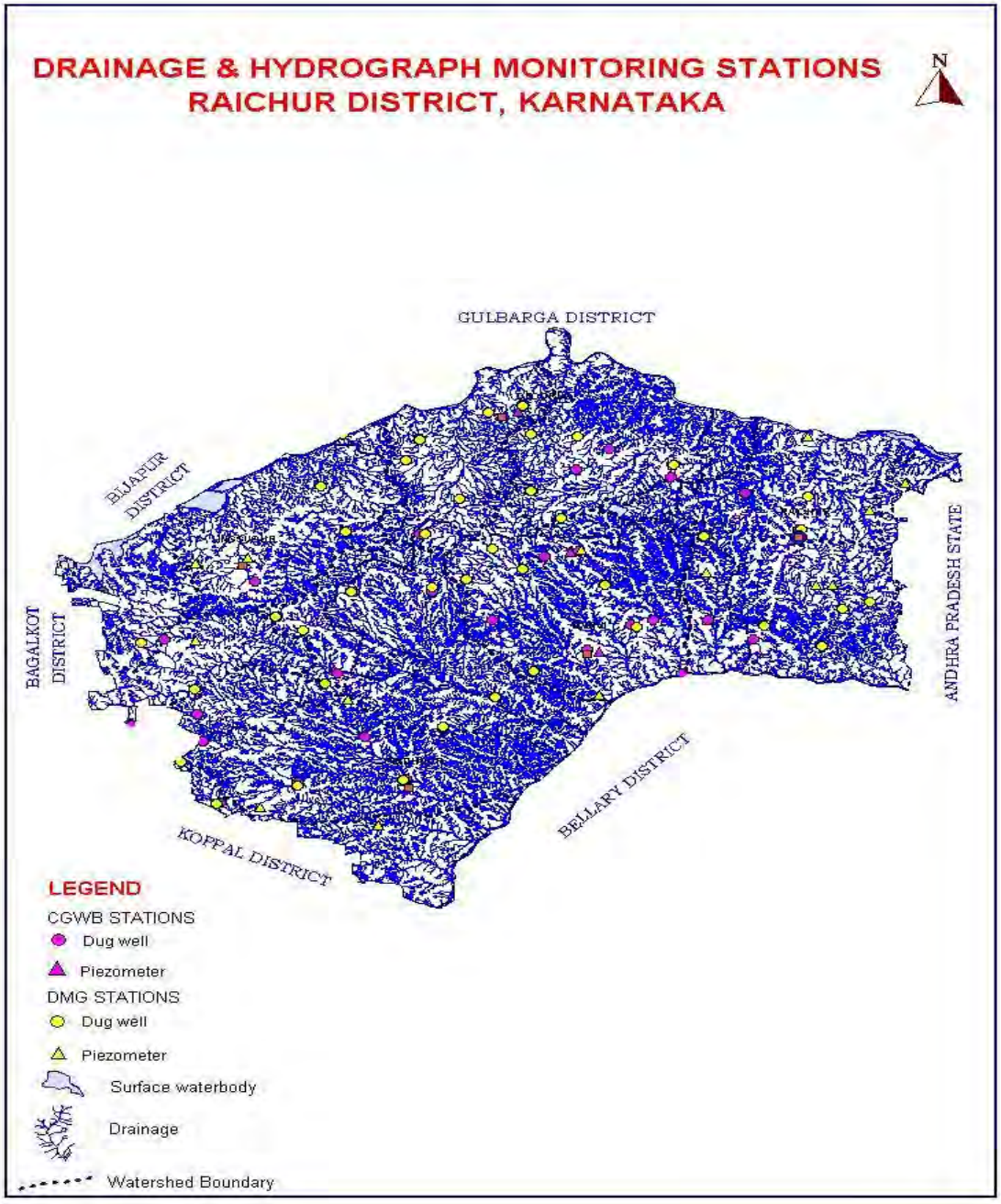

Fig. 2. Drainage map of Raichur district

1.4 Irrigation practices

The net sown area comprises 69% (5814 sq.km) of the total geographical area of the district (table 2). Paddy, Jowar, Maize, Cotton, Sugarcane, pulses and oil seed are the major crops grown in the district. Nearly 20% of the geographical area in the district is under irrigation. Canals, tanks, wells, bore wells, lift irrigation are the important sources for irrigation. A major dam has been constructed across the river Tungabhadra near

Hospet in Bellary district. The Left Bank Canal of the project provides irrigation facility to an area of 123127 hectares of land in parts of Deodurg, Manvi, Raichur, Sindhanur and Lingsugur taluks of the district. The details of the area irrigated by different sources are given in table 3.

Table: 2. Taluk wise land utilisation in Raichur district (in sq.km)

Sl. No.	Taluk	Area (sq.km)	Forest	Land not available for cultivation	Un-cultivable land	Fallow Land	Area sown		
							Net Sown	Sown > once	Total
1	Devdurg	1508	53.01	99.78	93.55	222.04	1008.41	124.78	1133.19
2	Lingsugur	1948	90.77	130.13	113.34	119.23	1443.90	192.09	1635.99
3	Raichur	1535	4.01	21.72	111.13	354.45	992.75	90.96	1083.71
4	Manvi	1793	23.13	41.30	61.52	411.60	1245.75	124.65	1370.40
5	Sindhanur	1599	10.75	113.54	62.42	413.96	1123.32	334.39	1457.71
	Total	8383	181.67	406.47	441.96	1521.28	5814.13	866.87	6681.00

Table-2: Net Area Irrigated by different sources in Raichur district (sq. km)

S. No.	Taluk	Canals	Tanks	Dug wells	Bore wells	Lift irrigation	Other source	Total
1	Devdurg	80.07	2.65	43.07	13.00	2.58	-	141.37
2	Lingsugur	28.44	4.57	140.9	41.99	7.00	-	222.09
3	Manvi	423.95	-	9.97	30.92	9.56	-	474.40
4	Raichur	55.16	2.92	35.18	37.70	6.58	-	137.54
5	Sindhanur	643.65	-	1.08	19.50	2.48	-	666.71
Total		1231.27	10.14	229.39	143.11	28.20	-	1642.11

1.5 Studies carried out by CGWB

Ground water exploration by Central Ground Water Board was first initiated in the district during the year 1985. Subsequently the exploration was continued and completed in the year 1988. A total of 44 Exploratory wells and 34 Observation wells were drilled in the district. The department is also monitoring the water levels in the dug wells, under National Hydrograph Network Stations in Raichur district, where measurements are taken four times a year, during May, August, November, and January, from all the thirty-nine stations. Under the Hydrology Project 11 Piezometers were drilled in the district to monitor the water table fluctuations. Routine Systematic and Reappraisal hydrogeological surveys were carried out in the district from time to time.

2. RAINFALL AND CLIMATE

Raichur district is located in the northern Maidan Region of Karnataka State, which is drought prone and falls in the arid tract.

The climate of the district can be termed as mild to severe, with mild winters and hot summers. December is the coldest month with mean daily minimum of 17. 7º C, while May is the hottest month with mean daily maximum temperature of 39.8º C. The day temperature in May often touches 45.0º C. Relative humidity of over 75% is common during monsoon period. Wind speeds exceeding 15 km/h are common during the months of June and July. The recorded annual potential evaporation is around 1950 mm with May registering over 220 mm and December around 120 mm.

