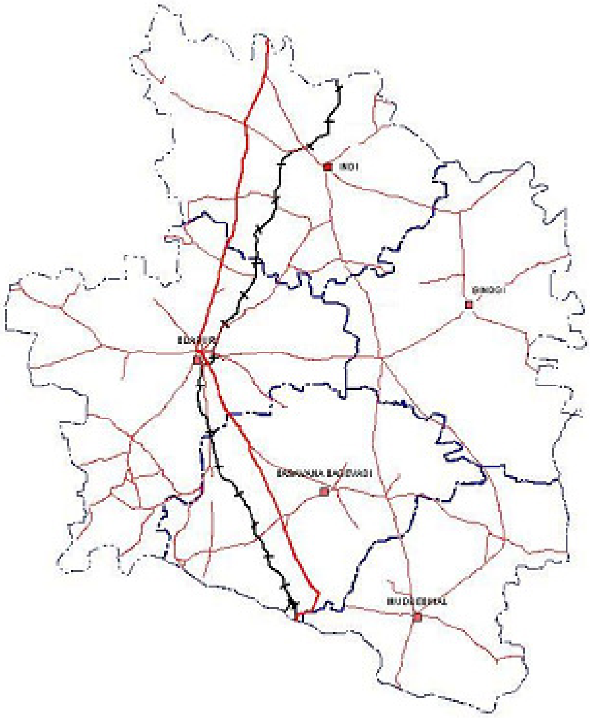
GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES

CENTRAL GROUND WATER BOARD

GROUND WATER INFORMATION BOOKLET
BIJAPUR DISTRICT, KARNATAKA



SOUTH WESTERN REGION
BANGALORE
JULY 2008

FOREWORD

Ground water contributes to 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 27 districts of Karnataka state, of which six of the districts fall under farmers' distress category.

The **Bijapur** 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 Dr.D.P.Reddy, Scientist-B under the guidance of Dr. K. Md. Najeeb, Superintending Hydrogeologist, Central Ground Water Board, South Western Region, Bangalore. The figures were prepared by S/Sri. H.P.Jayaprakash, Scientist-C and K.Rajarajan, Assistant Hydrogeologist. The efforts of Report processing section in finalising and bringing out the report in this format are commendable.

I take this opportunity to congratulate them for the diligent and careful compilation and observation in the form 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.

sd/-

(T.M.HUNSE)
Regional Director

BIJAPUR DISTRICT AT A GALANCE

Sl No	ITEMS	Statistics
1.	GENERAL INFORMATION	
	i) Geographical area (Sq.km)	10541.00
	ii) Administrative Divisions	5
	a) Number of Taluk	5
	b) Number of panchayat/Village	199
	iii) Population (As on 2001Census)	18,06,918
	iv) Average Annual Rainfall (mm)	578
2.	GEOMORPHOLOGY	
	Major physiographic units	03
	Major Drainages	03
3.	LAND USE (Sq.km)	
	a) Forest area	1977
	b) Net area sown	7,17,253
	c) Cultivable area	64,906
4.	MAJOR SOIL TYPES	3
5.	AREA UNDER PRINCIPAL CROPS	7,87,593
6.	IRRIGATION BY DIFFERENT SOURCES (I.P Sets)	76,906
	Dug wells (sq.km)	524.73
	Bore wells (sq.km)	354.24
	Tanks/Ponds (sq.km)	-
	Canals (sq.km)	234.92
	Other sources (sq.km)	170.36
	Net Irrigated area (Sq.km)	1283
	Gross irrigation area (sq.km)	-
7.	NUMBER OF GROUND WATER MONITORING WELLS OF CGWB	
	No of Dug wells	58
	No of Piezometers	23
8.	PREDOMINANT GEOLOGICAL FORMATIONS	Basalts, Shales, Sandstones, Limestones, Granites & Gneisses
9.	HYDROGEOLOGY	
	Major water bearing formation	Basalts, Shales, Sandstones, Limestones, Granites & Gneisses
	Pre-monsoon Depth to water level range during-2006	1.07 – 14.15 m
	Post-monsoon Depth to water level range during-2006	0.78 – 13.20 m
	Long term water level trend in 10 years (1997-2006) in m/year	Rise range from 0.009-0.740 m & Fall range from 0.009-0.580 m
10.	GROUND WATER EXPLORATION BY CGWB (As on 31.3.2007)	

	No of wells drilled (EW, OW, PZ, SH, Total Depth range (m)	55- EW 30.0 – 87.8 m 7-OW 47.0 – 120.0 m
	Discharge (litres per second)	0.01 – 7.6
	Storativity (S)	1.77×10^{-2} to 9.1×10^{-5}
	Transmissivity (m^2/day)	0.22-150
11.	GROUND WATER QUALITY	
	Presence of chemical constituents more than the permissible limit (e.g. EC, F, As, Fe)	EC: 380 – 11,100 micro mhos Cl: 110 – 2300 ppm, NO_3 : 4 – 258 F : 0.1 – 4.8
	Type of water	Potable to Brackish
12.	DYNAMIC GROUND WATER RESOURCES (2004) IN MCM	
	Annual Replenish able GW resources	573.04
	Net Annual Ground Water Draft	356.33
	Projected Demand for Domestic and industrial uses up to 2025	64.17
	Stage of G W Development	69%
13.	AWARENESS AND TRANING ACTIVITY	
	Mass Awareness Programme organised and No. of participants	ONE, dated 31.12.04 About 250
14	EFFORTS OF ARITIFICIAL RECHARGE & RAINWATER HARVESTING	Display of posters, Distribution of pamphlets, brochures & stickers, Organising drawing competitions in schools, conducting awareness and training programmes, Delivering lectures, and presenting through power points and showing documentaries
	Projects completed by CGWB (No & amount spent)	nil
	Projects under technical guidance of CGWB (Numbers)	nil
15.	GROUND WATER CONTROL AND REGULATION	
	OE Area in %	44% in B. Bagewadi, 15% in Bijapur, 31% in Indi, 55% in Muddebial and 59% in Sindagi taluk
	Critical area in %	30% in Bijapur taluk, 29% in Indi
	No of Blocks notified	Nil
16.	MAJOR GROUND WATER PROBLEMS AND ISSUES	Rainfall is erratic, irregular and deficit, Application of traditional farming and irrigation methods, unscientific develop ment of groundwater, Brackishness and salinity of groundwater along the major river courses

1. INTRODUCTION

1.1 LOCATION & ACCESSIBILITY

Bijapur district is located in the northern part of Karnataka state. It falls in the northern maidan region, between 15^0 50'- 17^0 28' north latitudes and 74^0 59'- 76^0 28' east longitudes and lies between two major rivers namely the Krishna and the Bhima. The district is bounded on the north by Sholapur district of Maharastra State, on the west by Belgaum district, on the east by Gulbarga district and on the south by Bagalkot district of Karnataka. Bijapur district is land locked district and is accessible both by rail and road. The broad gauge line of SW Railway connecting Hubli-Sholapur passes through the district. The NH 13 Bangalore to Sholapur and NH-213 of Hubli-Sholapur pass through the district. Bijapur district is connected with other district headquarters through state highways.

1.2 ADMINISTRATIVE DIVISIONS

Bijapur town is the headquarters of the district. The district has a total geographical area of 10,541 sq kms. The district has been divided into five taluks for administrative convenience viz. Basavana Bagewadi, Bijapur, Indi, Muddebial and Sindagi taluks. The population and density of the district as per the 2001 Census is 18,06,918 and 245 respectively. The district witnessed a growth rate of 23 % during the last decade. Taluk-wise statistics is given in Table.1 and administrative map of the district is presented in Fig-1.

Table-1: Taluk- wise Area, Villages & Population in Bijapur district

Sl. No.	Taluk	Area (sq. km)	No. of villages		Population (as per 2001 census)
			Inhabited	Uninhabited	
1	Basavana Bagewadi	1979	121	4	3,03,290
2	Bijapur	2659	118	-	5,69,348
3	Indi	2225	129	4	3,53,987
4	Muddebial	1502	145	8	2,53,638
5	Sindagi	2176	147	1	3,26,655
	Total	10541	660	17	18,06,918

1.3 DRAINAGE

The Krishna River forms the southern boundary with Bagalkot district and Bhima river forms northern boundary with the Maharastra State. Southern part of Bijapur district forms a catchment area of the Krishna while northern part forms catchment area of Bhima. Bhima River is an important tributary of the Krishna River. A major dam has been constructed across the Krishna River near Almatti in the district. Don River is the tributary of the Krishna and flows for about 160 kms in a meandering course from west to east in the central part of the district. The water of this river is generally brackish; it becomes saline at several places during dry months of the year, resulting salt encrustations on the banks of dry beds. During the rainy seasons the river is subjected to flash floods. The drainage pattern is sub-dendritic to sub-parallel in nature and the drainage density varies from 0.49 to 1.02 km/km^2. The drainage network of the district is shown in Fig-2.

