स्वच्छ सुरक्षित जल – सुन्दर खुशहाल कल

CONSERVE WATER - SAVE LIFE

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

GROUND WATER INFORMATION BOOKLET
BELGAUM DISTRICT, KARNATAKA

SOUTH WESTERN REGION
BANGALORE
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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.

Dr. S. C. Dhiman

PREFACE

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, vulnerability area 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, incorporating the data up to the period 2011-12.

The Belgaum 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. K.M.Viswanath, Superintending hydrogeologist, Central Ground Water Board, Unit Office, CGWB, Belgaum. The figures were prepared by Sri. J. Sivaramakrishnan, Assistant Hydrogeologist. The rainfall data provided by Shri H.P.Jayaprakash Scientist-C. 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, academicians, hydrogeologists and engineers to plan the water resources management in a better way in the district.

Sd/-
(K Md. Najeeb)
Regional Director

BELGAUM DISTRICT AT A GALANCE

Sl No	ITEMS		Statistics
1.	**GENERAL INFORMATION**		
	i) Geographical area (Sq.km)		13,444
	ii) Administrative Divisions (As on Mar. 2011)		
	a) Number of Taluks.		10
	b) Number of Panchayats.		485
	c) Number of Villages.		1,270
	iii) Population (As on 2011Census).		47,78,439
	iv) Average Annual Rainfall (mm).		769.1
2.	**GEOMORPHOLOGY**		
	Major physiographic units	2, Western Ghats and plains.	
	Major Drainages	Krishna, Ghataprabha, Malaprabha.	
3.	**LAND USE (Sq.km)**		
	a) Forest area		1,904
	b) Net area sown		7983
4.	**MAJOR SOIL TYPES: -** Shallow to Very deep black soils, red loamy soils, lateritic soils etc.		
5.	**PRINCIPAL CROPS (As on Mar. 2009 - 10): -** Jowar, maize, paddy, wheat, bajra, grams, tur, groundnut, sunflower, sugarcane, cotton, tobacco etc.		
6.	**IRRIGATION BY DIFFERENT SOURCES (Area in Sq. Kms)**		
	Dug wells		1189
	Tubewells /Borewells		1282
	Tanks/Ponds		21
	Canals		984
	Lift Irrigation		333
	Other sources		852
	Net Irrigated area		4660
7.	**NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (As on 31.03.2007)**		
	No of Dugwells		87
	No of Piezometers		41
8.	**PREDOMINANT GEOLOGICAL FORMATIONS: -** Dharwars, Kaladgis, Deccan traps, Recent Alluvium.		
9.	**HYDROGEOLOGY: -**		
	Major water bearing formation	Gneisses, schists, limestones, sandstones, basalts and alluvium.	
	Pre-monsoon Depth to water level during-2011 (m bgl)		0.89 -18.35
	Post-monsoon Depth to water level during-2011 (m bgl)		0.81 –12.78
	Long term water level trend in 10years (2001 - 2010) in m/yr		

10.	**GROUNDWATER EXPLORATION BY CGWB(As on Mar 2011)**	
	No of wells drilled : - EW =70, OW=16, PZ = 17, SH = 0, Total = 103	
	Depth range (m)	23 - 205
	Discharge (litres per second)	Negl. – 7.58
	Transmissivity (m^2 /day)	0.5 - 2220
11.	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than the permissible limit (e.g.EC,F)	EC, F, NO_3
	Type of water	Alkaline
12.	**DYNAMIC GROUND WATER RESOURCES (2008-09) IN MCM**	
	Annual Replenishable Ground water Resources	1246
	Net Annual Ground Water Draft	1219
	Projected Demand for Domestic and Industrial uses up to 2025	99
	Stage of Ground Water Development	107
13.	**AWARENESS AND TRANING ACTIVITY**	
	Mass Awareness Programs organised Date Place No of participants	2 Bailhongal, Chikodi
14	**EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING**	
	Projects completed by CGWB (No & amount spent)	I No
	Projects under technical guidance of CGWB (Numbers)	1 No. - Ongoing
15.	**GROUND WATER CONTROL AND REGULATRION**	
	Number of OE Taluks	9(P)
	No of Critical Taluks	4 (P)
	No of Taluks notified	Nil
16.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	
	• Declining water level (Resource) and excess nitrate and chloride quality problems in different parts on a localized scale.	

1.0 INTRODUCTION:

The district of Belgaum is located east of the Western Ghats and is situated in the northwestern part of Karnataka state. It is bordered by the state of Goa on its southwest and Maharashtra state towards its west and north. The districts of Bijapur and Bagalkot of Karnataka state lie towards its northeast and east respectively whereas; the districts of Dharwar and Uttar Kanara lie towards its south and southwest, respectively (Figure-1). The district lies between 15°00' and 17°00' north latitudes and between 74°00 and 75°30' east longitudes. It covers an area of 13,444 Sq. Km.

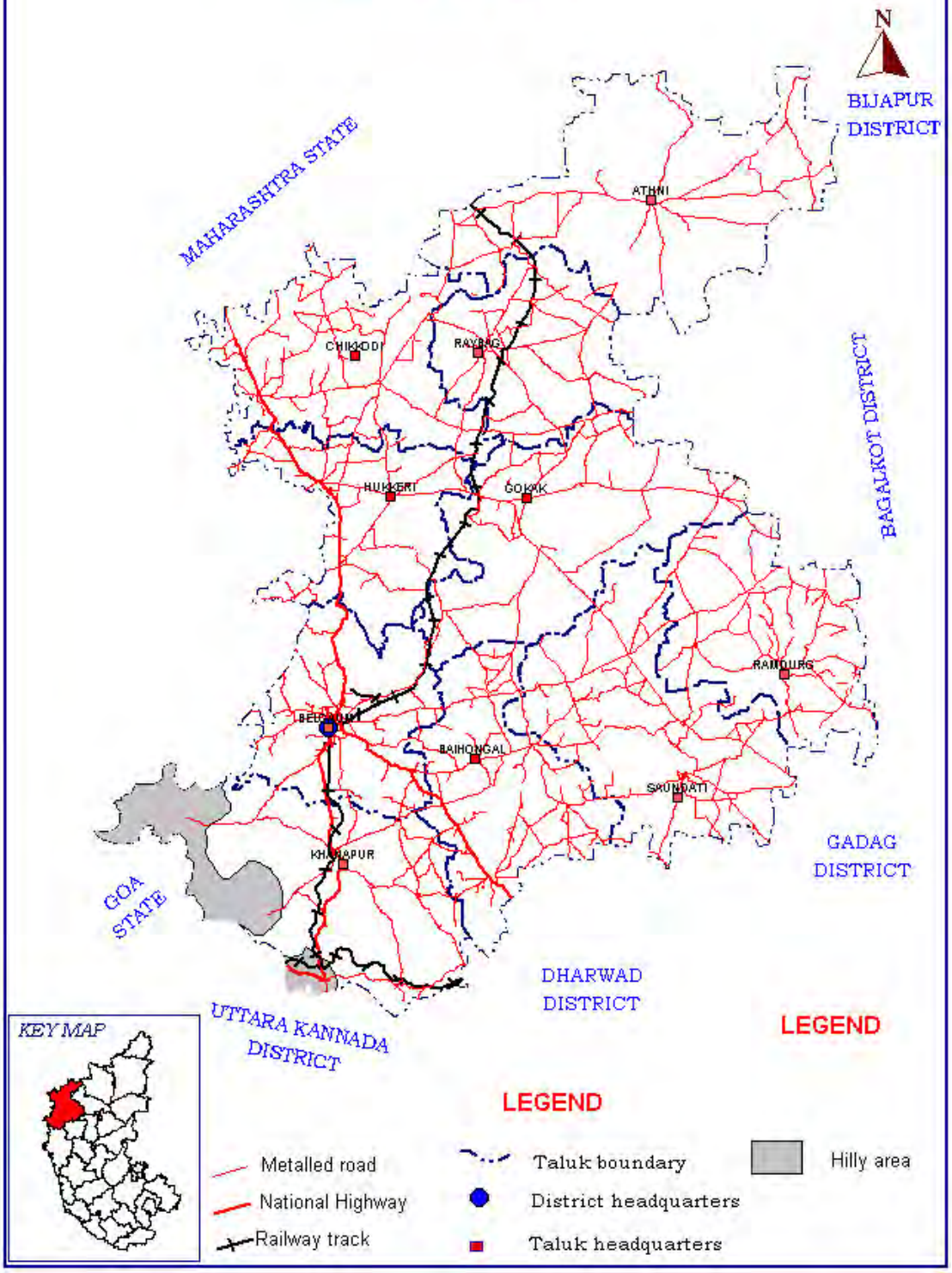
It has been reported that there were 87 cases of suicide among farmers in Belgaum district, in the last three years between 2003 and 2006, out of which 34 cases were due to crop failure and the remaining were due to other reasons (table-1). Talukwise suicide cases reported due to crop loss, as per the data from the state government are 9 from Bailhongal, 8 from Athni, 6 from Hukkeri, 5 from Chikodi, 3 from Ramdurg and 1 each from Belgaum, Gokak and Raybag. No suicide case due to crop loss has been reported from Saundatti and Khanapur taluks. During 2006-07, 24 numbers of farmer's suicide incidences were reported, but the numbers due to crops failure are not yet known.

Table-1. Talukwise statistics of farmers suicide cases in Belgaum district.

Sl; no	Taluks	2003-04			2004-05			2005-06			Total			2006-07
		Total cases reported	Due to Crop loss	Due to other reasons	Total cases reported	Due to Crop loss	Due to other reasons	Total cases reported	Due to Crop loss	Due to other reasons	Total cases reported	Due to Crop loss	Due to other reasons	
1	Saundatti	11	-	11	01	-	01	02	-	02	14	00	14	1
2	Raybag	01	01	-	-	-	-	-	-	-	01	01	-	0
3	Belgaum	05	01	04	01	-	01	-	-		06	01	05	2
4	Chikodi	03	02	01	03	02	01	01	01	-	07	05	02	0
5	Gokak	04	-	04	02	-	02	01	01	-	07	01	06	2
6	Hukeri	04	01	03	06	03	03	04	02	02	14	06	08	6
7	Khanapur	-	-	-	01	-	01	-	-	-	01	-	01	2
8	Ramdurg	03	01	02	02	01	01	01	01	-	06	03	03	2
9	Baila-hongal	07	02	05	11	05	06	02	02	-	20	09	11	3
10	Athni	03	03	-	06	04	02	02	01	01	11	08	03	6
	TOTAL	41	11	30	33	15	18	13	08	05	**87**	**34**	**53**	**24**

Fig-1

ADMINISTRATIVE SET-UP
BELGAUM DISTRICT
KARNATAKA



1.1 Administrative Set up

For administrative convenience, the district has been divided into 10 taluks namely: Athani, Bailhongal, Belgaum, Chikkodi, Gokak, Hukkeri, Khanapur, Ramdurg, Raybag and Saundatti; having 18 municipalities, 22 towns, 35 hoblies, 485 gram panchayats having 1,270 villages. It has a population of 47,78,439 with population density of 356 persons / Sq. Km (2011 census), majority of which are dependent on agriculture. (Table-2).