The normal annual rainfall of the district is 621 mm. The annual number of the rainy days is about 49 days. Nearly 67% of the rain is received during the southwest monsoon period (June - Sept) and the northeast monsoon contributes about 24% (table 4)

Table-4. Seasonal & Annual Nornmal Rainfall,Raichur District

Seasonal & Annual Nornmal Rainfall for the period 2001-2010 Raichur District, Karanataka				
Station	**Pre-Monsoon**	**SW Monsoon**	**NE Monsoon**	**Annual**
	Rainfall (mm)			
Deodurg	135	446	145	726
Lingsugur	69	315	126	510
Manvi	101	456	158	714
Raichur	94	466	138	699
Sindanur	73	422	173	668

DISTRICT AND TALUK WISE RAINFALL FOR THE YEAR 2011, RAICHUR DISTRICT, KARNATAKA																	
	DISTRICTS/ TALUKS	JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEPT	SWM	OCT	NOV	DEC	NEM	ANNUAL
2011	RAICHUR	0	0	0	30	21	50	59	91	119	36	305	30	1	0	31	386
1	DEODURGA	0	0	0	12	9	21	73	120	105	16	314	20	1	0	21	356
2	LINGSUGUR	0	0	0	80	45	125	45	27	84	73	229	30	3	0	33	387
3	MANVI	0	0	0	14	25	39	45	97	143	30	315	43	0	0	43	397
4	RAICHUR	0	0	0	12	11	23	106	117	93	16	332	38	0	0	38	393
5	SINDHANUR	0	0	0	30	14	44	27	94	168	44	333	21	1	0	22	399

Source: DES, Govt of Karnataka

3. GEOMORPHOLOGY AND SOIL TYPES

3.1 Geomorphology

Geomorphologically, Raichur district can be broadly classified into three major zones viz, (a). The Northern rugged plateau, ii. (b) The Southern lower plains with inselbergs and isolated hillocks and (c) Valley fills.

Continuous range of hills are absent in the district but a few cluster of hills are seen towards east, west, northwest, centre, and southwest.

The general slope of the terrain is towards the Krishna River in the northern part of the district and towards the Tungabhadra River in the southern part.

One hill range extends from west of Raichur towards Yergara for about 20 kms and another runs in the Raichur and Manvi taluks for about 15 kms and a third hill range extends south of Raichur towards Alampur in Kurnool district of Andhra Pradesh. Most of these hillocks are composed of granitic gneisses and partly schists.

3.2 Soils

The soils of the district can be classified broadly into the following four types namely: Mixed red and black soils, Medium black soils, Deep black soils and Red sandy soils.

Mixed red and black soils usually occur on gently undulating plains or complex geological formations comprising granitic gneisses and schists, which occupy the central parts of the district. Red soils are coarse grained and have better drainage capacity than the black soils. These soils respond better to water management practices. The crops grown under rain fed cultivation are jowar, cotton, groundnut, chillies, wheat and pulses. The crops grown under irrigation are paddy, sugarcane, maize, wheat, chillies, cotton, pulses, tobacco and plantains

Medium black soils are seen in the western part of the district overlying the Peninsular Gneisses. The soils are moderately deep, about one metre thick and are dark to greyish, brown to dark reddish brown or black in colour, usually calcareous, cracking clayey soils. Adequate soil and water management techniques are required to get sustainable yields. The crops grown under rain fed cultivation are jowar, wheat, millets, cotton, sunflower, tobacco, and groundnut. Under irrigation, crops like paddy, sugarcane, vegetables, onion, chillies, jowar, cotton, wheat, tobacco and plantains are grown.

Deep black soils occur on gently sloping to nearly even or low grounds on parent rocks like gneisses, schists of mixed origin and occupy considerable areas in the northern parts of the district. Nearly a metre in thickness, these soils are dark brown, dark greyish brown or black in colour. The texture is usually clayey throughout the section and at places on the surface clayey loam to silty clay texture. Lime concretions on the surface and sub surface are also present. These soils are generally fertile and produce good yields. Good drainage facilities are essential to obtain sustainable yields;

otherwise, salinity and water logging conditions may develop. Crops similar to medium black soils can be grown here.

Red sandy soils occur on undulating landscape on acidic rocks like granites and granitic gneisses under three distinct physiographic positions viz; upland, midland and low land regions. Red sandy soils occurring in the upland region are shallow to moderately deep, reddish-brown to dark reddish in colour, with high permeability and low yields. These soils need development for irrigation. Crops grown are Ragi, Jowar, Millets, Pulses and Groundnut. The soils of the midland region are deep to very deep reddish-brown, loamy-sand to sandy-loam and well developed with moderate permeability and respond well to irrigation. The crops grown are similar as above. The soils of the low land region are partially deposited soils occurring on very gently sloping to nearly flat valley bottom areas. The soils are deep to very deep dark brown, sandy-loam to sandy clay, loam to clayey soil in the sub-surface horizons. The soils are poorly drained and with low permeability. Saline patches are seen at places. Yields are generally good. The crops grown under rain fed conditions are ragi, jowar, groundnut, castor, and cotton while under irrigation crops like paddy, sugarcane, ragi, potato, etc, are grown.

4. GROUND WATER SCENARIO

4.1 Hydrogeology

Granites, gneisses and Dharwar schists are the main rock formations in the district. These formations are grouped under 'hard rock', as they do not have any primary porosity. However, secondary porosity is developed due to faults, fractures, joints, and due to weathering, which improved permeability and water yielding capacity of these rocks. Ground water occurs under water table conditions in the weathered and jointed hard rock, and under confined to semi-confined conditions in the fractured rock. Since the district is covered predominantly by black cotton soils, which inhibit percolation and circulation of water, there are pockets of poor quality ground water in the area. The hydrogeology of the district is shown in the figure-3.

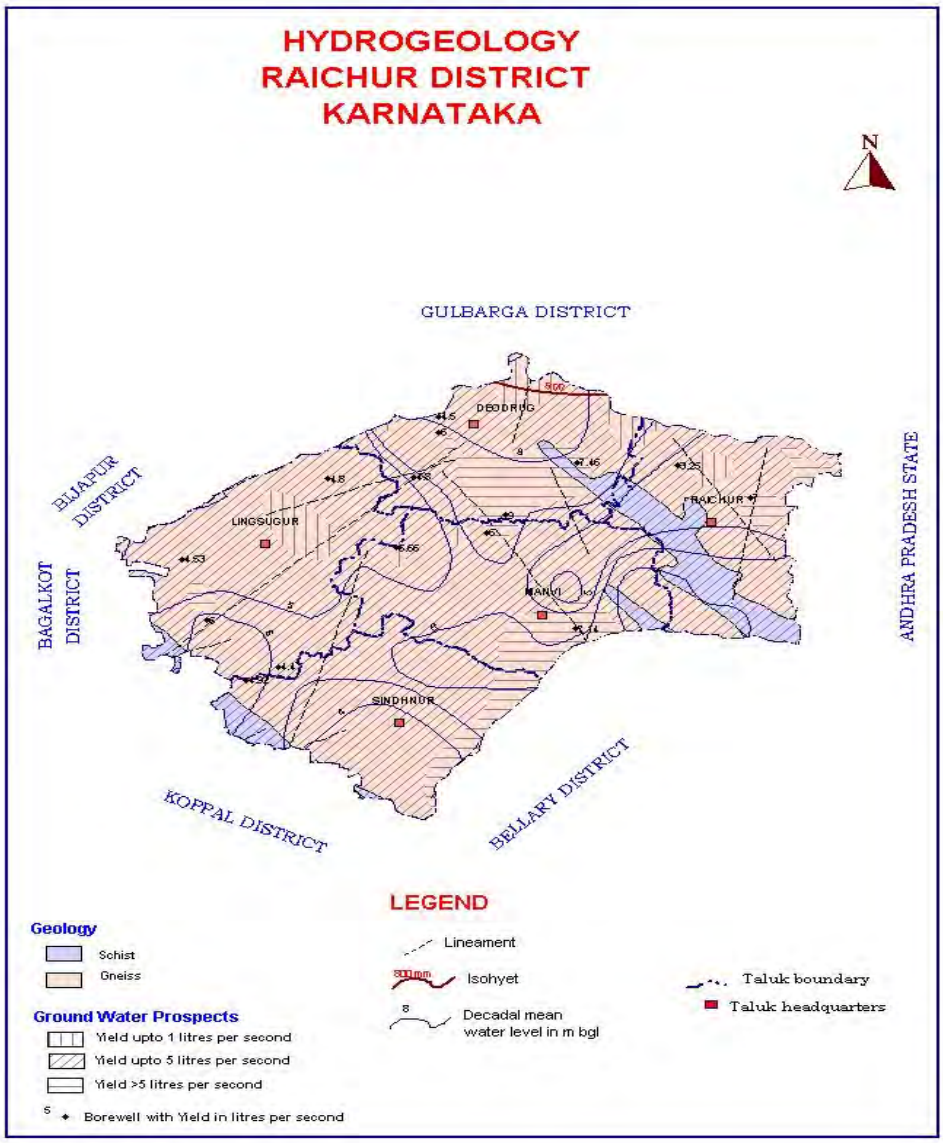

Fig. 3. Hydrogeology of Raichur district.