1.4 IRRIGATION PRACTICES

In the district, irrigation is carried out from surface water as well as from ground water. Nearly 12% percent of the geographical area in the district is under irrigation. The land utilisation in the district is given in Table.2.

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

Sl. No	Taluk	Area (sq.km)	Forest	Land not available for cultivation	Un-cultivable land	Fallow land	Net area sown		
							Net Sown	Sown > once	Total
1	Basavana Bagewadi	1978.65	11.43	123.99	14.23	617.05	1211.95	96.88	1308.83
2	Bijapur	2657.69	8.34	198.50	80.88	777.51	1592.46	118.58	1711.04
3	Indi	2224.92	-	141.55	24.93	610.87	1447.57	244.14	1691.71
4	Muddebial	1497.44	-	85.14	20.89	160.73	1230.68	123.78	1354.46
5	Sindagi	2176.01	-	99.88	22.90	363.36	1689.87	120.02	1809.89
	Total	10534.71	19.77	649.06	163.83	2529.52	7172.53	703.40	7875.93

Canals, tanks, wells, bore wells and lift irrigation are the important sources for irrigation. Taluk wise irrigated area from the different sources is given in Table.3. Ground water contributes nearly 68% of the total irrigation. There are 76,906 irrigation pump sets as on 31st March 2006 irrigating an area of 87,897 ha out of 1,28,590 ha. The canal irrigation in Shorapur taluk of Gulbarga district is through Indi canal of NLBC of Narayanpur project. Some of the areas of Basavana Bagewadi and Bijapur taluks are to be irrigated from the ALBC and Lift irrigation from the Almatti Dam in Basavana Bagewadi taluk of Bijapur district. Almatti and Narayanpur reservoirs submerge some of the areas of Basavana Bagewadi and Muddebial taluks respectively.

Table-3: Area Irrigated by different sources in Bijapur district (in ha)

Sl. No.	Taluk	Canals	Tanks	Dug wells	Bore wells	Lift irrigation	Other source	Total
1	Basavana Bagewadi	-	-	2,310	3,526	-	3,319	9,155
2	Bijapur	-	-	11,206	13,772	-	5,820	30,798
3	Indi	5,657	-	14,700	3,118	-	6,280	29,755
4	Muddebial	-	-	265	9,117	-	686	10,069
5	Sindagi	17,835	164	23,992	5,891	-	931	48,813
	Total	23,492	164	52,473	35,424	-	17,036	1,28,590

The major crops grown in the district are Jowar, Bajra, Maize, Wheat, Pulses, Oil seeds and Vegetables.

1.5 STUDIES CARRIED OUT BY CGWB

The Central Ground Water Board (CGWB) has drilled bore wells under 'Ground Water Exploration Programme'. The statistics of these bore wells comprising number bore wells drilled, their depths, discharge etc. It also takes up periodic monitoring of depth to water levels of observation wells in the district during January, May, August and November months every year, which are discussed in the Hydrogeology chapter. Officers from the CGWB have carried out Systematic and Reappraisal Hydrogeological surveys and geophysical studies in the district.

2.0 RAINFALL AND CLIMATE

The district experiences semi-arid climate with extreme summers. It enjoys a climate with hot summers and chilly winters. Incidence of drought occurs due to inadequate and erratic distribution of rainfall in space and time. The dust storms and severe heat waves are common during April and May months. The district experiences the temperature variation between 20^0C and 42^0C. The temperature begins to rise by the end of February, till the month May, which is the hottest month. Coldest months are December and January. The year is divided in to summer season from March to May, monsoon season from June to September, post-monsoon season from October to November. The highest monthly rainfall recorded 149.2 mm in September and the lowest is 3.4 mm in the month of February. The district receives an average annual rainfall of 578 mm and taluk wise normal rainfall of the district is given in Table.4. The normal rainfall of the district received is varied from 569 to 595 mm and the normal rainy days also varied from 36.5 to 39.5 mm in the year.

Table: 4 Taluk-wise normal rainfalls in Bijapur district

Sl No	Taluk	No. of Rain gauge stations	Normal rainfall (mm) 1901-70	Actual rainfall (mm) 2006	Rainy days
1	Basavana Bagewadi	6	584	685.7	38.9
2	Bijapur	9	565	429.4	36.4
3	Indi	7	595	505.4	37.6
4	Muddebial	4	577	569.2	39.5
5	Sindagi	7	569	474.7	36.5
	Average		578	532.8	37.7

3.0 GEOMORPHOLOGY AND SOIL TYPES

The entire district is categorised as Deccan Pediplain. Physiographically, it can be divided into four physiographic units' viz., residual hills, pediments, pediplains and valleys. The ground altitude varies from 470 to 650 m above MSL. The ground surface is flat, gently sloping forming broad valleys and flat-topped hills. Flat topped hills with step like sides exhibit the terraced landscape. The northern belt is a succession of low rolling uplands devoid of vegetation.

The district is occupied by three types of soils viz. Black soils, Red sandy soils and mixed soils. Formation of various types of soils is a complex function of chemical weathering of bedrocks, vegetative decay and circulation of precipitated water. Soils are mostly insitu in nature.

Black soils derived from basaltic bedrock. These soils in upland areas are shallower and are deeper in valley portions. The Don River valley has plains and consisting of rich tracks of deep black cotton soils stretching from west to east in the central part of the district. The infiltration characteristics are poor to moderate. The constant rate of infiltration in these soils varies from 0.75 to 2.5 cm/hr. These soils are alkaline in nature, low in potassium and nitrogen. Black cotton soils with high clay and humus content in low-lying areas. They have high moisture holding capacity and on drying up these soils develop open cracks.

Red soils, which are sandy in nature derived from granites, gneisses and sandstones, are found in southern part of Muddebial taluk of the district. The infiltration rates of these soils range from 2.6 to 3.8 cm/hr.

Mixed soils are derived from the fringe areas of Deccan traps and granites, gneisses, limestones and sandstones in Muddebial and Basavana Bagewadi taluks of Bijapur district. These are dark greyish brown and dark brown to dark reddish brown in colour. Their texture varies from loam to clay. The infiltration characteristics of these soils are moderate to good in nature.

4.0 HYDROGEOLOGY

The hydrogeological map of Bijapur district has been shown in Fig.3, which depicts isohyets, depth to water levels contours and yields of bore wells.

4.1 WATER BEARING FORMATIONS:

The major part of the district is occupied by the basaltic flows of Deccan traps, which constitutes the main rock formation in the north and central part of the district. These basaltic flows belong to the sequence of Middle Deccan Traps of Upper Cretaceous to Lower Eocene Age. The formations of Granites and Gneisses of Penisular Gneissic Complex and Bhima Series cover a small portion in south and southeastern part of the district.

The Granites and Gneisses of Penisular Gneissic Complex cover south and southeastern part of Muddebial taluk, which forms the oldest formations in the district. They are seen as big, rounded, massive boulders and isolated hills. The granitic rocks are pink in colour, coarse grained with well-developed joints and are intruded by pegmatites, quartz veins and basic dolerite dykes. The depth of weathering in the district varies from1.00 to 15.0 m.

The Lower Bhima Series comprises of flaggy limestone and shales, ortho-qurtzites and sandstones are overlying crystalline rocks, which are separated by Basal Conglomerates. The exposures of these formations are found in the east and northeastern parts of Muddebial taluk of Bijapur district.

The basalts of Deccan Traps are either horizontal or gently sloping towards southeast. The basalts are generally dark grey to black in colour, fine grained, highly vesicular and zeolitic in nature. At some places closed spaced joints, the columnar jointing and spheroidal weathering are commonly observed. The amygdaloidal basalts on weathering results in light grey to purple coloured decomposed material with shining secondary minerals similar to Blue dust. The inter-flow horizons are marked by the presence of red bole beds.

The study of the fence diagram prepared based on exploration, indicates that a broad classification of three types of aquifers viz., 1. The top shallow weathered zone, which extends down to the depth of 30 m and form the shallow or phreatic aquifer, tapping mostly by dug wells dug-cum-bore wells and shallow bore wells and filter points, 2. Middle zone aquifer, which lies below the shallow zone extends to a depth of 80 m. and deeper zone to the depth up to 250 m, which was explored by the farmers.

Weathered layer forms an important zone for infiltration of water and as its thickness increases, the holding capacity of formation increases. The extent of weathering depends on several factors like, topography, texture, mineralogical composition and extent of fracturing and jointing. Thick weathered zones with porous residual material forms in topographic lows, act as potential groundwater reservoirs. The thickness of weathered zone varies from place to place because of varied litho logical character of flows, slope, intensity of weathering and prevailing climate. Thick weathered zone favoured for storage of more water since the layer has more porosity and permeability than compact rock. Length of casing lowered indirectly indicates the thickness of weathered zone.