1.2 Basin & Drainage:

The entire district falls in the Krishna river basin except small catchments of Khanapur, Belgaum and Bailhongal taluks that fall in the catchments of Mahadayi and Kalinadi rivers that flow towards the west. The river Krishna, along with its tributaries Ghataprabha and Malaprabha are perennial and effluent in nature and flow in easterly direction. The drainage density varies from 0.80 to 3.4km/sq.km (Figure-2).

Landuse:

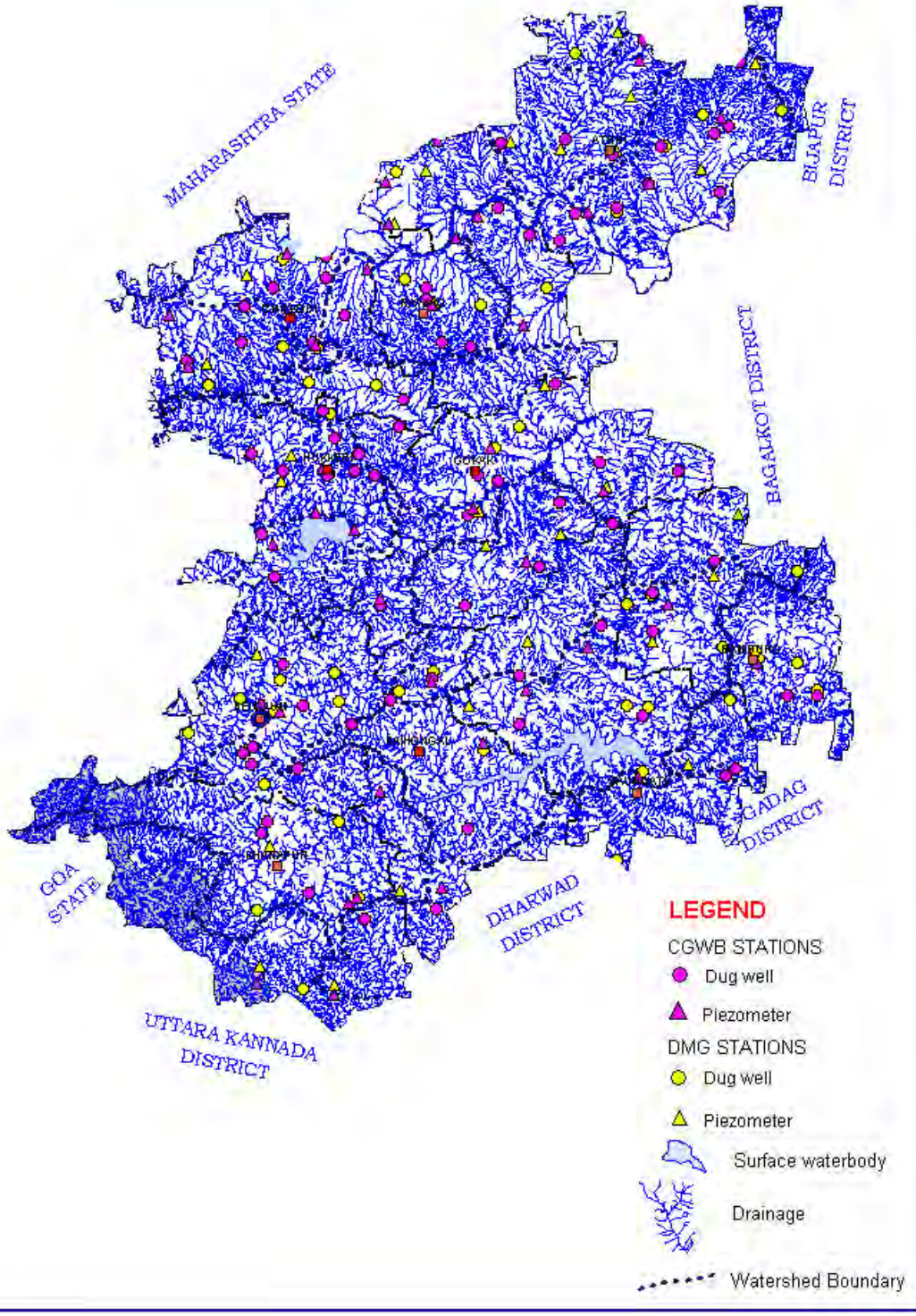
Net sown area in the district is 798289 hectares, which is 59% of the total geographical area of 1,344,382 hectares of the district. About 26.4% of the 'Net sown' area i.e. 211008 hectares is sown more than once (Table-3). Major crops grown in the area are jowar, maize, paddy, wheat, bajra, grams, tur, groundnut, sunflower, sugarcane, cotton, tobacco etc.

Table: 2 Talukwise Land Utilisation in Belgaum District (2008 – 09, Area in Hectares)

Sl. No	Taluk	Geog. Area (Hect)	Forest	Land not avail-able for culti-vation	Un-culti-vable land	Fallow land	Sown Area	
							Net	More than once
1	**Athani**	199,513	581	10870	5,434	62902	119726	29546
2	**Bailhongal**	112,233	7,913	11856	2783	20506	69175	29492
3	**Belgaum**	103,721	22,643	9443	6801	8707	56127	5550
4	**Chikkodi**	126,949	547	12292	4689	24345	85076	16205
5	**Gokak**	154,308	22,284	11586	1771	21752	96915	32384
6	**Hukkeri**	99,140	13,987	14239	2882	10253	57779	15221
7	**Khanapur**	172,956	91,309	8134	7118	16811	49584	788
8	**Raibag**	95,874	2,647	9657	2347	13677	67546	12430
9	**Ramdurg**	121,542	15,081	9161	1198	4208	91894	20172
10	**Saundatti**	158,146	13,432	16615	4334	12298	104467	49220
	Total District	**1344,382**	**190,424**	**113853**	**39357**	**202459**	**798289**	**211008**

Fig-2

DRAINAGE & HYDROGRAPH MONITORING STATIONS
BELGAUM DISTRICT, KARNATAKA



1.3 Irrigation practices:

The district has registered 1,73,684 irrigation pump sets out of which 173,452 are electrified. Lift irrigation pumps are mostly located in the vicinity of the rivers, thus providing surface water irrigation. Canals also contribute substantially to irrigation. Out of the total irrigated area, more than 50% is being irrigated by ground water sources alone.

The area irrigated by surface and ground water resources is 466008 hectares which is about 58% of the net sown area. Irrigation by the ground water resources alone covers an area of 247033 hectares, which is about 31% of the 'Net sown' area. (Table-3)

Table-3: Area Irrigated by different sources in hectares. (2008-09)

Sl. No.	Taluk	Canals	Tanks	Dug wells	Bore wells	Lift irrigation	Other source	Total
1	Athani	2806	0	30777	16480	27193	24356	101612
2	Bailhongal	0	0	663	12512	0	2601	15776
3	Belgaum	0	0	4588	850	0	0	5438
4	Chikkodi	6171	0	15000	16090	678	7182	45121
5	Gokak	28059	0	33100	23970	1428	9643	96200
6	Hukkeri	2422	0	8220	6093	344	4719	21798
7	Khanapur	0	329	12437	1932	86	36	14820
8	Raibag	25620	0	5920	17489	0	17780	66800
9	Ramdurg	10200	870	3744	9113	0	13388	37315
10	Saundatti	23986	896	4411	23653	3619	5463	61128
Total district		**98364**	**2095**	**118860**	**128173**	**33348**	**85168**	**466008**

1.4 Studies/Activities carried out by CGWB

Central Ground Water Board carries out hydro-geological surveys, ground water exploration and ground water monitoring under its normal programme. Apart from the above, special studies and short-term water supply investigations for government agencies are also taken up, from time to time. 'Systematic Hydro-geological Surveys' were carried out in the initial stages. The dynamic nature of ground water necessitates the continuation of such surveys. Therefore, 'Ground Water Management' studies were carried out in the district. Groundwater exploration has been carried out in the district and 70 exploratory wells have been drilled. To mitigate the water supply needs of drought-affected villages, construction of additional bore wells were carried out by CGWB.

There are 87 National Hydrograph Network stations and 41 piezometers that are monitored in order to evaluate the quantitative and qualitative changes in groundwater regime of the district.

'Conjunctive Use' studies in Ghataprabha basin were carried out to quantify different components of water balance and identification of critical areas of water logging and salinity, so as to evolve suitable plan for proper management of surface and groundwater and to evaluate the cost benefit ratio. Studies have also

been carried out on 'Urban Hydrogeology' of Belgaum town and identification of waterlogged areas has been carried out in Malaprabha basin.

Investigations have also been carried out for Central Ground Water Authority by assisting National Highway Authority of India in Golden Quadrilateral project by identification and clearance of groundwater abstraction structures. Similar studies were also carried out for Renuka Sugar Works located near Manoli in Saundatti taluk.

In addition to above 'Short Term Water Supply Investigations' for defence have been carried out from time to time.

2.0 Rainfall and Climate

The climate of the district as a whole can be termed as semi-arid. The variation in the maximum temperature during the year ranges from 27^0C to 35.7^0 C and minimum from 13.9^0C to 20.6^0 C. The district experiences pleasant winters and hot dry summers. The hot season extends from March to May, during which the daily maximum temperature often shoots up to $35.7\ ^0$C.

Agro-climatologically the district can be divided into three zones i.e. high rainfall "Hilly zone", "Northern transitional zone" and "Northern dry zone" from southwest to northeast respectively. The normal rainfall in the district decreases from more than 1859 mm in Khanapur taluk in the southwest, to less than 491 mm in Raybag taluk towards northeasterly direction. Those areas, that receive less than 750 mm annual rainfall are classified as semi-arid and thus drought prone. Hence, the entire district except, the southwestern part is categorized as semi-arid and drought prone.

Total normal rainy days vary from 90 in Khanapur to 37 in Athani. Eastern and northeastern parts of the district are prone to drought of mild nature.

Table- 4: Statistical computations of Mean rainfall in Belgaum district (1971-2000)

Sl. No.	Rain gauge stations	Mean annual rainfall (mm)	Std. Dev. (mm)	Coeff. of Var. (%)	Highest Rainfall in mm (Year)	Lowest Rainfall in mm (Year)
A	B	C	D	E	F	G
1	Athani	513.8	161.5	31.4	960.1 (1974)	273.8 (1994)
2	Bailhongal	664.5	157.8	23.8	1,010.3 (1981)	445.4 (1985)
3	Belgaum	1,284.3	329.7	25.7	2,377.0 (1994)	764.0 (1989)
4	Chikkodi	678.6	170.5	25.1	1,027.0 (1991)	333.5 (1972)
5	Gokak	507.6	133.7	26.3	901.4 (1979)	263.5 (1976)
6	Hukkeri	658.4	157.6	23.9	1,116.6 (1977)	398.0 (1990)
7	Khanapur	1,859.1	348.6	18.8	2,824.6 (1994)	1,117.0 (1989)
8	Raibag	491.7	180.1	36.6	836.4 (1975)	162.8 (1986)
9	Ramdurg	529.6	156.3	29.5	836.0 (1975)	221.3 (1980)
10	Saundhati	503.6	166.0	33.0	894.0 (1996)	224.1 (1985)
Belgaum district		**769.1**	**196.2**	**25.5**	**1,064.0 (1975)**	**536.4 (1985)**

The average annual rainfall during the period 1971 to 2000 recorded in the district is 769.1 mm. The standard deviation and Coefficient variation of rainfall for the Belgaum district is 196.2 mm and 25.5% respectively (Table-4). The highest mean annual rainfall recorded in the district was 1,064 mm in the year 1975 and the lowest rainfall 455 mm in the year 2003.