The depth to water level in general varies from 0.41 mbgl to 8.32 mbgl in the area during the pre-monsoon period (May, Fig. 4), and from 0.05 mbgl to 8.87 mbgl during the post-monsoon (Nov, Fig. 5) period. The decadal fluctuation between pre-monsoon (fig.6) and post-monsoon levels (fig.7) shows rise in 30 stations from 0.005 to 0.578 m and fall in 6 stations from 0.009 m to 0.221 m, during the decade.

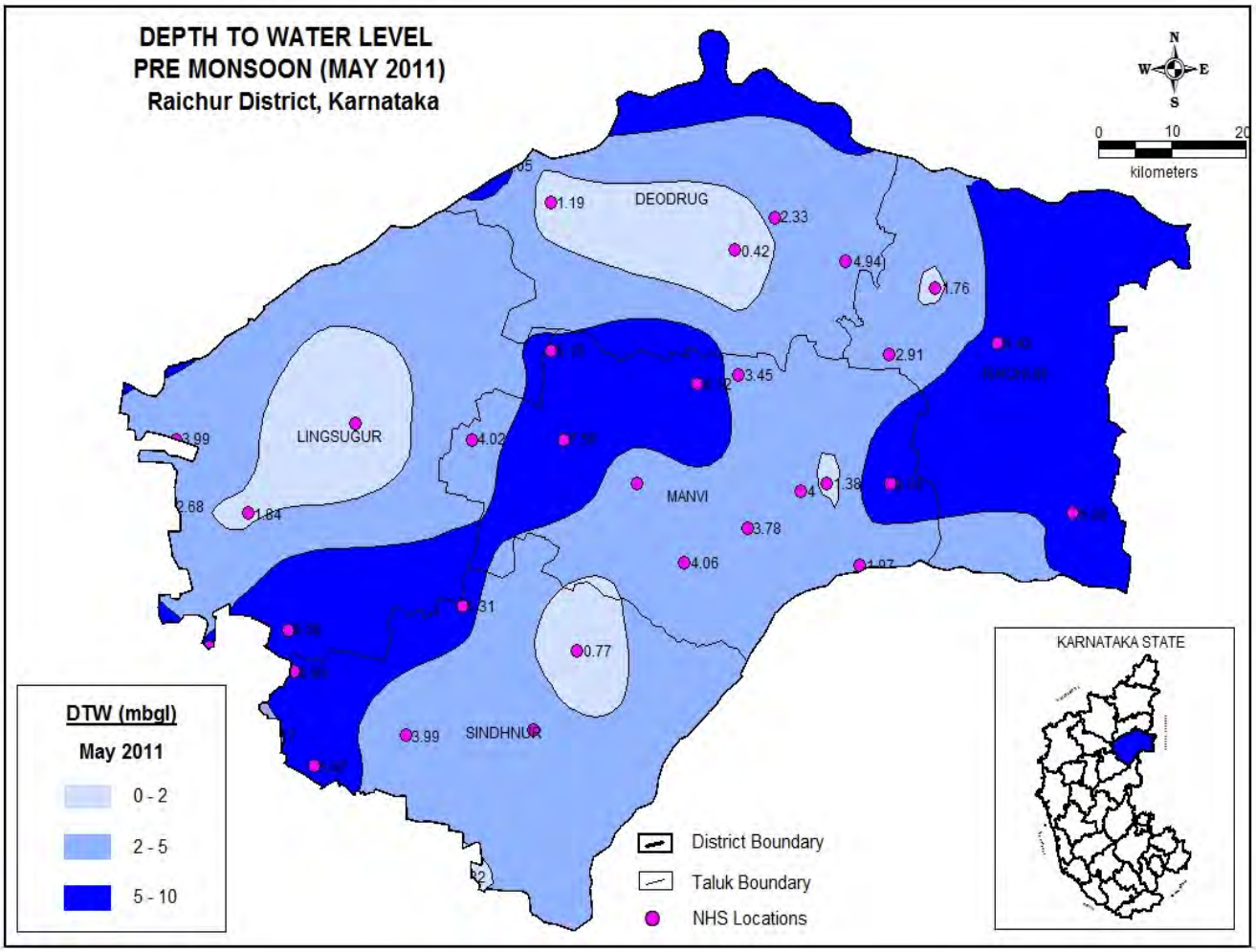

Fig. 4. Pre-monsoon Depth to Water Level map of Raichur district.

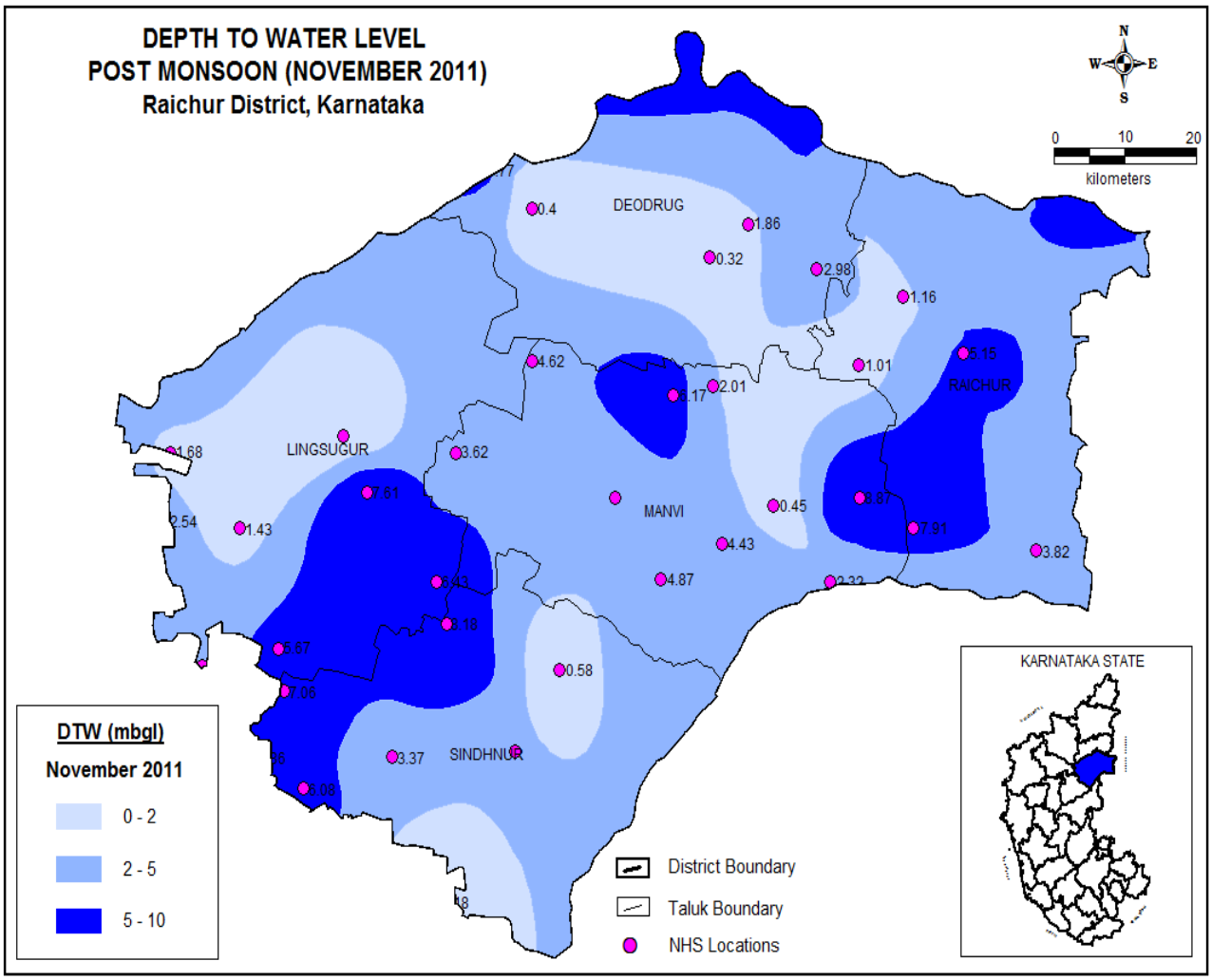

Fig. 5. Post-monsoon Depth to Water Level map of Raichur district.