4.2 OCCURRENCE OF GROUND WATER

The groundwater occurs under water table and semi-confined to confined conditions in weathered, fracture zones in basalts, limestones, shales, ortho-qurtzites, sandstones, granites and gneisses. The vesicular portion of different flows varies in thickness and has the primary porosity. The nature and the density of vesicles, their distribution and interconnection, depth of weathering and topography of the area are decisive factors for occurrence and movement of ground water in these units. The weathered and fractured basalts occurring in topographic lows are the main water bearing formations in the district.

The Deccan traps / basalts are the major litho-unit of the Bijapur taluk. The basaltic lava flows are mostly horizontal to gently dipping. The contrasting water bearing properties of different lava flows control groundwater occurrence in them. The topography, nature and the extent of weathering, jointing and fracture pattern, thickness, depth of occurrence of vesicular basalt and occurrence of red bole bed are the important factors, which play a major role in the occurrence and the movement of ground water in these rocks. Deccan basalts usually have medium to low permeability depending upon the presence of primary and secondary porosity. The weathered residuum serves as an effective ground water repository in this region.

The massive portions of the basaltic flows are devoid of water but when it is weathered, fractured, jointed, thus forming a weaker zone, then the ground waters occurs in it. The massive basalt showing spheroidal weathering and exfoliation have more groundwater carrying capacity than the unweathered massive trap. However, the water carrying capacity of the massive trap is not homogenous as it is completely depends upon the presence of fractures and joints, their nature, distribution and interconnection.

4.3 DEPTH TO WATER LEVEL

The depth to water level is a subdued replica of the topography of the area. Besides the topography, geological features- fractures and joints control the water level. The depth to water level is highly variable. Shallow water level conditions are commonly observed in valley areas, topographic lows and flat terrain, whereas, the deeper water table conditions noticed near water divides and the topographic highs. The ground water flow is towards the Krishna River in the south, towards Don River in the middle of the area and towards north and northeast in the Bhima River.

The depth to water levels under unconfined conditions mainly dependent on the thickness of the weathered zone, permeability, topographic set up, the nature of aquifer material and are the functions of recharge and discharge components in space and time. The groundwater table is deepest just prior to the onset of the predominant monsoon and reaches a peak a little before the cessation of monsoon. There after the groundwater table shows a declining trend with recession limb having two significant segments.

4.4 PRE-MONSOON DEPTH TO WATER LEVEL

The Central Ground Water Board monitors, water levels at 58 NH Stations 23 Peizometers, four times in a year in the district. The depth to water levels during the pre-monsoon period varies from 1.75 (Almatti) to 24.15 mbgl (Bijapur). The deepest is recorded at Bijapur (Fig.4) because of elevated area.
The depth to water level < 5.00 mbgl covers an area of about 10% and is recorded at Almatti, Hullur and Almel. About 70% of the area of the district falls 5.00-to 10.00 mbgl category. And the rest of the areas, where the depth to water levels of more than 10.0 m are observed at Honwad, Tikota, Jigjiwangi, Rugi, Indi, Tangadi and at Jumnal.

4.5 POST-MONSOON DEPTH TO WATER LEVEL

The depth to water levels during post monsoon period varies from 0.75 at Almatti to 18.87 mbgl at Bijapur. The distribution of post-monsoon depth to water levels is shown in fig.5. Depth to water level of < 5.0 mbgl observed in 30% of the area and is observed at Kannur, Alipur, Aliabad and Shivanagi. About 10% of the area recorded depth to water levels > 10.00 mbgl. And the rest of the area has the depth to water levels of 5.00 to 10.00 mbgl.

4.5 SEASONAL FLUCTUATION

Water level changes occur due to seasonal variations in rainfall, seepage from canals and return flow from applied irrigation, which affect the recharge and discharge components of the groundwater regime.

As a consequence of change in seasonal distribution of rainfall, the water levels record a rise after the rain, indicating the building up of the storage in the groundwater reservoirs. During the non-monsoon period, the exploitation and evaporation deplete this. The water levels, in general, show regression from December to May months. The change in ground water levels also may be due to changes in groundwater storage, atmospheric pressure, deformation of aquifer, disturbance within wells.

The water level fluctuation i.e., the difference in water level between the two specified periods represents the change in groundwater storage. A decline or fall in water level represents groundwater abstraction in excess of increment, while a rise represents ground water increment in excess of abstraction.

Groundwater level represents the storage position of the reservoir. The difference over a period of time is the input and out put components of the storage equation, which reflects as change of storage.

The water level fluctuation depends upon several factors like, climate, drainage, topography, geology, structure, sub-surface distribution of aquifer and recharge to and discharge from the aquifers etc. The specific yield of the formation in the zone of water level fluctuation is a prime factor in controlling the magnitude of fluctuation. Under similar hydrogeological conditions the water level fluctuation is inversely proportional to specific yield.

Large water table fluctuation reflects in recharge areas or in areas of upland regions. Water table fluctuation varies from 1.0 m at Almatti to 6.91 m at Bijjargi. The principal factors that, control water level fluctuation are recharge to groundwater, withdrawal and specific yield of aquifer. 15% of the area recorded water level fluctuation of < 2m, 65% of area show 2 – 4 m fluctuation and rest of the area has the fluctuation of >4.00 m.

4.6 LONG-TERM WATER LEVEL TREND

Long term water level data of NH Stations of the Central Ground Water Board have been observed that the water levels falls from 0.20 to 16.70 m. at all locations. The highest fall (16.70 m) in water levels has been observed at Tikota. 70% of wells show falling trend and 30 of wells show rising trend especially in canal command area in Indi, Basavana Bagewadi, Muddebial and Sindagi taluks.

4.7 SPECIFIC YIELD OF UNCONFINED AQUIFER

The weathered residuum and the fractured rocks occurring at shallow depths form the shallow aquifers. The thickness of weathered zone varies in thickness from 5 to 15 m with an average thickness of 10 m. Ground water occurs in the phreatic condition in this type of aquifer, can be developed through open wells. Results of pumping tests conducted on such open wells show that the open wells sustain yields from 2 to 8 hrs. The Specific Capacity ranges from 5 to 127 lpm\m\m. draw down and the Unit Area Specific capacities ranged from 0.7 to 3.3 lpm/m/dd/m^2.

4.8 AQUIFER PARAMETERS OF CONFINED AQUIFER

The aquifer in the depth zone up to the depth of 80m categorized as moderate zone. The aquifers in this category consist of weathered and fractured basalts, vesicular and zeolitic basalts. Groundwater occurs in the open spaces of jointed and fractured formations under semi-confined conditions. In 65% of the area the yields are less than 0.5lps. In 20% of the area, the yields are in the range of 1-2 lps. In 15% of the area, the yields are of more than 2 lps. Based on exploratory drilling data and other bore well data it is inferred the highest productivity is shown by wells drilled in the depth range of 20-60m, and further the productivity decreases with depth.

The aquifers in zone up to the depth of 200 m are grouped under deep aquifer category. The aquifers consist of weathered and fractured vesicular and zeolitic basalts. Groundwater occurs in the open spaces of fractured and jointed formations under semi-confined and confined conditions.

In 40% of the area the 'T' is <10 m^2/day. In 30% of the area the T is 10 to 50 m^2/day and 20% of the T is 50 to 100m^2/day and 10% of the area the T is >100m^2/day. In major part of the area (60%) the yields are <1lps. 30 % of the area is within the yield range of 1-5 lps. and rest is >5lps.

In case of basalts, the productivity of wells is high in the depth range of 40-80 m. The productivity of wells drilled to the depth greater than 100 m is lowest.

Some bore wells drilled down to a depth of 250 m (private bore wells) recorded very low (<1 lps) discharge. The low discharge of bore wells may be due to compact and massive nature of rock. Water bearing fractures yielding 5 lps occur within 60 to 80 m depth, which is the promising zone for the groundwater development. At places, deep fractures (80 – 100 m depths) with moderately good discharges were encountered. About 50% of bore wells drilled recorded moderate discharge (3 lps) indicating good prospects for groundwater development through bore wells with depth range of 60 – 120 m.

4.9 GROUNDWATER EXPLORATION

The exploratory drilling was taken up in the district, aimed at identification of aquifer system, demarcation of their vertical and lateral extent, delineation of potential aquifer zones and evaluation of aquifer characteristics. These studies have provided valuable information on well design and drilling techniques. Exploratory drilling was taken up by the Central Ground Water Board to ascertain the occurrence and distribution of water bearing fracture zones in different litho-units and development of potential of fractured rocks down to the depth of 120 m. Apart from the above, the suitability of particular type of rig, nature of material required for taking up drilling etc., could be inferred from the exploratory drilling. A Down the Hole Hammer (DTH) rig was deployed for the purpose. Depth of Exploratory bore well ranged from 30 to 120 m. The loose over burden (weathered residuum) at the top ranging in the thickness from 0.33 to 25 m was cased with 150 mm diameter. 55 EW and 7 OW were drilled in the district. The discharge observed was varying from negligible to 7.6 lps. The Transmissivity (T) is varied from nil to 150 m^2/day.