Season wise rainfall in the district during the decade 2001 to 2010 is given in table 5. It is seen from the table that bulk of the rainfall is received during southwest monsoon period (June to Sept) that is nearly 74% of the annual. The contribution by the northeast monsoon or post monsoon (Oct to Dec) is nearly 15% and the rest 11% is the contribution of the dry weather and pre-monsoon period (Jan to May).

Table 5: Seasonal & Annual Nornmal Rainfall for the period 2001-2010 Belgaum District, Karanataka

Station	Pre-Monsoon	SW Monsoon	NE Monsoon	Annual
	Rainfall (mm)			
Athani	86	372	124	582
Bhailiongal	96	427	139	662
Belgaum	126	1087	128	1341
Chikodi	91	554	100	744
Gokak	66	278	110	453
Hukkeri	79	450	121	650
Khanapur	121	1733	124	1978
Raibagh	73	388	105	566
Ramdurg	66	303	162	532
Soundatti	88	367	119	574

3.0 Geomorphology and Soil Types

Geomorphology:

The district is primarily located on the eastern side of the Western Ghats and its topography is predominantly undulating. A “rugged terrain” marks the western part of Khanapur and Belgaum taluks with deep cutting ravines on the foothills of the Western Ghats. The elevation of these hills varies from 796 to 1025m amsl. Northern portion of the district is a plateau region formed by basaltic lava flows, which represents “Deccan peneplain”. The central and southern parts exhibit moderate to gently “undulating terrain” having sparsely distributed knolls and

tors. In some parts, especially in Ramdurg and Saundatti taluks, hills with elevations between 686 and 783m amsl are present. The famous Yellamma temple in Saundatti taluk is located in one of these isolated hills. The remaining part of the district is in general a “plateau area”. The elevation in the plains varies from 534m in the northeastern part to 820m amsl in the southwestern part of the district. This has its bearing on the regional slope which is towards northeast. The differential altitude is significant because, it is likely to cause irregular ground water flow patterns on the micro scale.

Soil Types:
The soils of Belgaum district can broadly be classified into **red soils** and **black soils**. These soils vary in depth and texture, depending on the parent rock type, physiographic settings and climatic conditions. By and large, black soils predominates the Deccan Trap terrain and the red soils are found in the southwestern and southeastern part of the district in gneissic terrain. These soils in turn can be grouped into seven categories as given below, out of which the first five cover large tracks of land while the last two are local in nature.

1. Shallow black soils:
These soils occur in the Deccan trap region and to some extent are also developed in schist, shale and limestone terrains. They are greyish to dark greyish-brown in colour, with clayey texture. These soils have poor to moderate infiltration characteristics.

2 Medium black soils:
These soils are predominantly derived from Deccan traps and occupy large parts of the district. They are dark greyish-brown to very dark greyish-brown with clayey texture. These are derived from the weathered products of basalts and limestone and are darker in valleys than in high lands. Their texture varies from loam to clay, with low to moderate infiltration characteristics.

3 Deep to Very deep black soils:
These soils occupy large tracts in Deccan trap terrain along the Krishna River and also in the gneissic terrain. These soils are dark greyish-brown to very dark greyish-brown in colour and have clayey texture. These soils occur on plains or lands having gentle slopes. These soils exhibit wide cracks in summers. These are derived from a wide variety of parent rock types, like traps, schists, gneisses and sedimentary rocks. They are generally transported and therefore occur in valleys and depressions. Accumulation of lime, gypsum and soluble salts at varying depths in the soil profile often pose problems. They have poor infiltration characteristics.

4 Mixed red and black soils:
These soils occur in the northern parts of the district. They are dark reddish-brown to dark greyish-brown in colour with silty-clay to clayey-loam textures. These soils are derived from gneisses, schists and sedimentary rocks. Red soils

having high infiltration characteristics are confined to uplands, whereas, black soils of poor to medium infiltration characteristics occur in valleys and low lands.

5 Red loamy soils:
These soils occur as small strips in the valleys adjacent to the Western Ghats. They are generally transported and are loamy to silty-loam in texture. They have moderate to good infiltration characteristics.

6 Lateritic soils:
Lateritic soils are red in colour and occur as pockets. They occur at high-levels as insitu in Deccan Trap terrain and at low-levels as transported in Malnad region. They are derived from Deccan traps as well as sedimentary rocks, Dharwarian Schists and peninsular gneisses. These soils have good to moderate infiltration characteristics.

7 Alluvial soils:
These soils are developed over the alluvium deposited by the Krishna River and its tributaries. They are very limited in extent and thickness and are local in nature. These soils have good infiltration characteristics and are composed of coarse sand, sandy-loam and loams.

4.0 Ground Water Scenario

4.1 Hydrogeology

Water table generally follows the topography of the area and is at greater depths in the water divides and topographic highs, but becomes shallower in the valleys and topographic lows and therefore, groundwater moves down and follows the gradient from the higher to lower elevations, that is, from recharge area to discharge area. Therefore, locally direction of flow from higher elevations is towards the rivers. Overall, the general flow direction of ground water in the district is generally towards the east.

The district is underlain by gneisses, schist, limestone, sandstone, basalts, alluvium etc. of Archaean to Recent age. Deccan basalts cover an area of 7,650 Sq.Kms. in the northern part of the district and have a maximum thickness of around 256 m, which gradually thins out in the southern direction. Exploratory drillings were carried out to study the yield potential of fracture systems and are shown in figure 3. The hydrogeology of the district is depicted in Figure-4.

Hard rocks occupy a major part of the district; majority of which are basaltic lava flows. Most of these rocks have poor capacity of storing and transmitting water, except through favourable zones and at favourable locations. Aquifer systems encountered are therefore limited in nature. Ground water occurs both in weathered and fractured zones. Ground water occurs in all weathered formations

of the district under phreatic conditions and in fractured and jointed formations under semi-confined conditions.

Deccan basalts act as a multilayer aquifers having low to medium permeability. In Deccan basalts that comprise different flows, fractures and interstitial pore spaces of vesicular zones, are good repositories of ground water. Groundwater occurs under phreatic conditions in weathered zone of these basalts and under semi-confined to confined conditions in inter-trapeans and also in joints and fractures at deeper levels.

In limestone, solution cavities are considered to be more potential than weathered and fractured ones. In gneisses and schist, weathered zone varies from 7 to 12 m and water-bearing zones extend down to 80m.

The aquifers occurring within the shallow depth range of 0 to 20 m bgl are mainly weathered and fractured formations. Groundwater occurs in these formations under phreatic conditions and the average thickness of these aquifers ranges from 5 to 15m. In general, 60% area of the district is having the weathered thickness in the range of 5 to 10 m. About 25% of the district area has weathered thickness in the range of 10 to 15m and 15% in the range of 15 to 20m.

The depth to water level in the district during pre-monsoon period i.e. May 2011 ranged from 0.89 to 18.35 mbgl. Out of 70 nos. of wells monitored for water level, it is seen that 5.7% wells showed a water level less than 2 m., 27% wells had water level in the range of 2 to 5 m., 48.6% wells had water level between 5 to 10m. And the remaining 18.6% wells had water levels in the range of 10 to 20 mbgl. (Fig. 5)

During the post monsoon period, i.e. Nov 2011, the depth to water level in the district ranged from 0.81 to 12.78mbgl. Out of the 70 nos. of wells monitored, the depth to water level was less than 2m in15.71% wells, 2 to 5m in 40% wells, 5 to 10m in 35.7% wells and 10 to 20m in the remaining 8.6% wells. (Fig. 6)

To know the long term changes in the water levels in the district, the depth to water level during pre- and post- monsoon period of 2011 in the district was compared with the mean water level of the preceding decade. The change in water level during May 2011 as compared with the mean pre monsoon water levels of the preceding decade is shown in Fig. 7. It is seen that out of 68 wells for which water levels were compared, 64.7% wells showed a rise in water level and the remaining 35.3% wells showed a fall in water level as compared to the preceding decade. In the rise category, 45.58% wells showed a rise in the range of 0 to 2m, 17.64% wells showed a rise of 2 to 4m and 1.47% wells recorded a rise of >4m. In the fall category, a fall in water level in the range of 0 to 2m is seen in 26.47% wells, fall of 2 to 4m is seen in 7.35% wells and a fall of >4m is seen in 1.47% wells.

Fig: 3

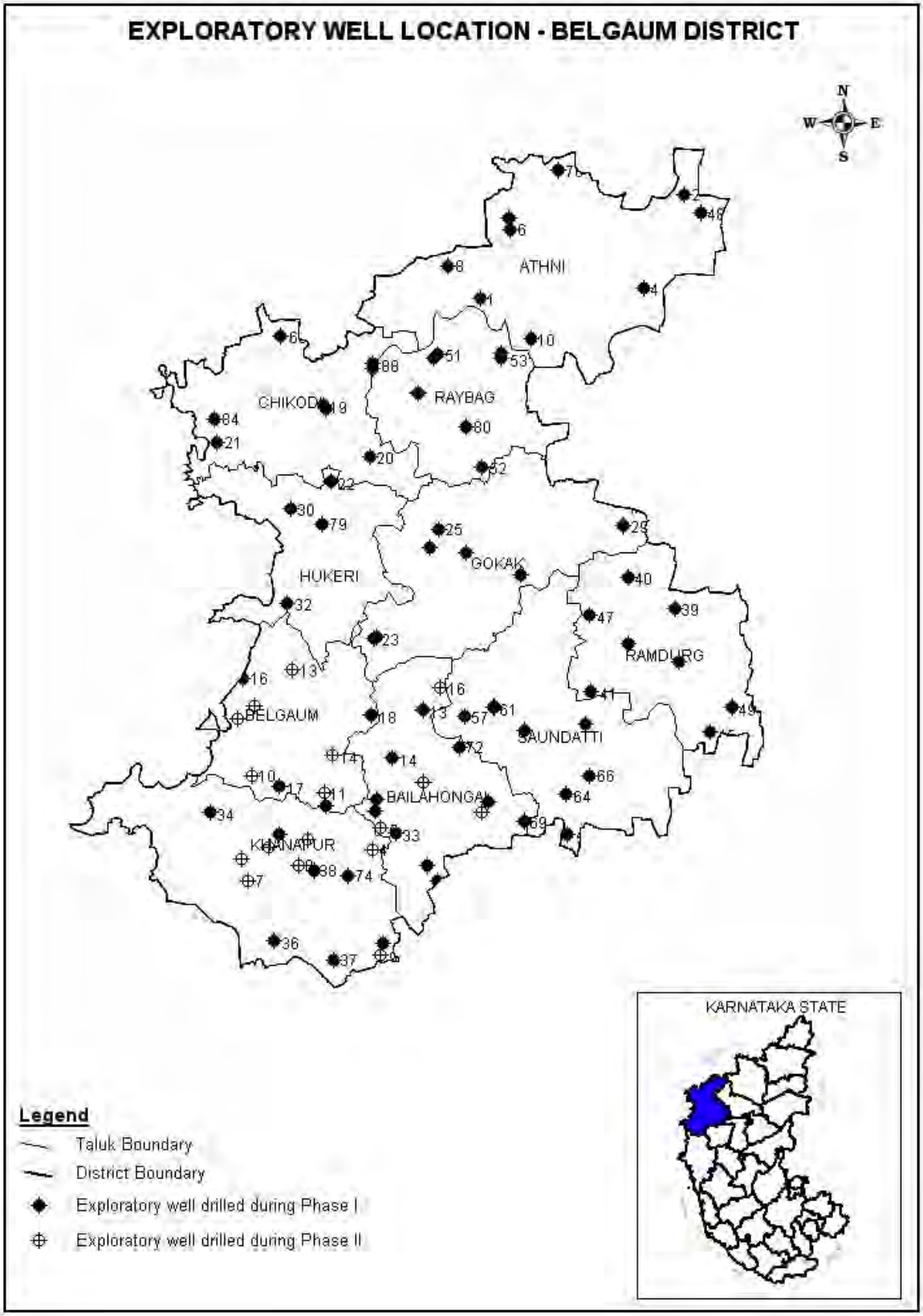

EXPLORATORY WELL LOCATION - BELGAUM DISTRICT
N
W
E
S
ATHNI
CHIKODI
RAYBAG
HUKERI
GOKAK
RAMDURG
BELGAUM
SAUNDATTI
BAILAHONGAL
KHANAPUR
KARNATAKA STATE
Legend
Taluk Boundary
District Boundary
Exploratory well drilled during Phase I
Exploratory well drilled during Phase II