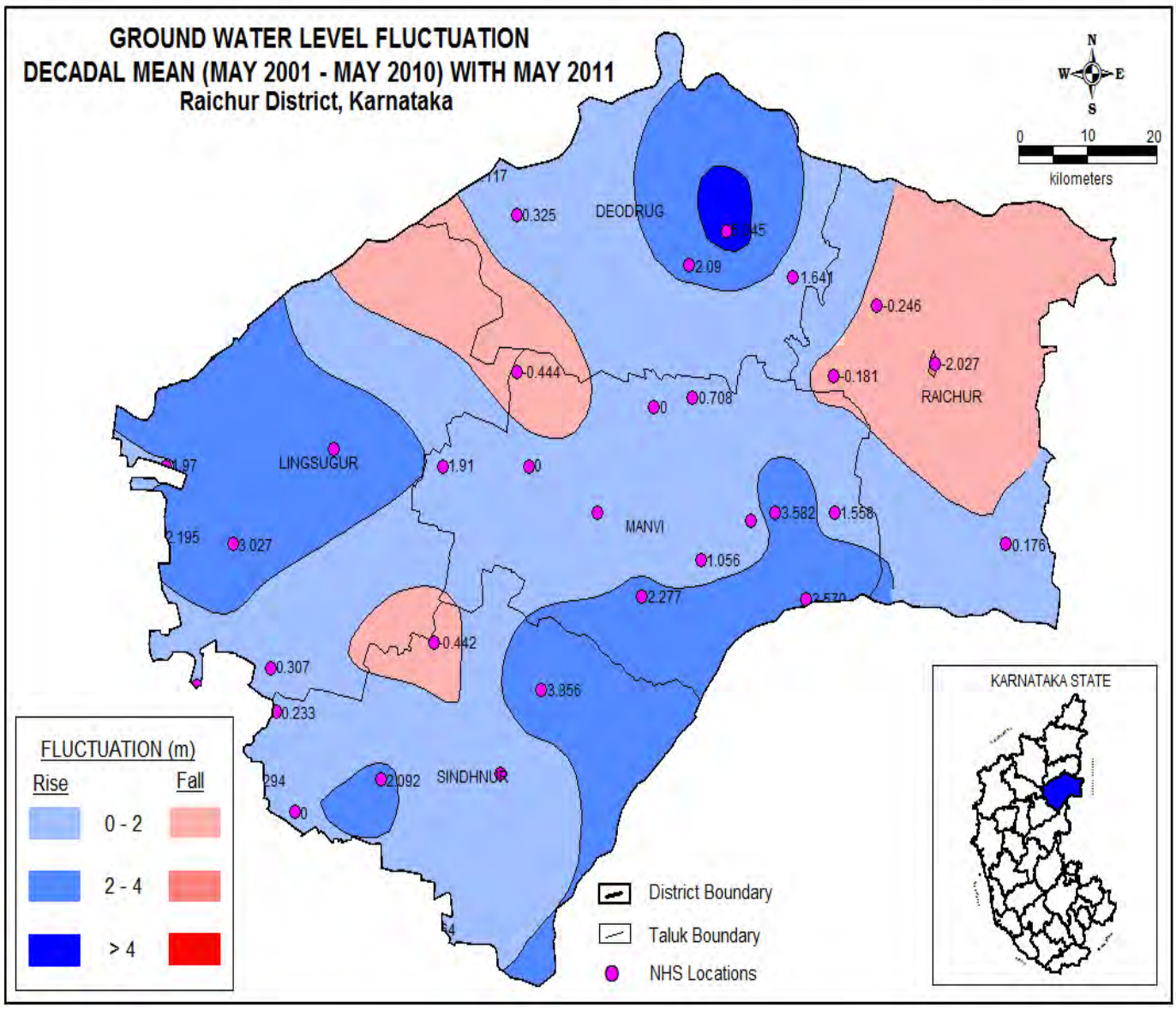

Fig. 6. Post-monsoon Depth to Water Level map of Raichur district.

Aquifers, in the district have been classified into two types based on the various surveys and ground water exploration.

Shallow aquifers: The shallow aquifers in the district constitute mostly weathered, semi-weathered and partly fractured hard rocks occurring below the semi weathered zone, up to the approximate depth of 30 mbgl. Ground water occurs in the open spaces of weathered and fractured rock formations under phreatic to semi-confining condition. Ground water development seen in the district is mainly from this zone, through dug wells, dug-cum-bore wells and shallow bore wells and filter points. The direction of ground water movement corresponds to the drainage on the surface. Based on the data collected from various hydro geological surveys and yield tests carried out, the yields of dug wells varied from 10m^3/day to 250m^3/day. The recuperation is generally poor in the wells tapping schistose rocks.