A study of drilling data indicates that an average 5 to 15 m of weathered zone occur in different bore holes, underlain by fractured and massive rocks. Generally 3 to 4 water saturated fracture zones were encountered with in the depth of 90 m, beyond which fractures are not common. It is also observed that there is wide variation in the occurrence and distribution of fracture zones both vertically and laterally. Based on the drilling data the occurrence of three types of aquifers viz., shallow, moderate and deep aquifers have been inferred.

Groundwater occurs in basalts in the weathered, vesicular and fractured zones. Much of the original porosity in the vesicular zone has been obliterated due to amygdaloidal fillings. Weathering is the main factor, which has given rise to secondary porosity, otherwise these are impervious formations. Fractures and joints have also developed secondary porosity down to depth of 90.0m as indicated by drilling in the study area. This exploration programme has shown that the intra-formational paleo-weathering has given rise to multi aquifer system. All most all flow contacts down to explored depth (90.00 m) have yielded water.

4.10 YIELDS OF GROUNDWATER ABSTRACTION STRUCTURES

Dug well yield varies from 20-to 250 m^3 \day for 4 to 6 hrs of pumping. During summer months, very little water column available for pumping for 1 to 2 hrs daily. However, during monsoon months pumping hours go up to 8 to 10 hrs. Bore wells drilled for domestic and irrigation purposes, in the depth range 60 to 90 m yield up to 5 lps, rarely up to 10 lps, depending upon favourable locations.

Bore wells located on the major lineaments or near to the intersection of two lineaments generally recorded very good discharge. Bore wells located near or minor lineaments have not given good yields.

PHED, Govt. of Karnataka has drilled over 7558 bore wells to meet drinking water requirements in rural areas in Bijapur taluk. During the first phase of drilling up to 1995, the maximum depth of drilling was 100m, whereas the later part of decade up to 2005, the maximum depth of drilling has gone to beyond 200 m. There are 537 piped water supply schemes and 552 Mini water supply schemes in the district.

5. 0 GROUND WATER RESOURCES

The resource estimation and categorization is carried out as per the recommendations of 'Ground Water Estimation Methodology – 97'(GEM – 97) considering watershed as a unit. Watershed 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 an over all idea about the taluk.

It is seen from Fig.6 and Table.5, that no taluk is completely safe. The percentage of safe area in the district is varied from 1% in Basavana Bagewadi to 36% in Indi taluk. The percentage wise area of safe, semi-critical, critical and over exploited is given in Table.5. Thus the district as a whole comes under 'semi-Critical to Critical stage' of development. All taluks are partly safe, semi-critical, and critical and over exploited, and stage of ground water development varies from the taluk to taluk. The status of ground water utilization is shown in Fig.6

TABLE: 5 TALUKWISE GROUND WATER RESOURCES OF BIJAPUR DISTRICT AS ON 31ST MARCH 2004

Taluk	TOTAL ANNUAL GROUND WATER RECHARGE	NET ANkNUAL GROUND WATER AVAILABILITY	EXISTING GROSS GROUND WATER DRAFT FOR IRRIGATION	EXISTING GROSS GROUND WATER DRAFT FOR DOMESTIC AND INDUSTRIAL WATER SUPPLY	EXISTING GROSS GROUND WATER DRAFT FOR ALL USES	ALLOCATION FOR DOMESTIC AND INDUSTRIAL USE FOR NEXT 25 YEARS	NET GROUND WATER AVAILABILITY FOR FUTURE IRRIGATION DEVELOPMENT	AVERAGE CROP WATER REQUIREMENT	BALANCE GROUND WATER IRRIGATION POTENTIAL AVAILABLE	CATEGORISATION OF TALUKS AS ON MARCH 2004			
										SAFE AREA (%)	SEMI-CRITICAL AREA (%)	CRITICAL AREA (%)	OE AREA (%)
	HAM	HAM	HAM	HAM	HAM	HAM	HAM	(m)	HAM				
Basavana Bagewadi	**9794.97**	**9318.08**	**5807.48**	**594.06**	**6401.40**	**825.69**	**2704.51**	**71**	**2997.48**	**1**	**55**		**44**
Bijapur	**14500.99**	**13936.16**	**5637.45**	**1599.97**	**7229.09**	**2223.80**	**6251.38**	**56**	**6887.14**	**33**	**22**	**30**	**15**
Indi	**15427.03**	**14657.65**	**10162.54**	**1055.73**	**11217.88**	**1467.36**	**3127.67**	**79**	**3473.06**	**36**	**4**	**29**	**31**
Muddebial	**6324.59**	**6053.81**	**3093.72**	**610.16**	**3701.45**	**848.06**	**2265.03**	**65**	**2499.32**	**12**	**33**		**55**
Sindagi	**11256.73**	**10695.33**	**6327.22**	**757.43**	**7083.61**	**1052.76**	**3664.39**	**69**	**3141.32**	**33**		**8**	**59**
Total	**57304.32**	**54661.03**	**31028.42**	**4617.35**	**35633.43**	**6417.67**	**18012.98**	**69**	**18998.33**				

5.1 GROUND WATER DEVELOPMENT

Ground water is being developed through dug wells, bore wells, and the taluk wise ground water development in Bijapur district is given in Table.6. Within 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.

Table: 5 Taluk wise ground water structures in Bijapur district

Sl. No	Taluk	Irrigation structures	Domestic water supply		
			Bore wells	Piped WS Schemes	MW schemes
1	Basavana Bagewadi	13100	1860	98	72
2	Bijapur	24266	1862	135	141
3	Indi	22420	1276	105	88
4	Muddebial	5459	1171	95	123
5	Sindagi	11661	1389	104	128
	Total	76906	7558	537	552

Average thickness of these aquifers ranges from 5 to 15m. At deeper depth range (40-200m) 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. The average well density in the district is 8-wells/ sq.km. There are 76,906 irrigation pump sets in the district creating sizeable amount ground water draft.

5.2 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. Making aware, the water users on the 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-à-vis surface and groundwater resources, thereby, enabling 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 crops that require less water for its production 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.

5.3 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, thus by constructing suitable structures; 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 structures are recommended and shown in the fig.6. Most of the area in the district is plain i.e. having slopes less than 20% and therefore are suitable for construction of percolation tanks, check dams and point recharge structures. Existing bore wells/ dug wells and recharge pits especially the abandoned ones can also be used as point recharge structures.

Moderate to high sloping, undulating terrain is suitable for artificial recharge structures such as contour bunds and contour trenches. Selection of suitable artificial recharge structure is site specific. Therefore, 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 than 5 m. bgl.

5.4 GROUND WATER QUALITY FOR DRINKING AND IRRIGATION PURPOSES

The analysis of ground water samples of the district revealed that the ground water quality when compared with standards prescribed by BIS was in general found to be potable. It is also suitable for irrigation purposes in the major parts of the district. The groundwater quality depends upon multiple aspects viz., rock types, irrigation practices adopted, release of effluents from various industries and due to over exploitation. The chemical quality map of the district is shown in fig.7. In majority of water samples the pH is more than 7.0 i.e. the ground water is alkaline in nature.

DOMESTIC USE

The quality parameters considered are physical, chemical and biological. The physical parameters include- odour, colour, taste, turbidity and temperature. The water from bore wells is generally colourless and odourless and good to taste. But due to effluents or the presence of excess chemical salts it can impart taste to water. Surface effluents change colour, odour, and taste. Temperature of water does not vary much from the atmospheric temperature. The bacteriological parameters indicate the presence of disease causing bacteria. Normally the water from bore wells does not contain harmful bacteria but the water from dug wells may contain disease-causing bacteria. Chemical parameters-pH, TSS, TDS, EC, Dissolved Oxygen, cations (Ca, Mg, K, Na, Fe and Mn), anions (Cl, CO_3, HCO_3, SO_4, NO_3), phosphates and F present in water. In addition, there are other parameters like heavy metals, organic micro pollutants and pesticides. Parameters like fluoride; Nitrate, Total Hardness and Iron content in excess of their permissible limits affect the health of the people.

HARDNESS: Hardness in ground water is a major domestic water quality hazard. The hardness may be temporary or permanent depending upon salts content present. Both the forms of hardness reduce the cleaning ability of soaps and detergents. Hardness in ground water ranges from 75 to 2860 mg/l. Higher concentration of hardness (>600 mg/l) reported at Bijapur, Telgi, yarnal, Kanmadi, Tatnapur, Sharwadi, Agarkhed, Hire Bhevur, Hullur, Gunadal, Jumnal, Tikota, Atharga, Rugi, Solagi, Golgeri, Siondagi, Yankanchi, Belaganur, Chandarki and Basavana Bagewadi.