Fig: 4

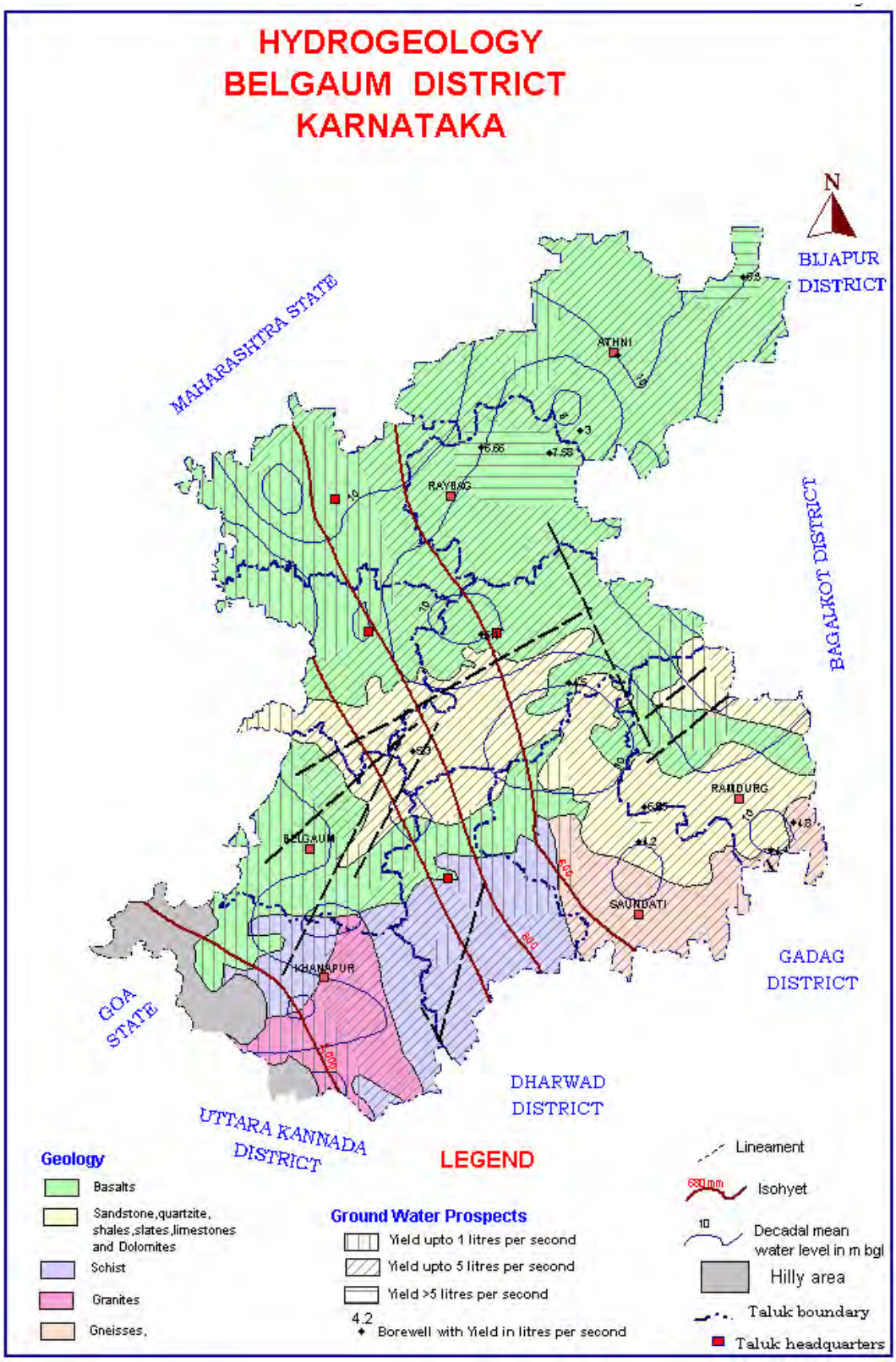

HYDROGEOLOGY
BELGAUM DISTRICT
KARNATAKA
N
BIJAPUR DISTRICT
MAHARASHTRA STATE
BAGALKOT DISTRICT
ATHNI
RAYBAG
RAMDURG
BELGAUM
SAUNDATI
KHANAPUR
GADAG DISTRICT
GOA STATE
DHARWAD DISTRICT
UTTARA KANNADA DISTRICT
LEGEND
Geology
Basalts
Sandstone,quartzite, shales,slates,limestones and Dolomites
Schist
Granites
Gneisses.
Ground Water Prospects
Yield upto 1 litres per second
Yield upto 5 litres per second
Yield >5 litres per second
4.2
Borewell with Yield in litres per second
Lineament
Isohyet
10
Decadal mean water level in m bgl
Hilly area
Taluk boundary
Taluk headquarters

Fig: 5

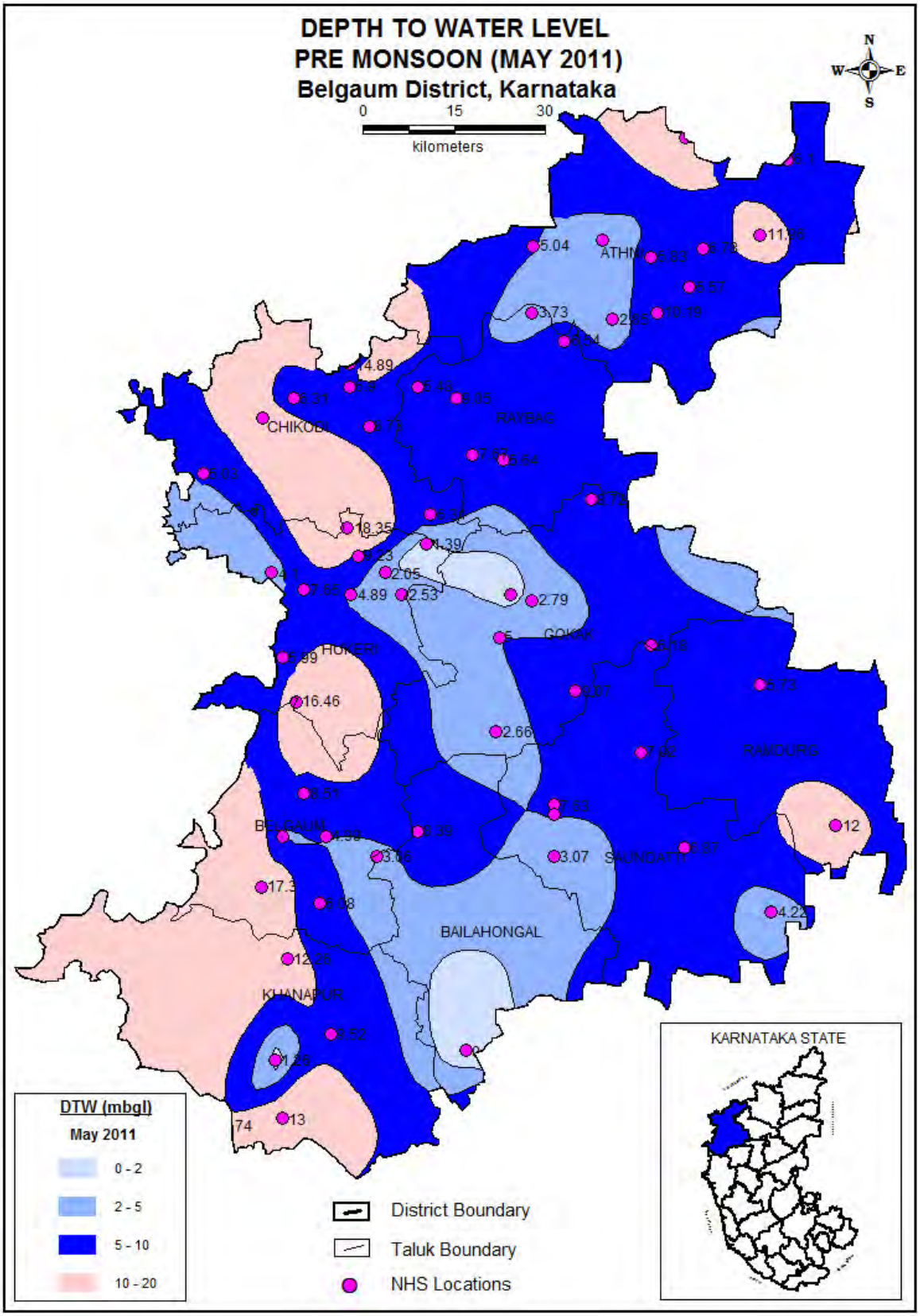

DEPTH TO WATER LEVEL
PRE MONSOON (MAY 2011)
Belgaum District, Karnataka
0
15
30
kilometers
N
W
E
S
ATHNI
CHIKODI
RAYBAG
GOKAK
HUKERI
RAMDURG
BELGAUM
SAUNDATTI
BAILAHONGAL
KHANAPUR
DTW (mbgl)
May 2011
0 - 2
2 - 5
5 - 10
10 - 20
District Boundary
Taluk Boundary
NHS Locations
KARNATAKA STATE