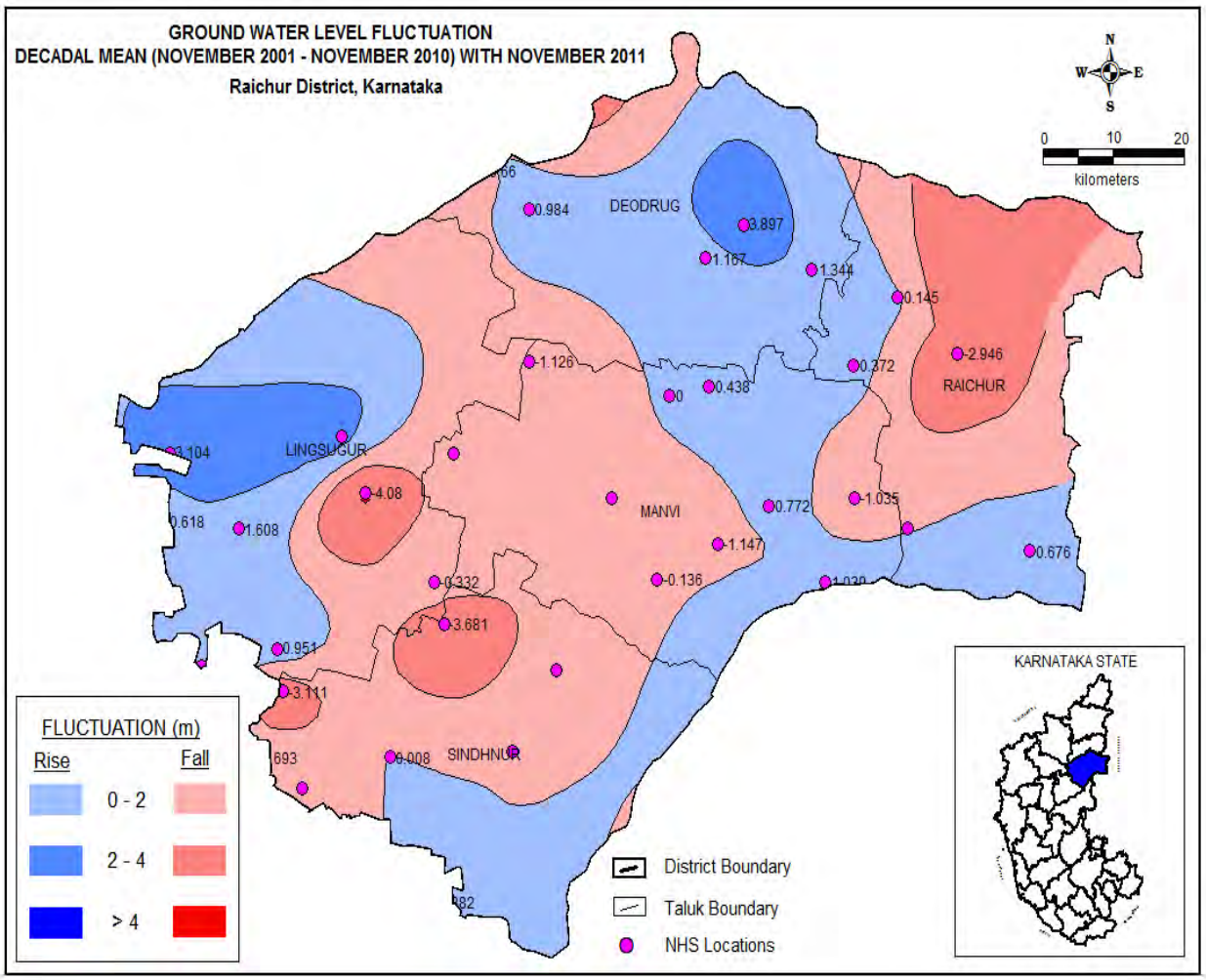

Fig. 7. Post-monsoon Depth to Water Level map of Raichur district.

Medium to deep Aquifers: The medium to deep aquifers occurring in the district are mostly located in the semi-weathered to fractured hard rock and these aquifers are occurring between the depths of 30 -100 mbgl and are tapped through the bore wells. Ground water occurs under semi-confined condition in the semi-weathered zone, but occurs under confined conditions wherever fractures occur at depth, (generally below 40 m depth). Many drinking and irrigation bore wells tap these aquifers. The department has drilled 44 exploratory and 34 observation wells in the district. The yield from these bore wells ranged from less than 1.0 m^3/hr to 75.4 m^3/hr. The transmissivity of the fractured aquifers varied from 0.24 m^2/day to 542 m^2/day. It has been observed that granites and gneisses yield better than schists. Also maximum numbers of productive fractures have been observed in this depth range.

4.2 Ground Water Resources

The resource estimation and categorization is carried out as per the recommendations of 'Ground Water Estimation Methodology – 97 '(GEM – 97) considering water shed as a unit. Water shed and hydrological boundaries do not match with the administrative boundaries. As a result, different parts of taluk fall in different watersheds having different stages of ground water development and categorization. Pro-rata approach to consolidate the watershed data into taluk wise data gives only details on ground water resource, draft and additional irrigation potential. Pro-rata approach cannot be applied for taluk, as a unit, as far as stage of development and categorization is concerned. However, average stage of development is given to have over all idea about the taluk.

It is seen from the Map (Fig. 8) that the taluks in general are 'safe' except Lingsugur taluk where only eighty per cent of the area is safe and the rest (20%) is semi-critical to over exploited area. The percentage of safe area in the district is 75% and the rest 24 % is the 'over-exploited' and 1% 'semi-critical' area. The percentage of 'safe' and 'over- exploited' area in each taluk is given in Table -5. The average stage of ground water development in the district is about 48%. Thus, the district as a whole has scope for ground water development.

1. Net Ground water availability = 82095 Ha m
2. Existing Gross Draft for Irrigation = 23525 Ha m
3. Gross Domestic and Industrial draft = 2757 Ha m
4. Total Draft for all uses = 26282 Ha m
5. Allocation for Domestic and Industrial = 4244 Ha m

   Requirement up to 2025
6. Net ground water availability for irrigation = 55760 Ha m
7. Existing Stage of Groundwater development = 48%

From above it can be inferred that Groundwater development is on a moderate scale. As can be seen from the table, the highest stage of groundwater development is observed in Lingsugur taluk (92%) followed by Raichur taluk (70%). The least development has taken place in Sindhanur taluk (21%). Higher groundwater development is seen those taluks (Lingsugur and Raichur) where major parts of the area are under rainfed agriculture.

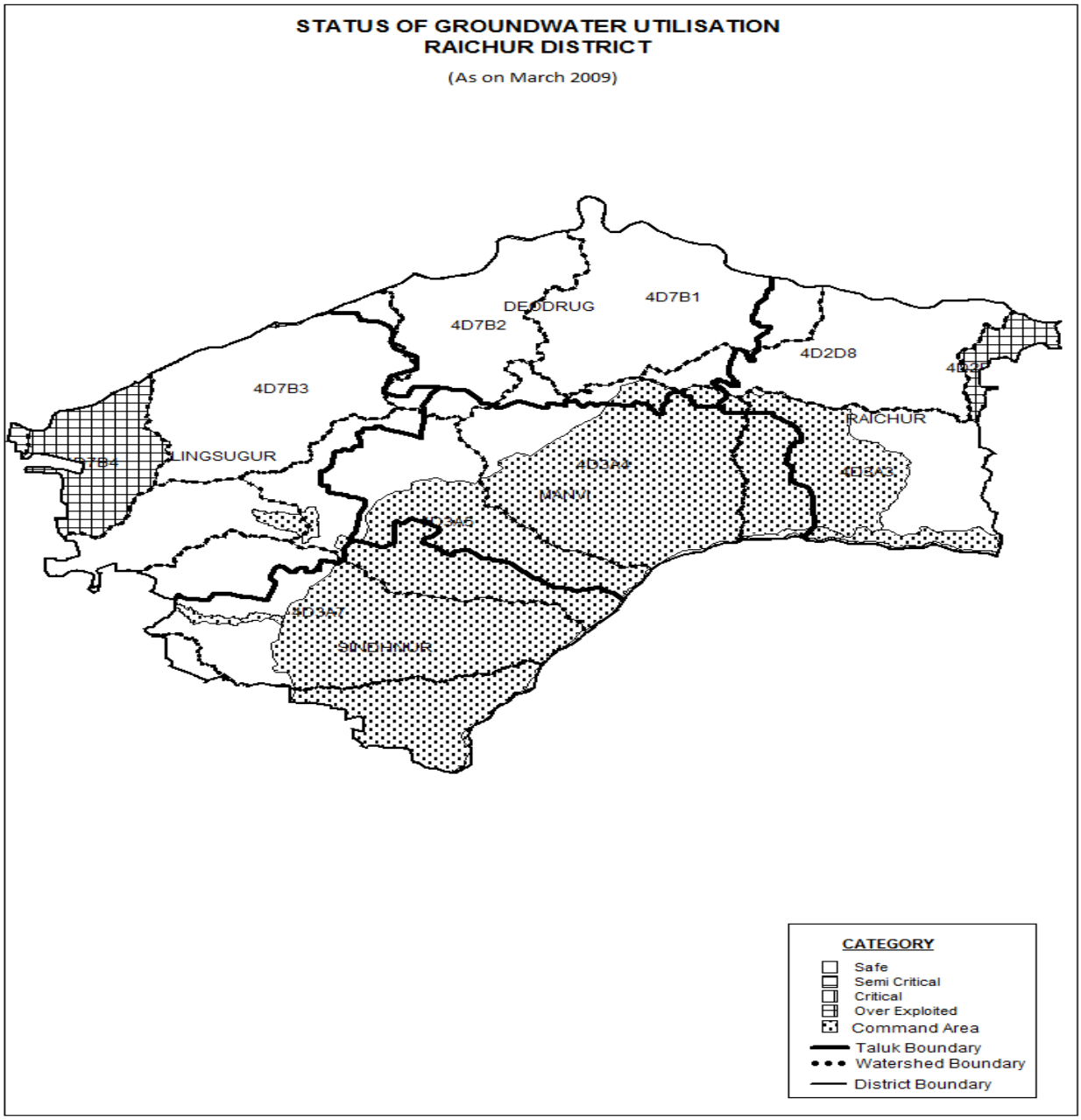

Fig. 8. Status of Groundwater Utilisation in Raichur district (March 2009)