NITRATE: Presence of nitrate in ground water increases due to human activities on the surface especially near wells/ bore wells like sewage disposal, animal dung pits, and use of nitrogen fertilizers. Higher concentration (>45 mg/l) of nitrate is reported at Basavana Bagewadi, Hebbal, Huvina Hippargi, Managoli, In Basavana Bagewadi taluk, Indi, Agarkhed, Hire Bhevur in Indi taluk, Dhavaslgi, Hire Mural, Hullur, and at Tambagi in Muddebial taluk and at Sindagi, Ambalnur, Belaganur, Chandakavate villages in Sindagi taluk.

FLUORIDE: Excess fluoride is reported in many parts of the district and is ranging from 0.3 to 4.8 mg/l. Higher concentration of (>1.5 mg/l) of fluoride is reported at Indi, Tamba, New Dhulikhed, Chadchan in Indi taluk, Dhavalgi, Hullur, Nidgundi, Devar Hulbagal, Hire Mural in Muddebial taluk, Ukkali, Huvina Hippargi in Basavana Bagewadi taluk and at Tikota in Bijjapur taluk, Sivanagi in Sindagi taluk. In major part of Bijapur district contains fluoride less than 1.5 ppm.

IRRIGATION USE:

According to the classification of ground water, based on electrical conductivity, most of the ground water samples fall under excellent, good and permissible class having EC values less than 2250 micro mhos/cm, except at some localised patches and all along the Don river in Bijapur, Basavana Bagewadi taluks and along the Krishna river in Bijapur and Muddebial taluks and along the Bhima river in Indi and Sindagi taluks where thick black cotton soils exists.

Chemical analysis of groundwater samples collected from exploratory bore wells at the time of exploration show that the Electrical Conductivity ranges from 480 to 8300 micromhos/cm at 25^oC. High value of EC of more than 3000 micromhos/cm at 25^oC reported at Golsangi, Manguli,Aliyabad, Honwad, Khatijapur, Bommanahalli, Talikota. The concentration of chloride ranges from 18 to 2135 mg/l. SAR values range from 0.6 to 16.13.

Chemical analysis of groundwater samples collected from dug wells during the surveys show that the Electrical Conductivity ranges from 430 to 11,100-micromhos/ cm at 25^oC. High value of EC is of more than 3000 micromhos/cm at 25^oC reported at Jumnal, Tikota, Solalgi, Golgeri, Yankanchi. The concentration of chloride ranges from 14 to 1700 mg/l. SAR values range from 0.48 to 9.29.

5.5 MASS AWARENESS PROGRAMME (MAP)) BY CGWB AT BIJAPUR

Mass Awareness programme on '' Protection and conservation of groundwater'' was held at ZP Hall, Bijapur, Zilla Panchayat on 31.12.2004. Smt.Lalita N.Patil, President, Zilla Panchayat, inaugurated the programme. Sri. M. Nagaraj IPS, CEO, ZP, Bijapur, presided over the function. Sri. Kallappa B. Bellundagi, Vice president, ZP, Bijapur, and Sri. Mohammad Mohsan IAS, Deputy Commissioner, Bijapur district were the Guests of honour. Shri. C. S Ramasesha, Regional Director, delivered the keynote address. As a part of programme, professional artist staged a drama depicting the theme and drawing competition on the theme was also conducted for school children and prizes were distributed. Documentaries on artificial recharge structures and rainwater harvesting with case studies and quality of ground water were also shown. Working models on rainwater harvesting and artificial recharge were displayed in the hall. About 250 people representing from the state government, educational institutions, farmer community and NGOs were participated in the programme.

Power presentation and lectures were delivered in the programme covering ground water development, conservation and management and stressed the importance of ground water recharge and rainwater harvesting. Radio and TV channels have covered the programme.

6. RECOMMENDATIONS

The ground water development is not uniform in the district; even within the taluk it is variable. The following measures are suggested to improve the ground water situations in semi-critical, critical and over exploited areas.

1. In the area of poor aquifer transimissivity, the large diameter well is an ideal structure. The performance of the well can be improved by putting small diameter bores either vertical or inclined depending upon the local conditions. In a relatively high transimissivity area, the ideal structure could be a bore well, which costs less and occupies less area than a dug well.
2. In the district, dug wells are usually circular or square in shape and the depth varies from 7 to 18 m. Dug-cum-bore wells are common in upland plains. The dug wells have extensions of 10 – 30 m of bores. The dug well portion acts as a reservoir**.** The design of a well depends upon thickness of phreatic aquifer.
3. Bore wells are comparatively less in number in the past, but are increasingly becoming popular. The diameter of bore wells normally 150 mm and depth range from 40 to 120 m. In order to avoid interference the wells spacing should be maintained at least 100-150 m distance in between two wells. The shallow tube well should be placed at 150 to 300 m. apart, and deep bore wells should be located more than 300 m apart.
5. Excessive groundwater withdrawal and unscientific methods of groundwater exploitation have led to the depletion of groundwater level. All these instances suggest an urgent need for the groundwater management, which involve various measures - enhancing the storage capacity of aquifers, protection of groundwater quality and proper utilization of existing groundwater resources.
6. Construction of minor irrigation tanks, percolation tanks, will increase groundwater recharge.
7. Black cotton soils are generally poorly drained, have high moisture holding capacity, and occupy low-lying areas, near riverbanks of broad valleys. The pH of these soils is more than 8.5 and groundwater is alkaline in nature. These soils are susceptible to water logging and salinity. Water levels in these areas have to be regulated and maintained more than 5.0 meters below the ground level so as to avoid above adversities.
8. Groundwater recharge through shafts is recommended in steep slope areas. The shafts are deep pits with dimensions of 1 x 2 x 10 m of width, length and depth respectively. These shafts may be uncased on the top, but are back filled with permeable soil, which facilitate more effective and faster percolation.
9. As for as possible, flooding of water in the fields has to be avoided, instead sprinkler and drip irrigation techniques are to be adopted. Evaporation and seepage losses can be minimized when water is supplied through pipes.

10. Farmers grow traditional crops, regardless of their suitability for the existing conditions. Cropping pattern should be selective. High water consuming crops are to be replaced by less water consuming crops. Long duration crop varieties are to be replaced by short duration crops. Use of improved hybrid varieties with drought resistant and salt tolerant crops should be preferred.

11. Evaporation of water in reservoirs is to be controlled by application of unharmful chemical, which form a thin layer on the surface of the water bodies.

12. De-silting of existing tanks is to be undertaken regularly to increase the storage and the recovered material is to be fed to the agricultural fields to improve the fertility.

13. Low forest density has been responsible for denudation of lands, degeneration of soils, and depletion of water table and degradation of environment. Revival of green cover is the only means to restore forest density. Green activities like grassing, hedging, rising crops, silviculture through bunds and boundary cultivation, horticulture, social forestry, aforestation and forestry are to be implemented. Contour techniques such as stone packing, ploughing, furrowing, trenching and bunding are to be adopted.

14. Sub-surface dykes\dams is to be constructed to check the sub-surface groundwater flow.

15. Educating the people by imparting the importance of groundwater in local languages, through regular village level camps, using audio-visual media, ensuring the participation of local chiefs, farmers has to be undertaken.

By watershed approach rainwater retained in the upper reaches, improves soil moisture, prolong water movement and increase recharge to groundwater.