Fig: 6

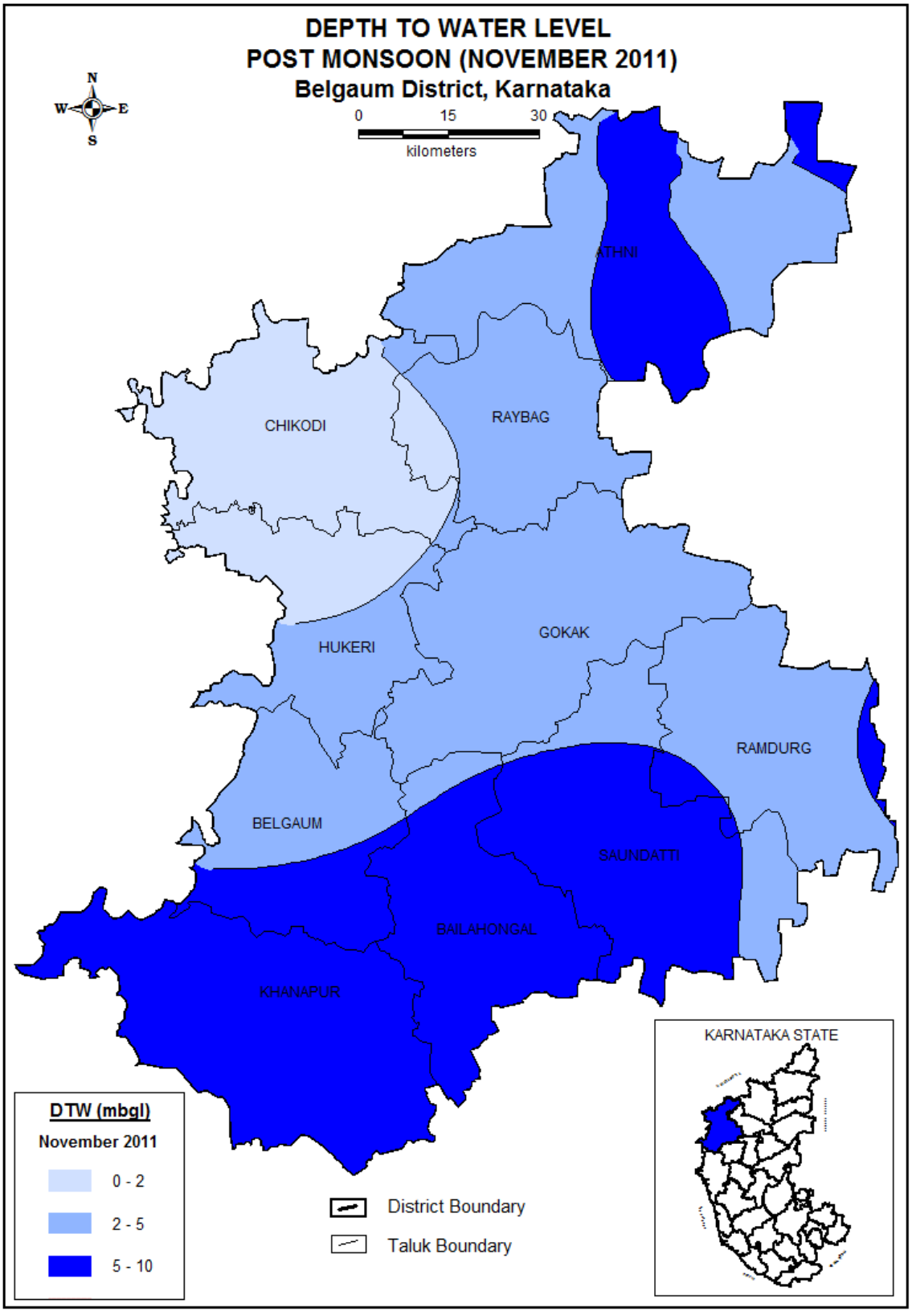
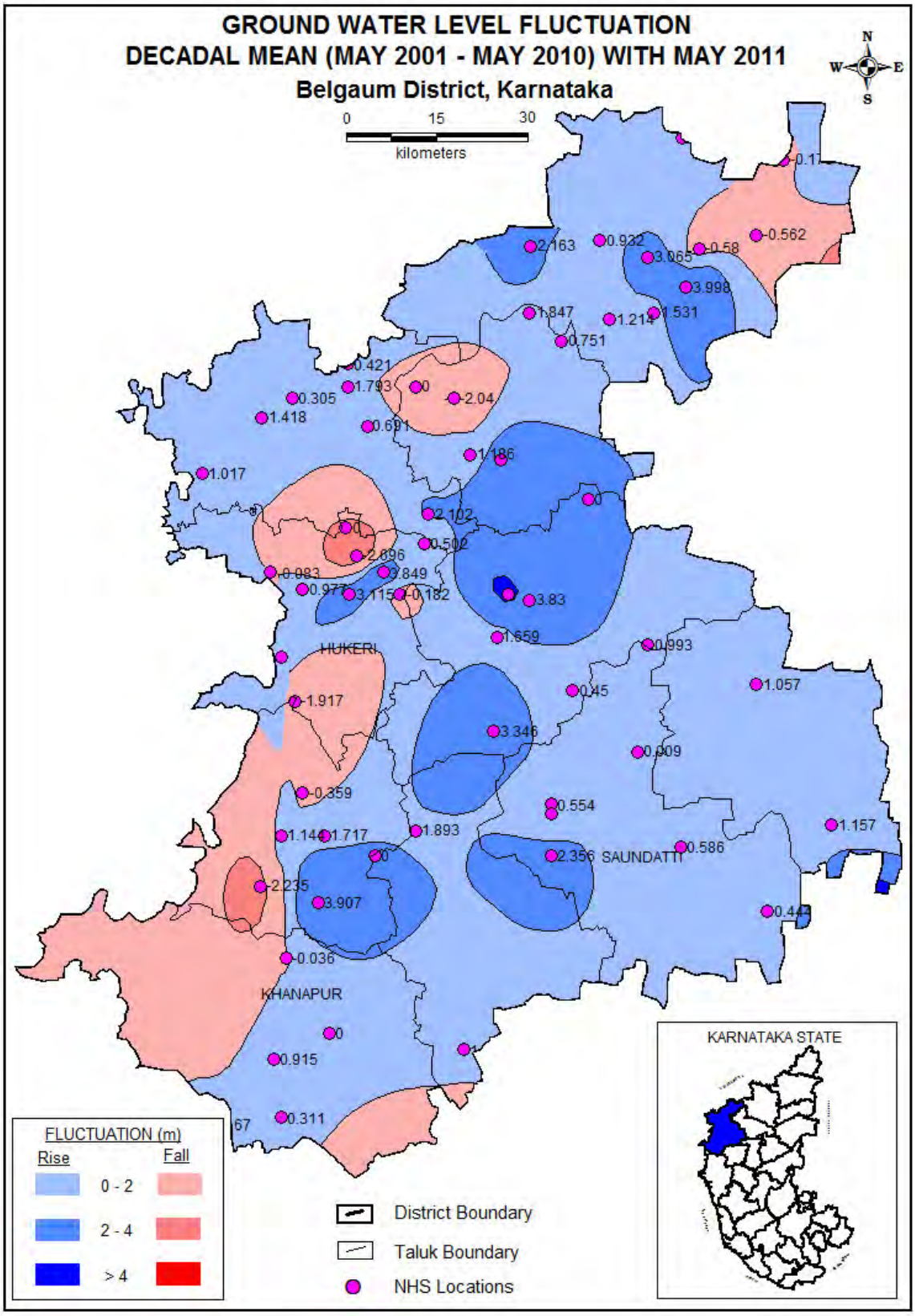

DEPTH TO WATER LEVEL
POST MONSOON (NOVEMBER 2011)
Belgaum District, Karnataka
N
W
E
S
0
15
30
kilometers
ATHNI
CHIKODI
RAYBAG
HUKERI
GOKAK
RAMDURG
BELGAUM
SAUNDATTI
BAILAHONGAL
KHANAPUR
DTW (mbgl)
November 2011
0 - 2
2 - 5
5 - 10
District Boundary
Taluk Boundary
KARNATAKA STATE

Fig: 7


GROUND WATER LEVEL FLUCTUATION
DECADAL MEAN (MAY 2001 - MAY 2010) WITH MAY 2011
Belgaum District, Karnataka
N
W
E
S
0
15
30
kilometers
0.11
2.163
0.932
3.065
0.58
0.562
3.998
1.847
1.214
1.531
0.751
0.421
1.793
0
2.04
0.305
1.418
0.691
1.186
1.017
2.102
0.502
2.696
3.849
0.983
0.977
3.115
0.182
3.83
1.659
HUKERI
0.993
1.057
0.45
1.917
3.346
0.909
0.359
0.554
1.157
1.144
1.717
1.893
0.586
2.356
SAUNDATTI
2.235
3.907
0.036
KHANAPUR
0.915
0.311
67
KARNATAKA STATE
FLUCTUATION (m)
Rise
Fall
0 - 2
2 - 4
> 4
District Boundary
Taluk Boundary
NHS Locations

Similarly, the change in water level during November 2011 as compared to the mean post monsoon water level of the preceding decade is shown in fig. 8. It is seen that, out of the 70 wells for which the water levels are compared, 42.85% wells recorded a rise in water level and the remaining 57.14% wells recorded a fall in water level as compared to the preceding decade. Further, in the rise category, 38.57%, 2.86% and 1.43% wells showed a rise in water level in the range of 0 to 2, 2 to 4 and >4m respectively. In the fall category, 44.29%, 10% and 2.86% wells showed a fall in the range of 0 to 2, 2 to 4 and >4m respectively.

The long-term pre-monsoon water level trend (2001-2010) shows a rise in 79% of the wells, while there is a fall in 21% of the wells. On the other hand during post-monsoon period, 93% of the wells show rising trend, while there is a falling trend in 7% of the wells. Over all the annualised trend shows a rise in 93% of the wells and fall in 7% of the wells.

Based on the pumping test data of the dugwells, it is inferred that there is a progressive increase in the permeability exceeding >100m/ day in the water table phreatic zones of basaltic aquifers towards the east, even though the area falls in the northern dry and transitional zone having low to moderate rainfall. Similar is the case with other lithologic units. On the other hand in Khanapur taluk, though it falls in high rainfall hill zone agro-climatically, the permeability of the principle water table aquifers of schists and gneisses range from < 25 to 50m/ day.

Analyses of Pumping test data of exploratory borewells show that wells have yielded discharges in the range of negligible to 7.58 lps and the draw down ranged between 0.068 to 35.48 m. The transmissivity (T) computed was between 0.5 and 2,220 m^2/day.

4.2 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 rain fall, 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 the state of 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 Belgaum district the unit area annual recharge is in the range of 0.025 – 0.10m in Khanapur, Belgaum, Bailahongal, Saundatti, Ramdurg and Athani taluks and in the range of 0.10 – 0.15m in Hukkeri, Gokak, Raibag and Chikkodi taluks. (fig. 9).