Table. 5. Assessment of Dynamic Groundwater Resources of Raichur District (March 2009)

Taluk	NET ANNUAL GROUND WATER AVAILABILITY	EXISTING GROSS GROUN WATER DRAFT FOR IRRIGATION	EXISTINGGROSS GROUND WATER DRAFT FOR DOMESTIC AND INDUSTRIAL WATER SUPPLY	EXISTING GROSS GROUND WATER DRAFT FOR ALL USES	ALLOCATIONFOR DOMESTIC AND INDUSTRIAL USE FOR NEXT 25 YEARS	NET GROUND WATER AVAILABILITY FOR FUTURE IRRIGATION DEVELOPMENT	EXISTING STAGE OF GROUND WATER DEVELOPMENT	CATEGORISATION OF TALUKS AS ON MARCH 2009			
								SAFE AREA (%)	SEMI-CRITICAL AREA (%)	CRITICAL AREA (%)	OE AREA (%)
	ham	ham	ham	ham	ham	ham	(%)				
Devdurga	7133	2170	521	2691	667	4297	38	100	-	-	-
Lingsugur	7158	5713	900	6613	1056	1256	92	80	01	-	19
Manvi	34285	5861	501	6362	996	27428	19	100	-	-	-
Raichur	7465	4838	418	5256	717	2475	70	95	-	-	05
Sindhanur	26054	4943	417	5360	808	20304	21	100	-	-	-
Total	**82095**	**23525**	**2757**	**26282**	**4244**	**55760**	**Av.48**	**-**	**-**	**-**	**-**

4.3 Ground water Quality

The analyses of ground water samples of the district revealed that the ground water quality when compared with Standards prescribed by BIS (IS-10500-1991) is in general found to be potable. It is also suitable for irrigation purposes in the major parts of the district.

Groundwater in major parts of Raichur district contains fluoride. Excessive fluoride causes mottling of tooth enamel and skeletal deformation. Distribution of fluoride concentration map has been prepared, based on chemical analysis of water samples (collected from shallow and deeper aquifers) and has been depicted in figure 9. The analysis reveals that the majority of the area is having fluoride concentration in the range of 0.10 mg/l to 4.70 mg/l, while the maximum permissible limit being 1.50 mg/l.

Table. 6 – Ground water quality for drinking purpose and ionic concentration range (BIS: 1991)

Parameters	Desirable limit, ppm	Permissible limit, ppm	Undesirable effect outside the limit	Concentration ranges in the district, ppm
Chloride	250	1000	Taste, Corrosion palatability are affected	1069 (max)
Nitrate	45	No Relaxation	May cause Methamoglo-bineimia	465.4 (max)
Fluoride	1.0	1.5	Excessive fluoride causes mottling of tooth enamel and skeletal deformation	0.10 - 4.70

Chemical analysis of groundwater samples collected from exploratory bore wells at the time of exploration shows that the Electrical Conductivity ranges from 150 to 9600 micro mohs/cm at 25^{o} C. Higher values of EC were reported from Kalmala (6440), Amadihal (9000), Potanal (8680) etc. The concentration of chloride ranges from 18 to 2066 mg/l. SAR values range from 0.63 to 63.51(epm). Brackish and saline pockets were encountered in the bore holes drilled at Sripuram, Waykarnal, Kotasivara, Kuppeguda, etc. Salinity is observed in canal command areas of Lingasugur, Raichur, and Sindhanur taluks of Raichur district. Ground water from above areas is unsuitable for irrigation purpose. The analysis results of ground water in some parts of the district indicate higher fluoride content in the deeper aquifers. Water has to be treated for fluoride before it is utilized for drinking purpose. The nitrate (NO_3) concentration above the permitted limits was observed in the district in small pockets as shown in the map (fig.-9). Nitrate concentration is observed where drainage system is very poor and in areas under intensive agriculture. The distribution of various chemical constituents is shown in map (fig-9). In general, Fluoride, Nitrate, Iron and salinity, are the important constituents affecting the ground water quality. As per the available report, nearly 514 habitations in the district are problematic, from quality point of view. High Fluoride

content in the ground water is a major problem in the district. Projects were implemented by the State Government, through Jalnirmal and Swajaldhara, schemes to provide safe drinking water to the affected villages. Further, surface water is drawn locally, from the rivers Krishna and Thungabhadra and extensively utilized for different drinking water supply schemes in the district, to meet the demands of the problematic areas.

4.4 Status of Ground Water Development

With in the weathered and fractured formations, phreatic aquifers are encountered at a shallow depth range of 0 to 20 mbgl and are tapped mainly by dug wells. Average thickness of these aquifers ranges from 5 to 15m. Details on the status of groundwater development are given in table 7.

Table.7 Taluk wise ground water structures in Raichur district

Sl. No.	Taluk	Energised Irrigation structures	Domestic water supply		
			Bore wells	Piped Water Supply Schemes	Mini Water Supply Schemes
1	Devdurga	4048	1324	47	117
2	Lingsugur	7130	1346	84	118
3	Raichur	6563	1351	73	92
4	Manvi	5940	1570	69	114
5	Sindhanur	4903	1445	79	87

At deeper depth range (40-200 m) bore wells are the most common abstraction structures with a yield ranging from 1 to 8 lps. The unit draft of dug wells and bore wells range from 0.5 to 1.25 and 1 to 24 Ham respectively. Well density in the district is 7 wells/sq.km.

4.5 Groundwater Vulnerability area

Groundwater being a dynamic resource, getting recharged annually, primarily from the rainfall, is vulnerable to various developmental activities and is prone to deterioration in quality and quantity. The vulnerability is high in certain areas while in other areas it is comparatively stable. Based on it's susceptibility to various stress factors the district vulnerability map is prepared on a regional scale considering the following factors viz.

1. Area under high stage of ground water development falling in over exploited (generally with stage of development more than100%) and critical (generally stage of development within 85-100%) category as on March 2009.
2. Area having intensive cultivation/ area falling under canal command, thus prone to pollution from fertilisers/ insecticides or water logging.

3. Area having fluoride above maximum permissible limit of 1.5 ppm

4. Area having nitrate above maximum permissible limit of 45ppm. (Even though nitrate is point source pollution due to anthropogenic activity and as such area cannot be demarcated, for the convenience of the user group, area having high incidence of pollution is marked. Within the marked area there may be points devoid of high nitrate and vice-versa.)

5. Industrial cluster as identified by Central Pollution Control Board, prone for pollution from industries.

In some of the districts parts of the area groundwater is vulnerable due to more than one of the above parameters, while in some others the entire district is free from vulnerability in Raichur district.(fig.9)