Fig- 1

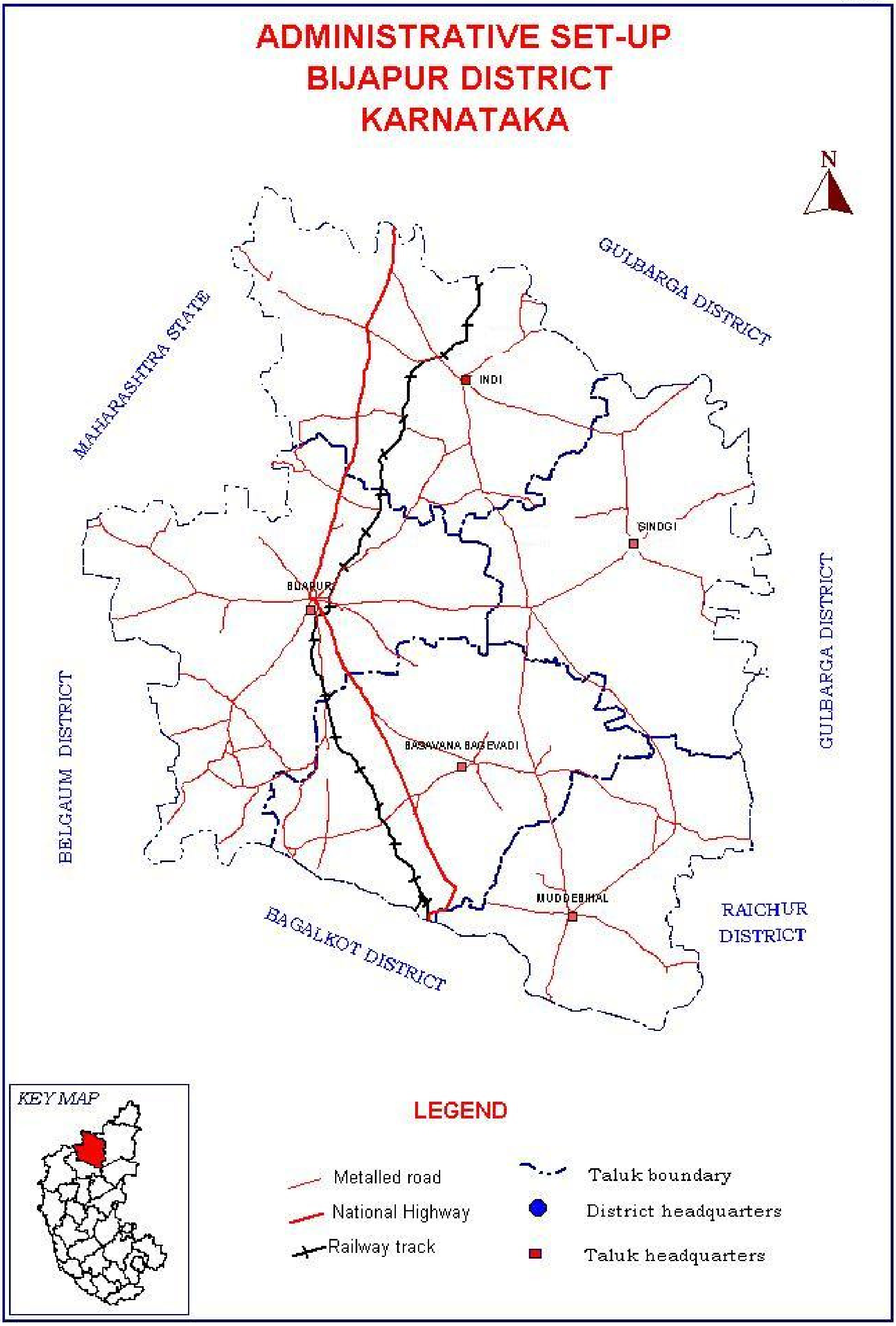
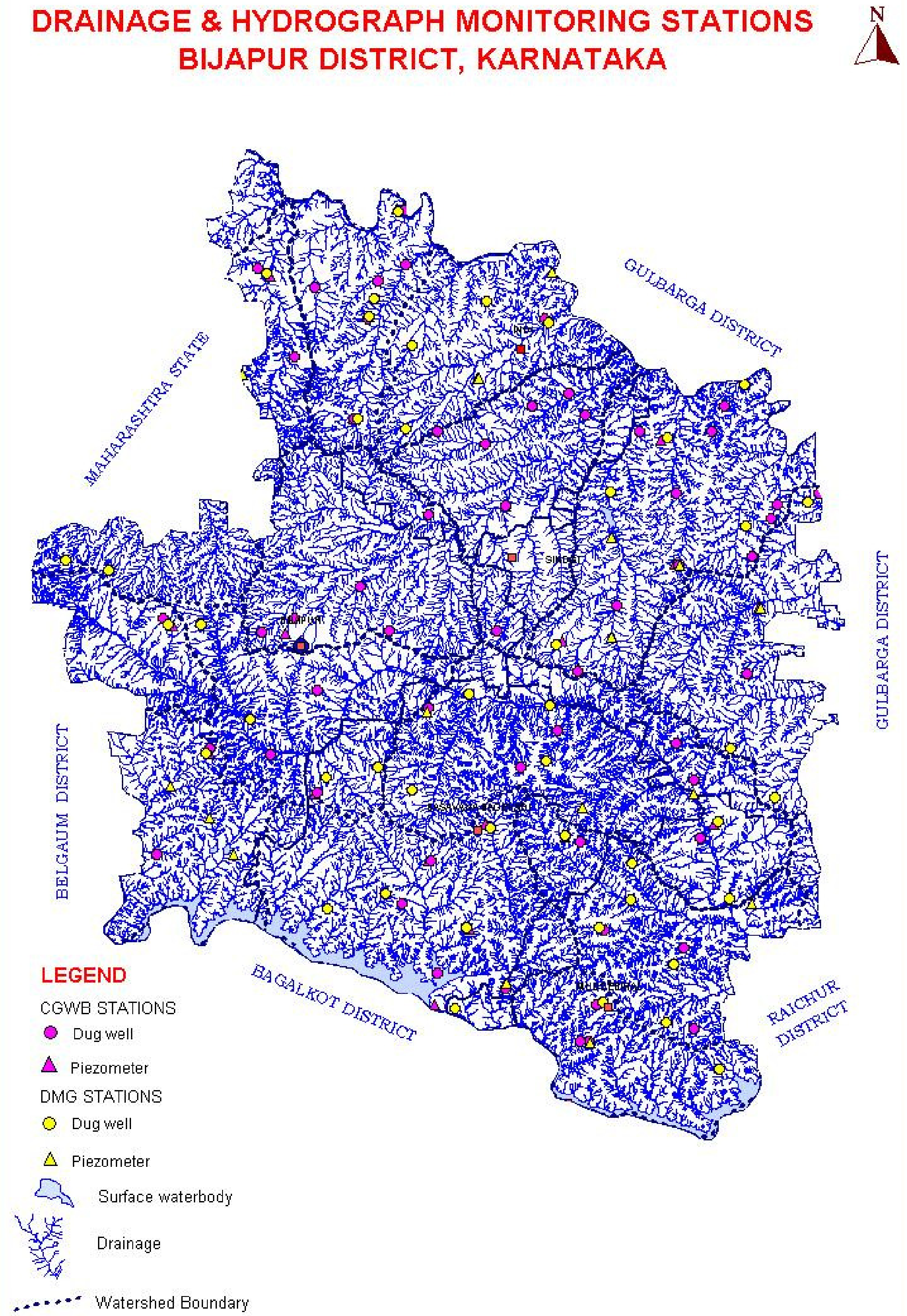

ADMINISTRATIVE SET-UP
BIJAPUR DISTRICT
KARNATAKA
N
GULBARGA DISTRICT
MAHARASHTRA STATE
INDI
SINDGI
BIJAPUR
BELGAUM DISTRICT
GULBARGA DISTRICT
BASAVANA BAGEVADI
MUDDEBIHAL
RAICHUR DISTRICT
BAGALKOT DISTRICT
KEY MAP
LEGEND
Metalled road
National Highway
Railway track
Taluk boundary
District headquarters
Taluk headquarters