Fig: 8

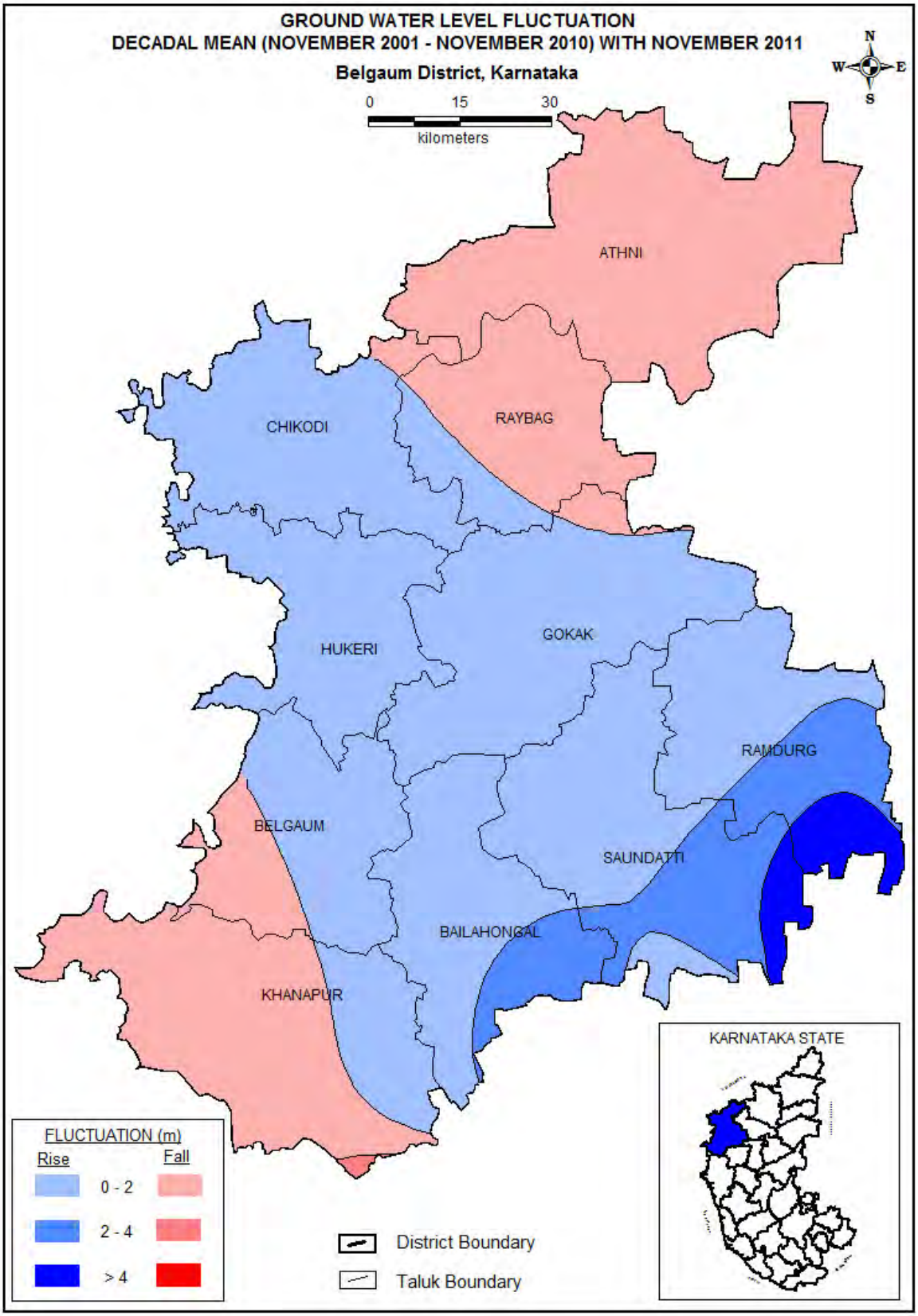
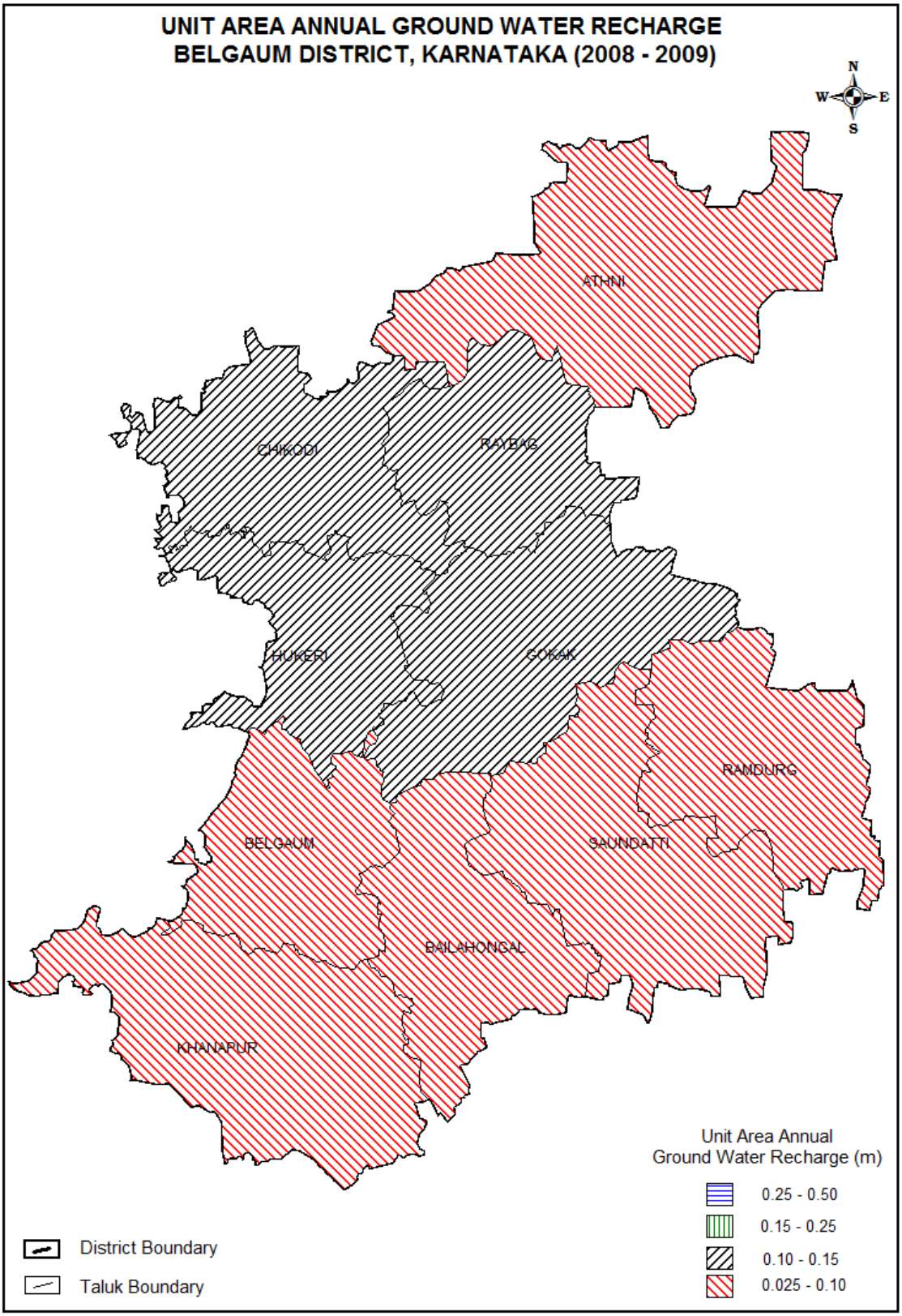

GROUND WATER LEVEL FLUCTUATION
DECADAL MEAN (NOVEMBER 2001 - NOVEMBER 2010) WITH NOVEMBER 2011
Belgaum District, Karnataka
N
W
E
S
0
15
30
kilometers
ATHNI
CHIKODI
RAYBAG
HUKERI
GOKAK
RAMDURG
BELGAUM
SAUNDATTI
BAILAHONGAL
KHANAPUR
KARNATAKA STATE
FLUCTUATION (m)
Rise
Fall
0 - 2
2 - 4
> 4
District Boundary
Taluk Boundary

Fig: 9


UNIT AREA ANNUAL GROUND WATER RECHARGE
BELGAUM DISTRICT, KARNATAKA (2008 - 2009)
N
W
E
S
ATHNI
CHIKODI
RAYBAG
HUKERI
GOKAK
RANDURG
BELGAUM
SAUNDATTI
BAILAHONGAL
KHANAPUR
Unit Area Annual
Ground Water Recharge (m)
0.25 - 0.50
0.15 - 0.25
0.10 - 0.15
0.025 - 0.10
District Boundary
Taluk Boundary

4.3 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. However for administrative convenience talukwise data is preferred. Hence talukwise resource and average stage of development is computed on prorata basis from watershed data and presented in table 7. Resources estimated are as follows:

1. Net Ground water availability = 1,13,799 ham
2. Total Draft = 1,21,866 ham
3. Groundwater availability for future irrigation = 19,941 ham

Areas falling in different categories of stage of development in the district are shown in fig. 10. It is seen from the figure that in the entire district, only in Khanapur taluk 100% taluk area falls in 'safe' category followed by Belgaum taluk, in which about 91% of the area is in the safe category, bothe of which receive high rainfall. All the remaining taluks are at different states of high stage of development. While Chikkodi and Hukkeri taluks have about 50% of the area under critical /Over Exploited (OE) stage, all the remaining taluks have more than 70% of the taluk areas under critical / OE categories. Major portions of the taluks under very high stage of ground water development in the district is seen in Athani, ramdurg and Bailhongal taluks.

4.4 Groundwater quality

The analyses of groundwater samples of the district between 2005 and 2007 revealed that the groundwater quality was in general found to be potable in nearly half of the district. It was also found suitable for irrigation purposes in the major parts of the district (Figure - 11).

Drinking water:

It is essential to know the quality of water as it affects the health of those who consume it. Therefore, quality of groundwater was compared with BIS standards and parameters like Chloride, nitrate, pH and fluoride were evaluated.

Chloride concentrations in general are within permissible limits i.e. 1,000mg/l in the district. Gokak (2,691mg/l) is the only station where chloride concentration is more than permissible limits. Though major part of the district have chloride concentration within desirable limits i.e. less than 250mg/l, isolated patches of higher concentration but below permissible limits i.e. <1,000mg/l are present in most of the taluks. Gokak is the only taluk having about 80% coverage by such an area.