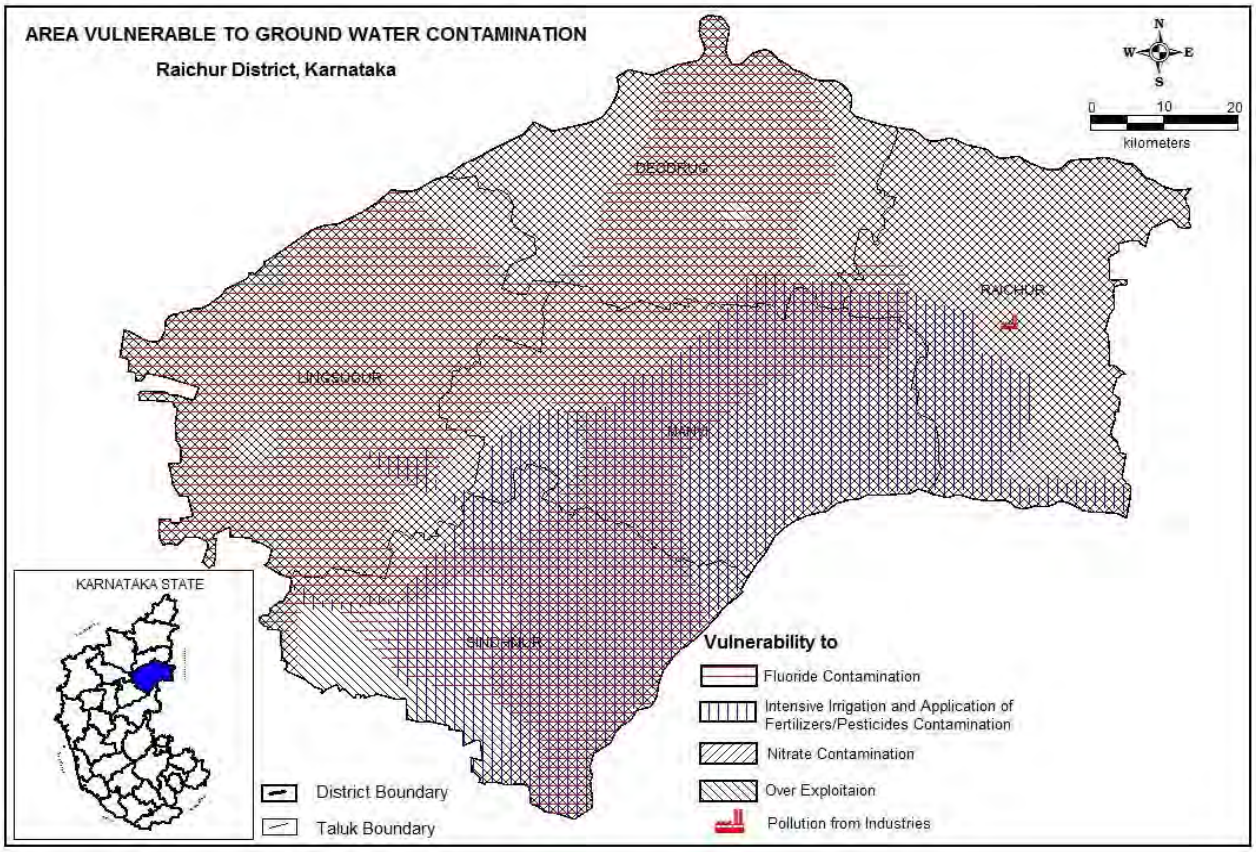

Fig. 9. Groundwater contamination vulnerability map of Raichur district

4.6 Unit area annual groundwater recharge

Sustainability of groundwater resource depends mainly on two factors viz. Annual groundwater recharge and annual groundwater draft. The annual groundwater recharge depends on the quantity and intensity of rainfall, the infiltration characteristics of the soil, the depth to groundwater level, the slope of the area and the geomorphology. The groundwater recharge is assessed separately for the monsoon and non-monsoon period due to rainfall as well as due to other sources. The annual groundwater recharge includes all the above.

The recharge from other sources includes return seepage from irrigated area, seepage from canals, seepage from water bodies, seepage from influent rivers etc. The recharge can be expressed in metres. In Karnataka, the unit area recharge is grouped into four categories viz. 0.025-0.10m, 0.10-0.15m, 0.15-0.25m and 0.25-0.50m. In Raichur district the unit area annual recharge is in the range of 0.10 -0.15 in the eastern parts and in the range of0.025-0.10 in the remaining parts of the district (fig.10)

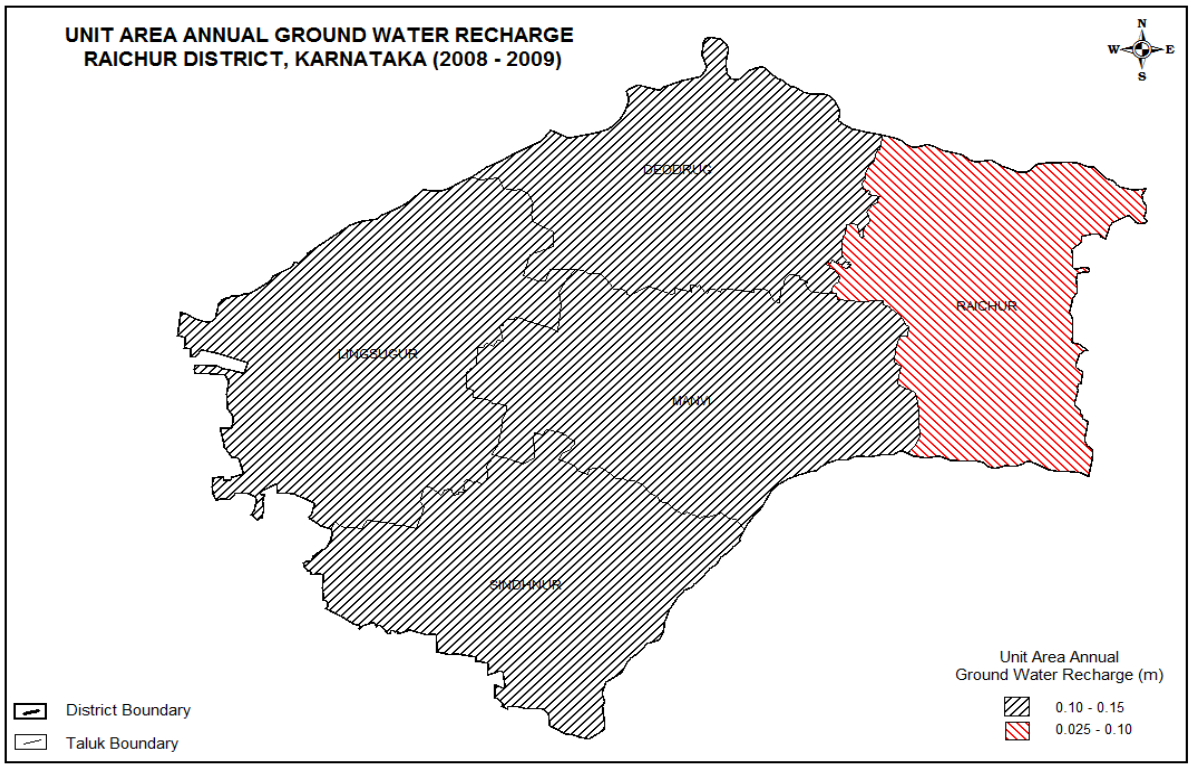

Fig. 10. Groundwater contamination vulnerability map of Raichur district

5. GROUNDWATER MANAGEMENT STRATEGY

A well-planned groundwater resource management strategy is essential to make economical, efficient and judicious use of ground water, so as to make the availability of ground water, sustainable. Creating awareness among the water users on ground water conditions in the different terrain conditions and encouraging its judicious use, adaptation of conjunctive use techniques of ground water and surface water can improve the ground water scenario. In view of the ever-growing population and increasing demand for groundwater for various developmental activities, it is suggested to adopt methods to artificially recharge the ground water in the water level depleting areas, in order to increase the ground water availability. The ground water management

will also help in environmental management and ecological stability in the area. The development of water management model should be resource based and the whole problem should be tackled in its totality, vis a' vis surface and subsurface resources. This will enable us to meet the ever-growing demand for this precious natural resource by practicing conjunctive use in canal command areas.

Apart from above, farmers should be encouraged to grow less water consuming crops and should be discouraged from growing water intensive crops like sugarcane and paddy, especially in the areas where water levels are falling. Transfer of water from areas where water levels are rising to the areas where water levels are falling can also be thought off.

Inter basin transfer of water, from west flowing rivers during monsoon period, in order to recharge ground water in the Krishna basin, where water levels are falling can be a workable strategy.