Fig-2

DRAINAGE & HYDROGRAPH MONITORING STATIONS
BIJAPUR DISTRICT, KARNATAKA



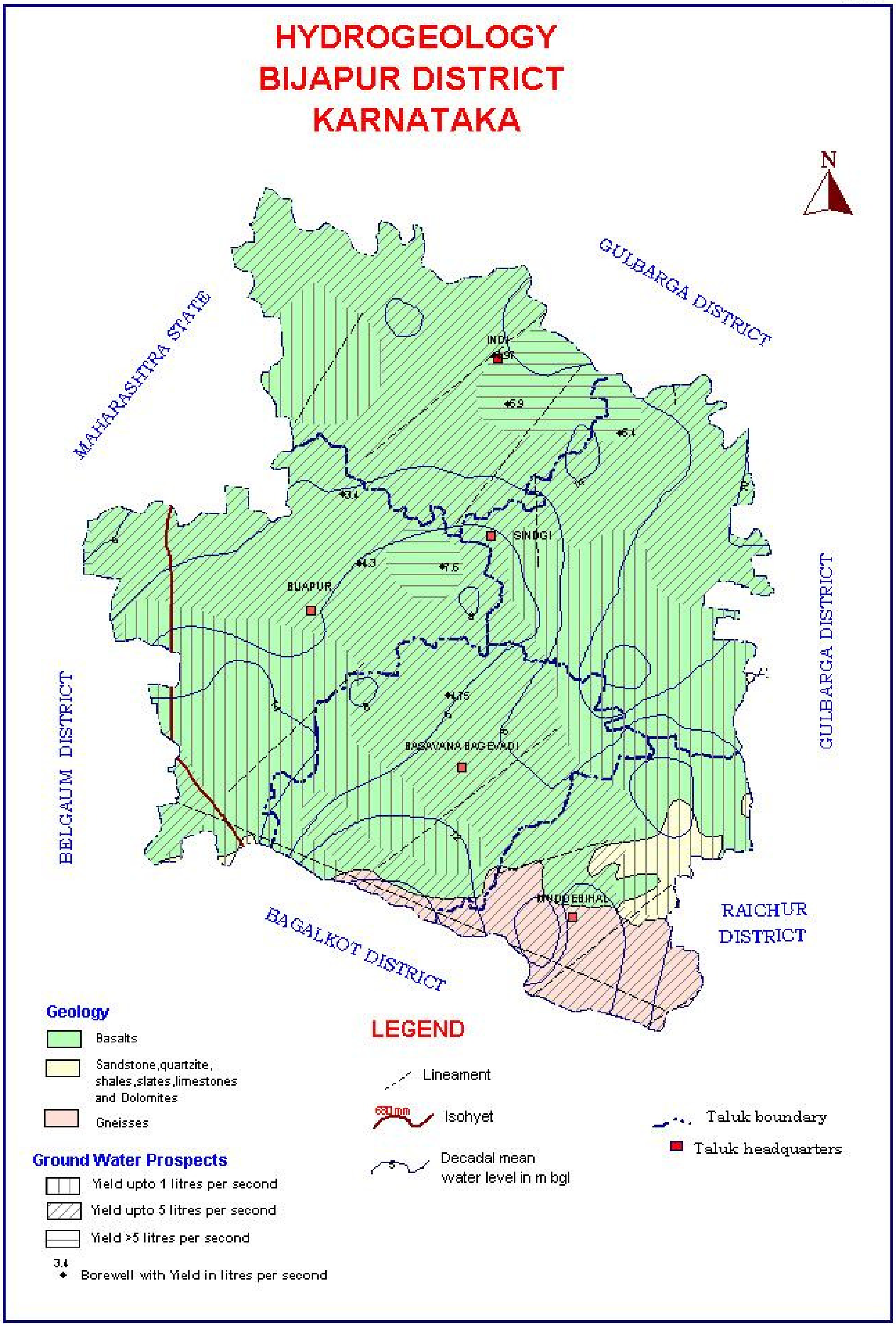
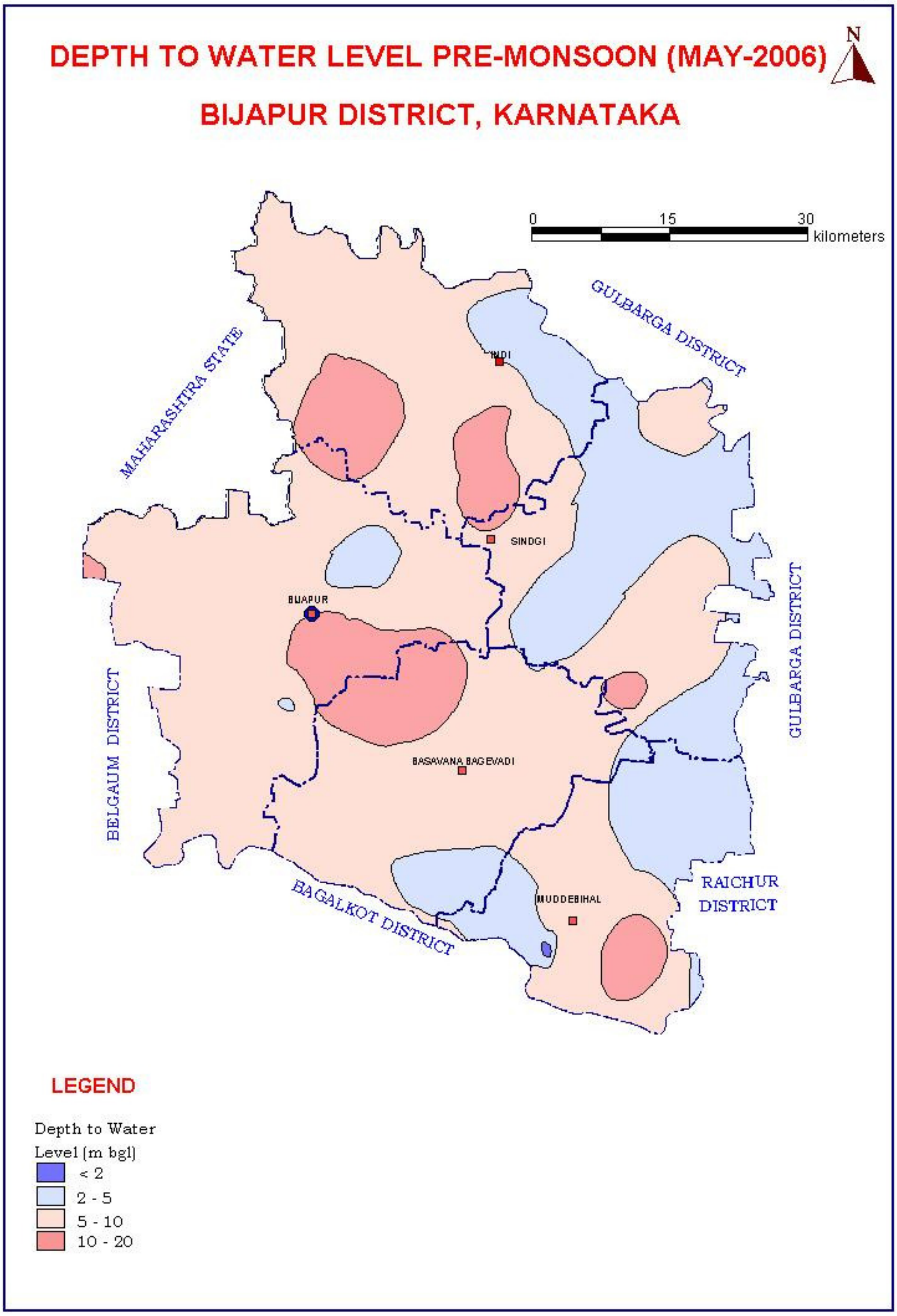

HYDROGEOLOGY
BIJAPUR DISTRICT
KARNATAKA
N
MAHARASHTRA STATE
GULBARGA DISTRICT
INDI
SINDGI
BIJAPUR
BASAVANA BAGEVADI
MUDDEBIHAL
GULBARGA DISTRICT
BELGAUM DISTRICT
BAGALKOT DISTRICT
RAICHUR DISTRICT
Geology
Basalts
Sandstone,quartzite, shales,slates,limestones and Dolomites
Gneisses
Ground Water Prospects
Yield upto 1 litres per second
Yield upto 5 litres per second
Yield >5 litres per second
Borewell with Yield in litres per second
LEGEND
Lineament
Isohyet
Decadal mean water level in m bgl
Taluk boundary
Taluk headquarters

Fig-4



DEPTH TO WATER LEVEL PRE-MONSOON (MAY-2006)
BIJAPUR DISTRICT, KARNATAKA
N
0
15
30
kilometers
MAHARASHTRA STATE
GULBARGA DISTRICT
INDI
SINDGI
BIJAPUR
BASAVANA BAGEVADI
MUDDEBIHAL
BELGAUM DISTRICT
GULBARGA DISTRICT
BAGALKOT DISTRICT
RAICHUR
DISTRICT
LEGEND
Depth to Water
Level (m bgl)
< 2
2 - 5
5 - 10
10 - 20

Fig-5

DEPTH TO WATER LEVEL POST-MONSOON (NOVEMBER-2006)