Fig: 10

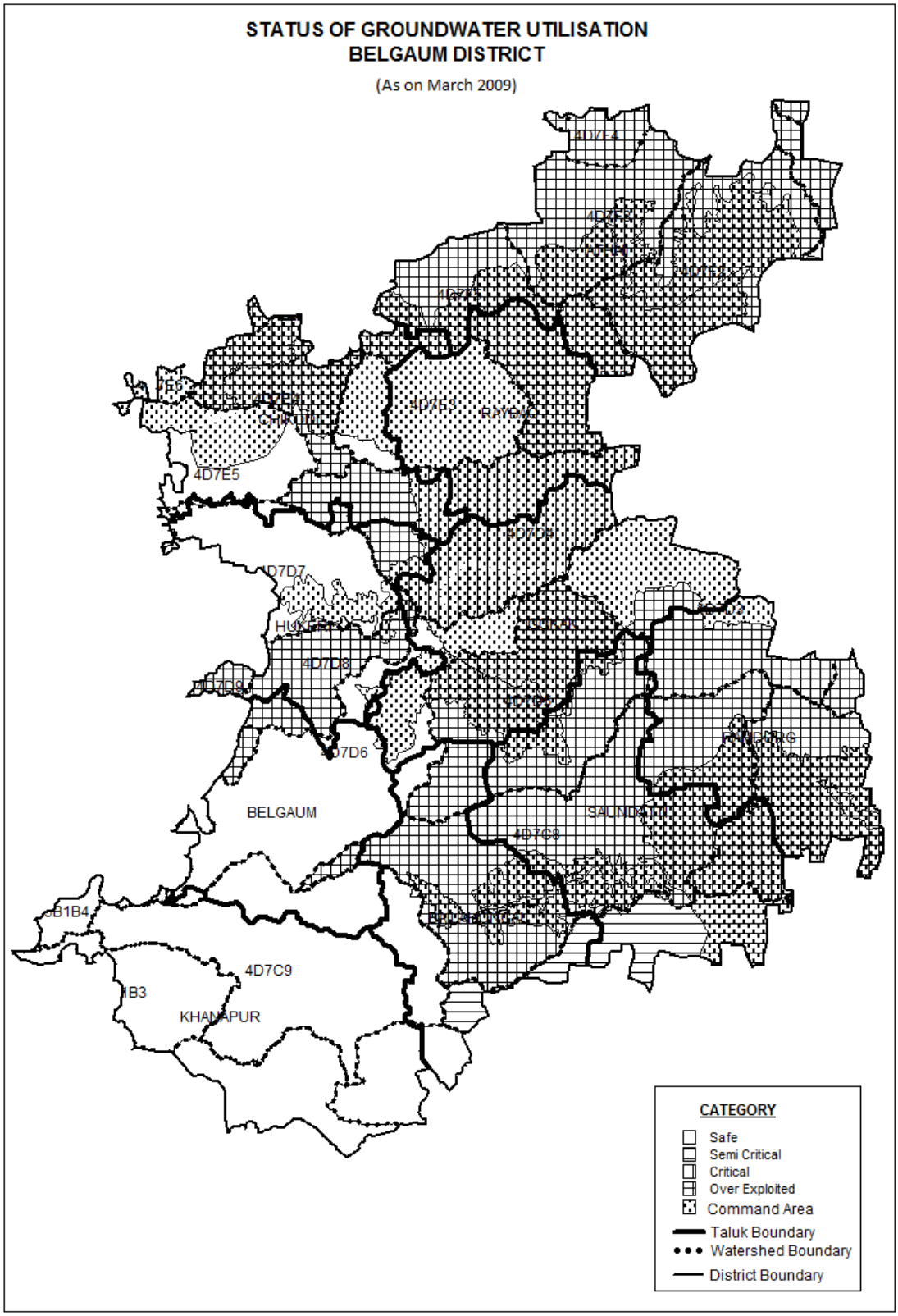
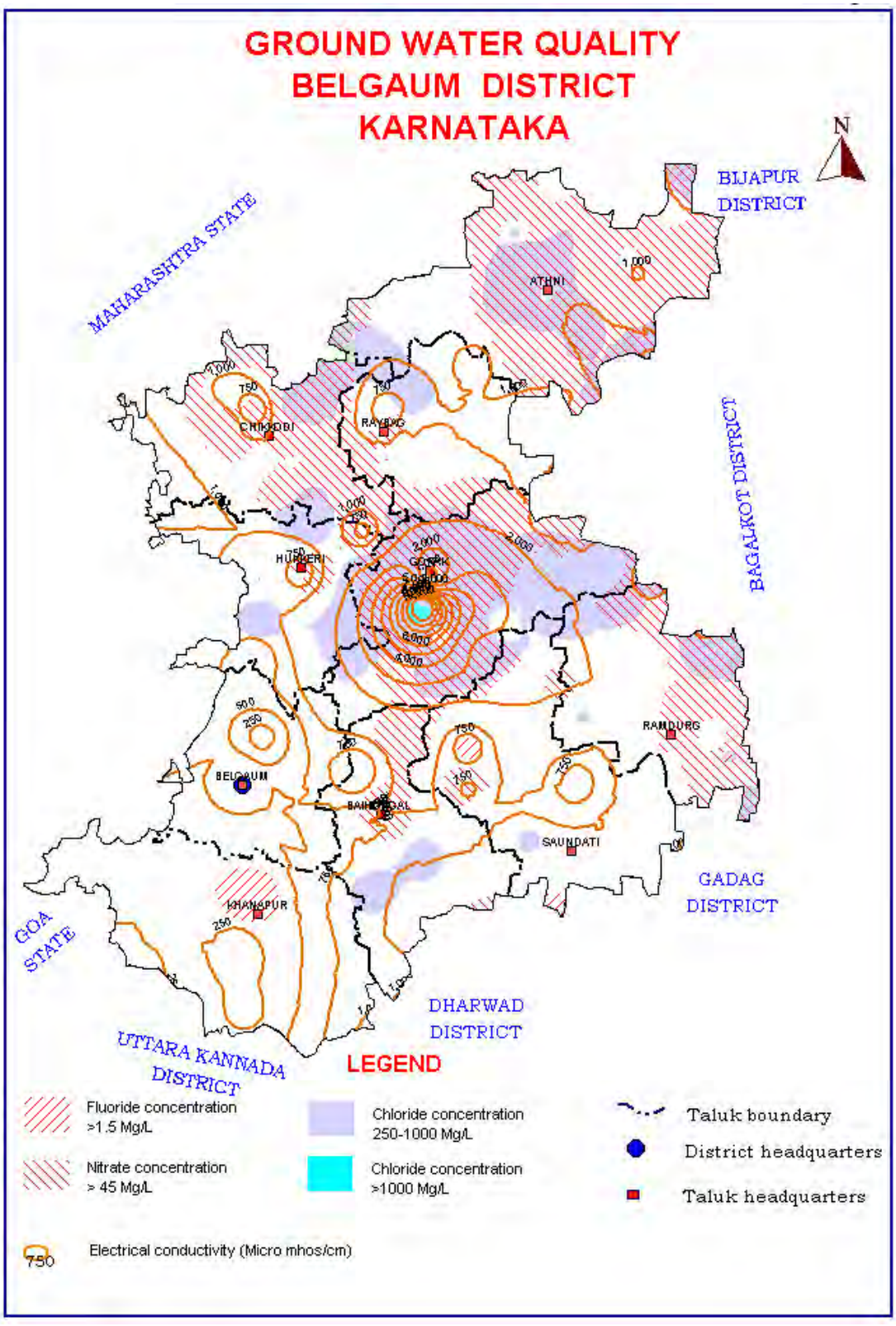

STATUS OF GROUNDWATER UTILISATION
BELGAUM DISTRICT
(As on March 2009)
4D7E4
4D7E5
4D7D7
4D7D8
4D7D6
BELGAUM
4D7C8
4D7C9
KHANAPUR
CATEGORY
Safe
Semi Critical
Critical
Over Exploited
Command Area
Taluk Boundary
Watershed Boundary
District Boundary

Fig: 11


GROUND WATER QUALITY
BELGAUM DISTRICT
KARNATAKA
N
BIJAPUR DISTRICT
MAHARASHTRA STATE
BAGALKOT DISTRICT
ATHNI
CHIKODI
RAYBAG
HUKKERI
GOKAK
BELGAUM
RAMDURG
SAUNDATI
KHANAPUR
GOA STATE
GADAG DISTRICT
DHARWAD DISTRICT
UTTARA KANNADA DISTRICT
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)

The permissible limit for nitrate in drinking water is 45 mg/l. Higher concentrations of nitrate in ground water are generally associated with areas having excessive use of chemical fertilisers and the areas where human and animal wastes are disposed. Ground water with nitrate content above permissible limit in Belgaum district is found mainly in parts of Ramdurg, Saundatti, Balhongal, Gokak, Chikkodi and Athani taluks. Long and continued consumption of water with nitrate above permissible limits can cause health hazards in humans and livestock.

Table 7: Dynamic Ground Water Resources of Belgaum District (2008 – 09)													
Taluk	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual 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	Provision for Domestic and Industrial Requirement Supply to 2025	Net Ground Water Availability for Future Irrigation Development	Existing Stage of Ground Water Development	% Taluk area falling in category			
										Safe	Semi Critical	Critical	Overexploited
			ham	ham	ham	ham	ham	ham	ham	%	%	%	%
ATHNI	9534	520	9013	11779	687	12466	687	0	138	1			99
BAILAHONGAL	9028	547	8481	9696	793	10489	844	1826	124	10	5		85
BELGAUM	6955	598	6357	4212	779	4991	873	1689	79	91			9
CHIKODI	16544	1245	15299	16738	931	17669	1308	1420	115	45		10	45
GOKAK	17852	1569	16282	14051	496	14547	896	2369	89	30		30	40
HUKERI	13975	1136	12838	9893	1573	11467	1683	3361	89	50		5	45
KHANAPUR	12736	2035	10701	3584	449	4033	547	6570	38	100			
RAMDURG	7980	572	7408	11329	924	12253	941	240	165	10			90
RAYBAG	20161	1920	18242	18695	605	19300	973	2294	106	30		30	40
SAUNDATTI	9845	667	9178	13641	1010	14651	1169	172	160	1	29		70
TOTAL	124610	10809	113799	113618	8247	121866	9921	19941	107				

Groundwater in the area is alkaline having pH values between 7.8 and 8.7. In general the groundwater samples revealed that majority of the area is having pH parameters within "Desirable" limits (6.5-8.5), exceptions being Hukkeri (8.7), Gokak and Soundalga (8.6).

Even though groundwater in majority of the district contains fluoride within permissible limits i.e. less than 1.5mg/l, there are small isolated pockets in some of the taluks that contain fluoride in excess of permissible limits, except Belgaum, Bailhongal, Hukkeri and Raybag. Excessive fluoride in drinking water i.e. more than 1.5mg/l may cause mottling of teeth enamel and skeletal deformation. Therefore, a periodic analysis of water used for drinking is needed, especially adjacent to afflicted pockets.

Irrigation:

Suitability of groundwater for irrigation is based on the measure of its Electric conductivity (EC). EC of the water samples in the district ranges between 150 to 11,320 micro mhos/cm. The southwestern part of the district comprising the taluks of Belgaum and Khanapur can be termed as 'Good' to 'Moderately saline'. Otherwise most of the ground water samples fall under the category of Medium to high salinity, having EC values between 750 and 2250 micro mhos/cm. On the other hand about 80% of Gokaki taluk in its central part and about 10% part of Athni taluk towards southeast have an E.C value of more than 2250 micro mhos/cm. Gokak (11,320) and Mamdapur (2,800) in Gokak taluk and Nandgaon (2,420) in Athani taluk. Groundwater of all such areas is 'Unfit' for irrigation.

Chemical analysis of groundwater samples collected from exploratory bore wells at the time of exploration show that the Electrical Conductivity ranges from 7.53 to 8600 microsiemens/cm at 25^{o} C. High value of EC is reported from Sirangi. The concentration of chloride ranges from 11 to 1535 mg/l. SAR values range from 0.38 to 21.14.

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 wise 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 1.5ppm
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.

The vulnerability map for Belgaum district is shown in Fig.12. It is seen from the map that except Khanapur taluk all the remaining taluks of Belgaum district are vulnerable for high stage of Ground Water development. Parts of Bailhongal, Saundatti, Ramdurg, Hukkeri, Gokak, Chikkodi, Raibag and Athani, falling in command areas as marked in the map (fig. 12) are prone for pollution from fertilisers / insecticides and to some extent water logging in reaches close to drainage courses. A central pocket of the district mainly covering parts of the taluks of Khanapur, Bailhongal, Saundatti, Gokak and Hukkeri taluks is vulnerable for fluoride contamination. Small areas in central parts of Chikkodi, south western parts of Raibag and northern parts of Athani taluks are also observed to be vulnerable for fluoride contamination. Vulnerability to nitrate contamination in the district is seen in north eastern parts of Khanapur taluk, southern part of Belgaum taluk, major parts of Bailhongal, Saundatti, Ramdurg, Hukkeri and Athani taluks and small to considerable parts of Gokak, Raibag and Chikkodi taluks.