5.1 Ground water Development

The stage of ground water development in the district, as per the norms is only 48%. Except for small pockets in Lingsugur and Raichur taluks, which are categorised as overexploited, the rest of the district is safe from ground water point of view. The available ground water resources for irrigation are to be utilized by construction of abstraction structures of suitable designs based on the hydro geological conditions prevailing in the area. The annual replenishable ground water resources of the district are 673.66 MCM and the net annual ground water draft is 131.77 MCM. As already parts of the district are canal irrigated, conjunctive use of surface and ground water is to be practiced for sustained development, and adequate surface water availability to tail end users.

5.2 Water conservation and Artificial Recharge

Indiscriminate withdrawal of groundwater by means of different abstraction structures has resulted in the decline of ground water levels. Most part of the rain leaves the area as surface run-off causing floods and soil erosion. By constructing suitable structures, water percolation into ground to recharge ground water can be enhanced.

By studying the nature of geological formations, slope of the land, depth of weathering, depth to water level and availability of land and water source for these artificial recharge structures, different types of artificial recharge structures can be taken up in the district. Except for a small area in the western part of the district, most of the area in the district is plain i.e. having slopes less than 20% and therefore is suitable for construction of percolation tanks, check dams and point recharge structures. Existing borewells/dugwells and recharge pits especially the abandoned ones can also be used as point recharge structures. Care should be taken while selecting the site for a particular type of structure. Suitable recharge structures should be located where the depth of the water level is more or conversely area having deep water tables. The map showing the area suitable for artificial recharge is shown in figure 11.

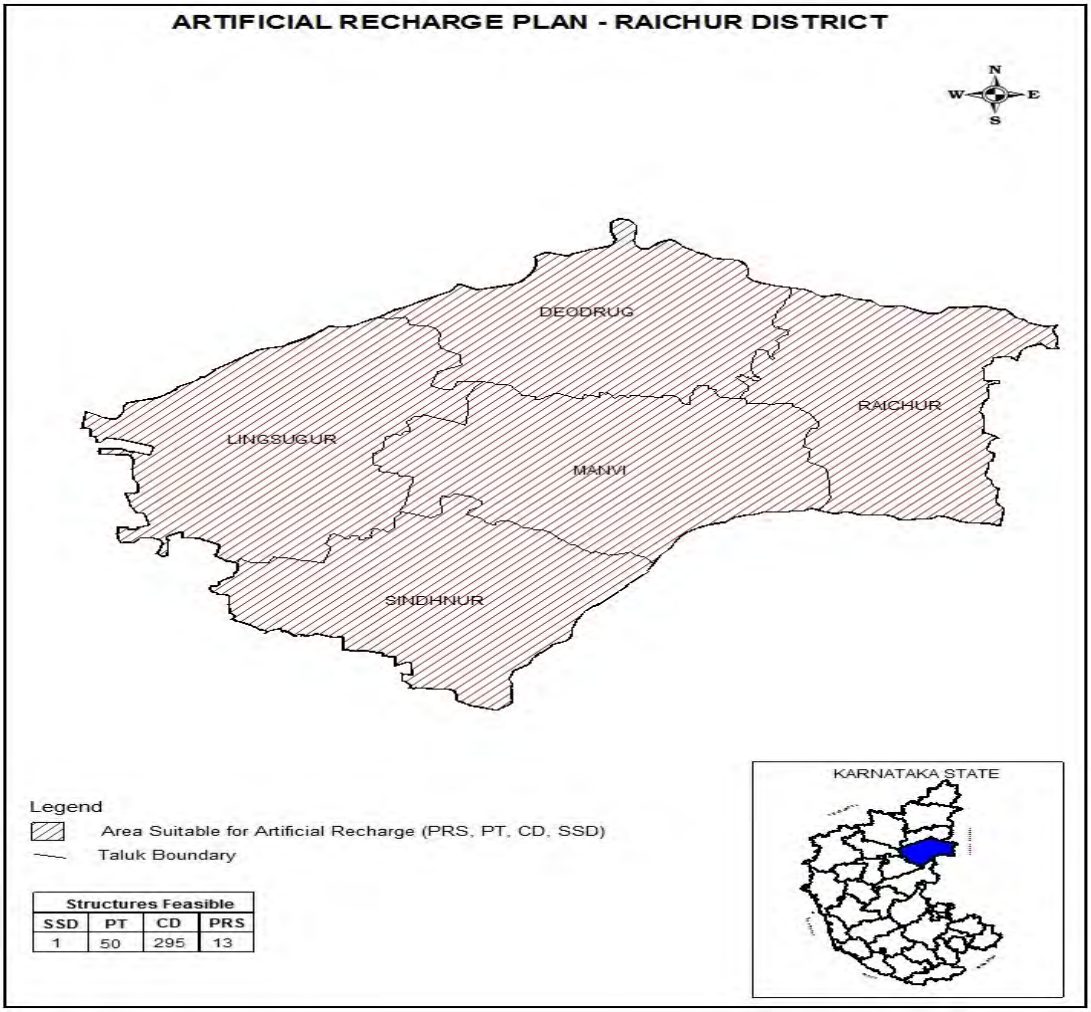

Fig. 11. Groundwater contamination vulnerability map of Raichur district

6. GROUND WATER RELATED ISSUES AND PROBLEMS

The district is located in the northern maidan region of the state, which is drought prone. It also falls in the northeast dry agro-climatic zone. Coupled with the low rainfall, both quality and quantity are affected. At places inland brackishness has been observed. Wherever the ground water is not potable, surface water has been supplied for drinking purposes. Higher fluoride content in ground water has been noticed.

7. AWARENESS AND TRAINING ACTIVITY

Mass Awareness programme was organised by the Mines and Geology Department, in association with Zillapanchayat office, at district headquarters. Central Ground Water Board actively participated in the workshop through resource persons, multimedia presentation, display of Rainwater Harvesting modules, and through distribution of technical information on artificial recharge methods.

7.1 Water Management Training programme (WMTP) by CGWB

Groundwater management training programme was conducted during 21 and 22 of September 2005, at district headquarters, Raichur. The theme of the training was "Ground Water Management". Officers were nominated by the state administration, from different departments like, Irrigation, ZP engineering, Mines and Geology, Watershed development, Jalnirmal, and Jalanayana. Agricultural Engineering College staff and students, local architects and others participated. The training programme was conducted for two days. Twenty-eight trainees attended the training programme. Locals also participated in this workshop with interest. Resource persons drawn from Hydrogeology, Hydrology, and Chemist, spoke extensively on the related subject of water management and water quality. Documentaries and Multimedia presentations were carried out. Case studies were also presented and it was followed by interaction session. Certificates were distributed to the trainees.

8. RECOMMENDATIONS

In Raichur district, bore wells are considered as ideal structures for irrigation purposes, considering the small land holdings in area to be irrigated. Favourable areas having river alluvium can irrigate larger areas. Attempts can be made to locate suitable sites for bore wells adjacent to canal/distributary so that wherever bad quality water is encountered it can be mixed with the good quality canal water and supplied for irrigation. This might help to meet water requirements at the tail end users of the canal command area. The soil needs leaching wherever the quality of water is unsuitable for irrigation. Proper leaching arrangements are to be carried out to avoid salt accumulation, which has already set in some parts of canal command area. A minimum spacing of 300 meters may be kept between two bore wells to avoid mutual interference that affects the yields. A vast area comes under the semi-arid tract and is also drought prone frequently. It is necessary to the monitor the future development of ground water, so that preventive measures can be taken. Simultaneously, these observations should be extended to the canal command area also to study deterioration in water quality. In areas of water logging, suitable anti-water logging measures can be initiated. Since the ground water exploration carried out by Central Ground Water Board was up to a depth of 100 meters in the first phase, it is necessary that the exploration be carried out upto a depth of 200 meters to locate any potential fractures. If this exploration proves successful, more number of deeper bore wells can be drilled for meeting the drinking water requirements. Conjunctive use of surface and ground water may be attempted by developing the potential in the canal command area, so that more area can be served by canal waters and at the same time inhibit the spread of salinity. Further, rainwater harvesting and augmentation of ground water recharge through artificial recharge structures can be taken up in over-exploited pockets of the district and also to improve the ground water quality in general.

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