BIJAPUR DISTRICT, KARNATAKA

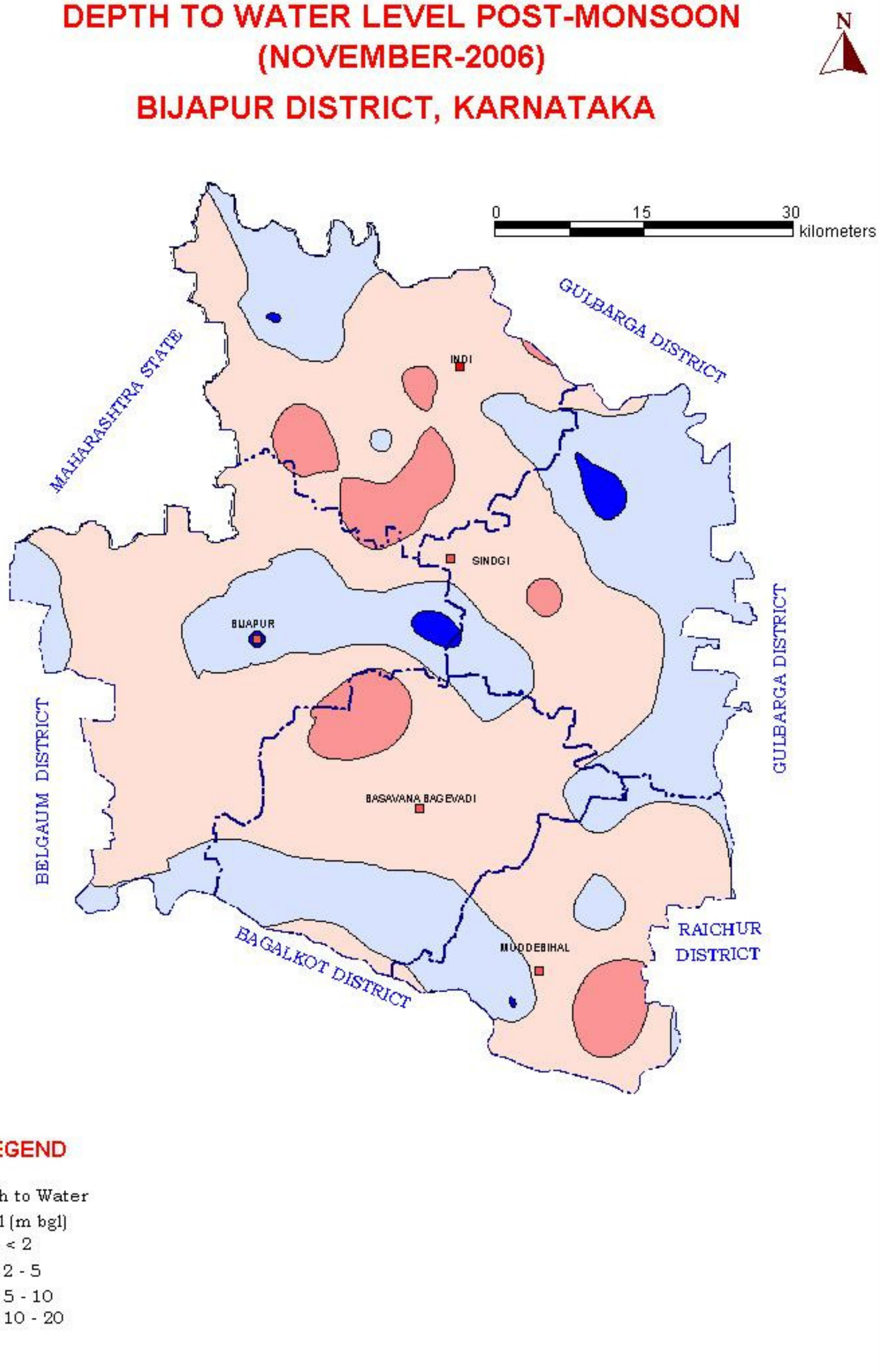


Fig –6

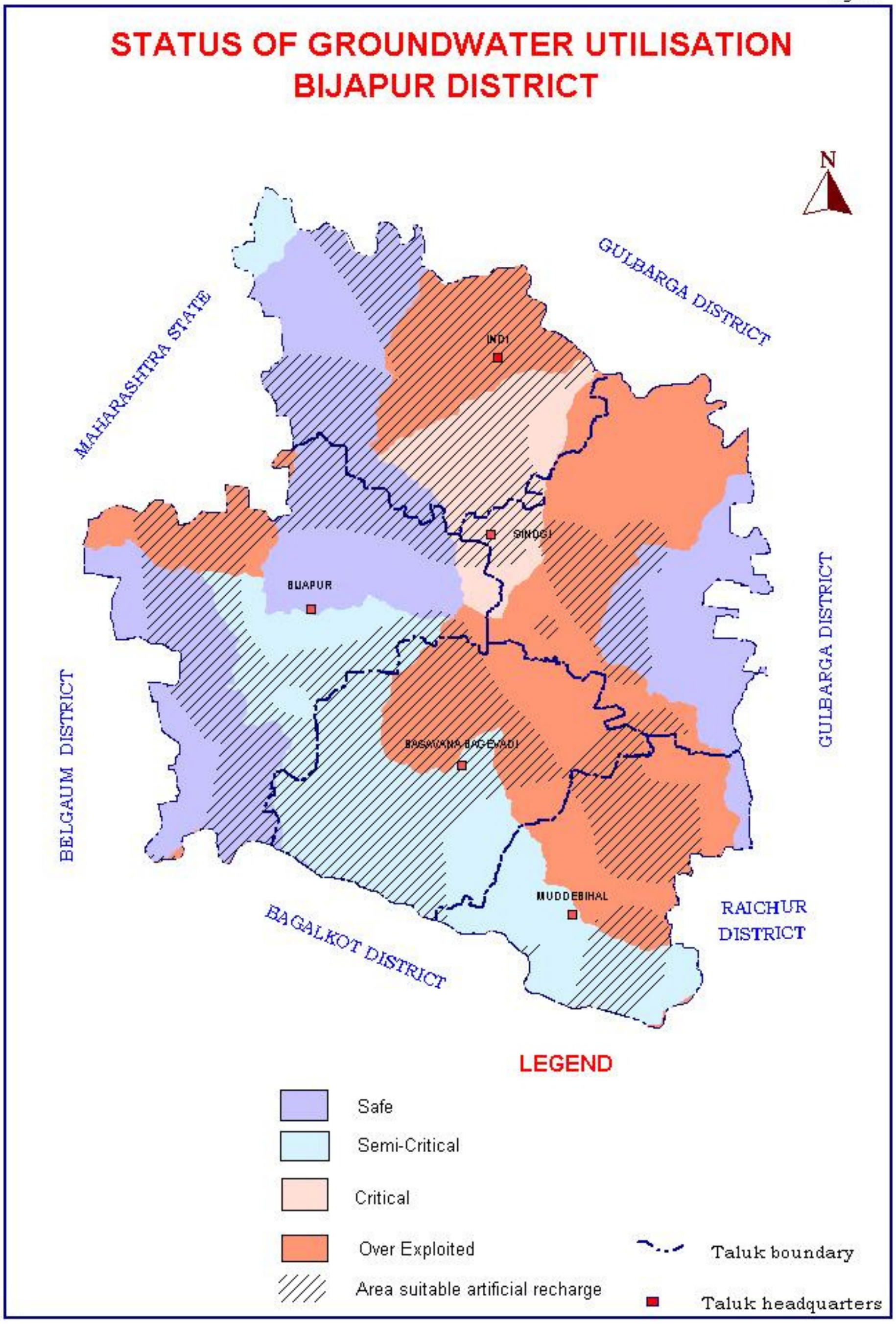
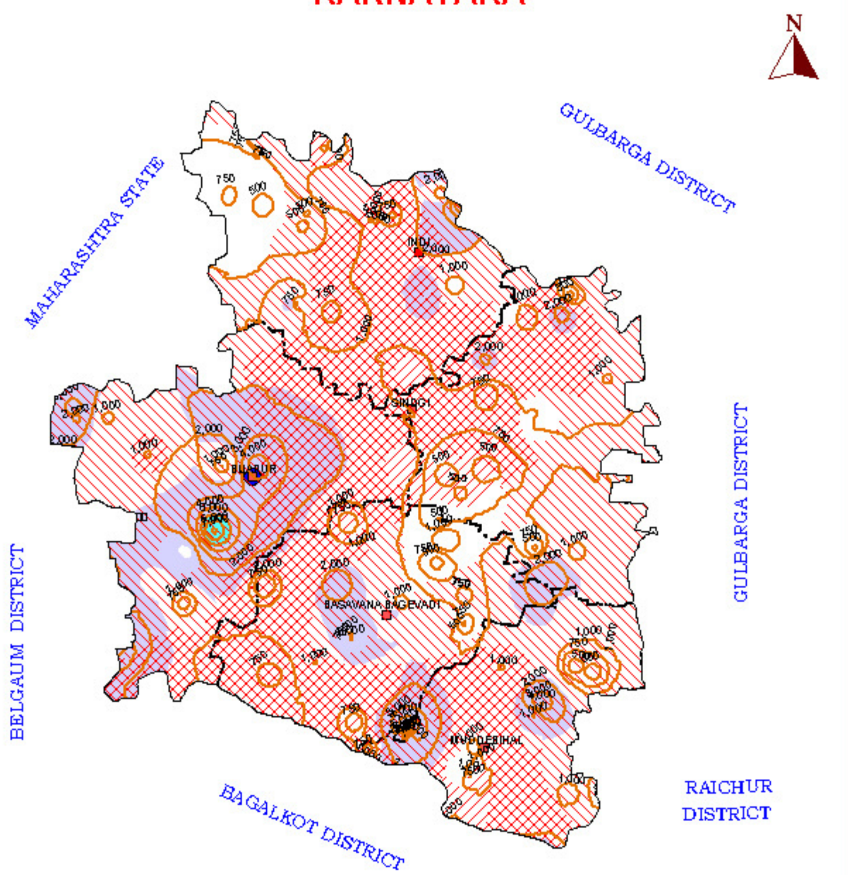

STATUS OF GROUNDWATER UTILISATION
BIJAPUR DISTRICT
N
GULBARGA DISTRICT
MAHARASHTRA STATE
INDI
SINDGI
BIJAPUR
GULBARGA DISTRICT
BELGAUM DISTRICT
BASAVANA BAGEVADI
MUDDEBIHAL
RAICHUR
DISTRICT
BAGALKOT DISTRICT
LEGEND
Safe
Semi-Critical
Critical
Over Exploited
Area suitable artificial recharge
Taluk boundary
Taluk headquarters

Fig-7

GROUND WATER QUALITY
BIJAPUR DISTRICT
KARNATAKA



LEGEND

Fluoride concentration >1.5 Mg/L

Nitrate concentration > 45 Mg/L

Chloride concentration 250-1000 Mg/L

Chloride concentration >1000 Mg/L

Taluk boundary

District headquarters

Taluk headquarters

750 Electrical conductivity (Micro mhos/cm)