4.5 Status of Ground Water Development

Ground water is being utilised both for domestic and irrigation purposes. Almost the entire domestic requirement of most of the towns and nearly the entire rural population along with its livestock is being met by the ground water sources. As per the data available for the year ending March 2006, about 15,439 bore wells have so far been drilled to meet the drinking water requirements of the district. As on March 2006, all together 1,289 piped water supply and 1,454 mini water supply schemes depended on ground water, in spite of the fact that two major irrigation projects are there in the district, whose reliability is dependent on the rainfall. Hence, ground water has a special role to play for dependable water supplies.

Fig: 12

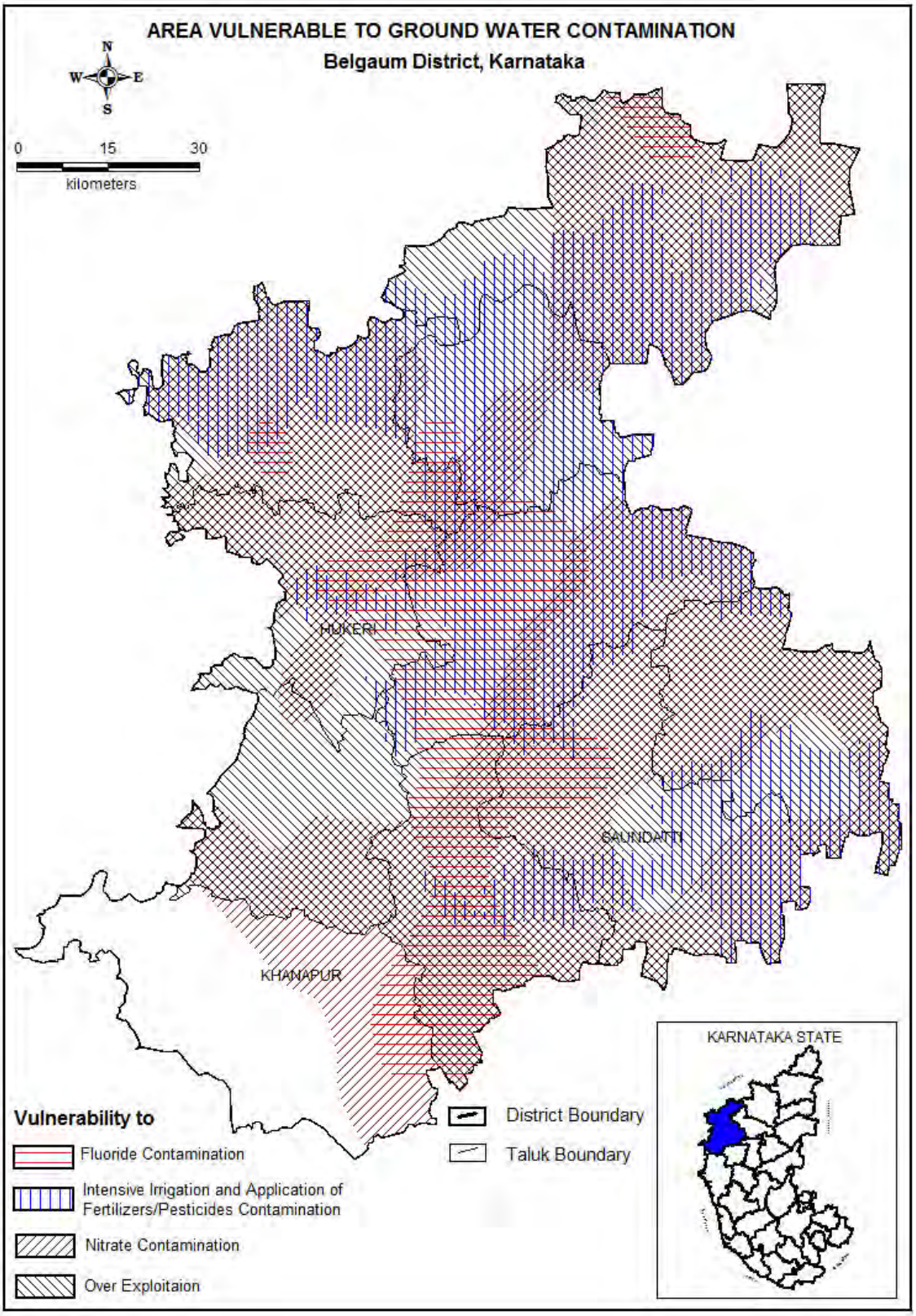

AREA VULNERABLE TO GROUND WATER CONTAMINATION
Belgaum District, Karnataka
N
W
E
S
0
15
30
kilometers
HUKERI
SAUNDATTI
KHANAPUR
KARNATAKA STATE
Vulnerability to
Fluoride Contamination
Intensive Irrigation and Application of Fertilizers/Pesticides Contamination
Nitrate Contamination
Over Exploitaion
District Boundary
Taluk Boundary

Table: 8 Taluk wise groundwater structures in Belgaum district
(Minor irrigation Census 2001)

Sl. No	Taluk	Shallow Borewells	Deep Borewells	Total Borewells	Dugwells
1	Athani	754	1,996	2,750	14,676
2	Bailhongal	891	5,000	5,891	1,016
3	Belgaum	1,982	742	2,724	6,011
4	Chikkodi	83	3,143	3,226	10,445
5	Gokak	659	1,535	2,194	7,555
6	Hukkeri	96	2,058	2,154	8,654
7	Khanapur	2,329	423	2,752	1,088
8	Ramdurg	445	1,784	2,229	0
9	Raybag	688	3,204	3,892	8,360
10	Saundatti	1,534	2,446	3,980	0
	Total district	**9,461**	**22,331**	**31,792**	**57,805**

As per Minor Irrigation Census of 2001 (Table-8) there are 57,805 dugwells, 9,461 shallow borewells and 22,331 deep borewells used for irrigation in the district. The maximum numbers of dugwells i.e. 14,676 are in Athani taluk whereas there are no irrigation dugwells in Ramdurg and Saundhatti taluk. Minimum numbers of shallow borewells are in Chikodi taluk i.e. 83, whereas Khanapur taluk has maximum number i.e. 2329. On the other hand Khanapur taluk has the least number of deep borewells i.e. 423 while the maximum number are in Bailhongal taluk i.e. 5000.

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. Average thickness of these aquifers ranges from 5 to 15m.In 80% of the district area the yields of shallow zones upto the depth of 20m was less than 1 lps. In rest of the 20% area of the district the yields recorded were between 1 to 2 lps, especially in Athni, Raibag and Ramdurg taluk.

Bore wells are the most common abstraction structures with depths ranging from 40 to 200m and have yields 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 2.4 Ham respectively.

5.0 Ground Water 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 ground water conditions in the different terrain conditions and encouraging its judicious use, adopting 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. 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.

It is further suggested that ground water recharge and rain water harvesting techniques, may be adopted, especially in over-exploited taluks so as to avoid further ground water depletion.

5.1 Ground water Development

The computation of ground water resources available in the district is given in table 7 and the table gives the percentage areas of different taluks falling in different categories of Safe, Semi Critical, Critical and Over Exploited (OE) categories. These areas falling under different categories of ground water development are shown in figure 10. The areas falling in safe category offer scope for further ground water development. It is seen from the figure that Khanapur is the only taluk in which the entire area is falling in the safe category and hence offers for further ground water development. In areas falling in semi critical category, as seen mainly in parts of Saundatti taluk, further ground water development should be taken up cautiously. However, in areas falling in critical and OE categories, any development of ground water should be accompanied with ground water conservation, artificial recharge and rain water harvesting measures. So in the areas with over development, all the efforts be made to enhance the recharge to groundwater storage by constructing suitable artificial recharge structures at suitable places. In urban and semi-urban areas rooftop rainwater harvesting techniques will ease the pressure on surface water projects from where, those places are getting the water supply at present. For irrigation as far as possible bore wells should not be recommended where the groundwater is very deep i.e. more than 10 m bgl. Even in those areas dug cum borewells are

suggested and by constructing suitable artificial recharge structures. All efforts should be made to bring the water levels up. The valley portions with thick valley fills supported by suitable artificial recharge structures in the proper viscinity are ideal sites for groundwater development. The well spacing should be maintained. The distance between two groundwater structures should not be less than 200 m to avoid the interference during simultaneous pumping of wells tapping the same aquifers.

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, thus by constructing suitable structures, percolation into ground to recharge ground water can be enhanced.

Central Ground Water Board has constructed rainwater harvesting and artificial recharge structures of different types in Air Force station Samra for demonstration and to increase the water supply to troops from existing boreholes.

Steps have been taken by the state government in this direction by constructing check dams, Mini percolation tanks, farm ponds, nala bunds and vented dams at an average cost of 1.2, 0.25, 0.12, 1.37 and 1.0 lakh rupees respectively. The capacity of these structures varies from 1,000 to 2,000 cubic metres for check dams, mini percolation dams and vented dams, while it varies between 300 to 400 cubic metres for farm ponds and 6,000 to 7,000 cubic metres for nala bunding. The talukwise details of different structures are given in Table-9.

Table-9 Talukwise details of type and No. of structures const. (2000-06)

Sl. No.	Taluk	Check Dams	Mini Percolation tanks	Farm ponds	Nala Bunding	Vented Dams	Total
1	Athani	104	22	31	96	0	253
2	Bailhongal	203	0	60	35	4	302
3	Belgaum	116	7	71	19	133	346
4	Chikkodi	167	33	43	58	0	30
5	Gokak	106	34	314	140	32	626
6	Hukkeri	158	4	139	55	11	367
7	Khanapur	43	0	260	10	203	516
8	Ramdurg	107	1	76	35	3	222
9	Raybag	102	38	53	90	0	283
10	Saundatti	106	17	111	33	0	267
	Total district	**1,212**	**156**	**1,158**	**571**	**386**	**3483**

The study of the nature of geological formations, soil cover, slope of the land, depth of weathering, depth to water level and availability of land and water source the type of artificial structures should differ from place to place. Except for a small area in the western part of Khanapur taluk, most of the area in the district is plain i.e. having slopes less than 20% and therefore, construction of percolation tanks, check dams, farm ponds, nala bunds etc. as done by the state government would have been more beneficial for recharging groundwater with little innovation. As has been said earlier, the Deccan traps occupy major part of the district that are layered formations of basalts and the black cotton soils derived from these formations which occupy most of the valleys, have poor to medium infiltration characteristics. Therefore, any water spreading or ponding methodology will not be so successful in such areas to recharge groundwater, until and unless it is coupled with point recharge structures that directly recharge the aquifer systems. Existing bore wells / dug wells especially the abandoned ones and recharge pits can also be used as point recharge structures. Elsewhere, especially in areas of other formations and soil cover existing techniques can continue to be employed. Moderate to high sloping, undulating terrain comprising the western parts of Khanapur taluk 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. These structures should be located where the depth of the water level is more than 5 m. bgl. Areas that are suitable for artificial recharge structures have been demarcated in Figure- 13.

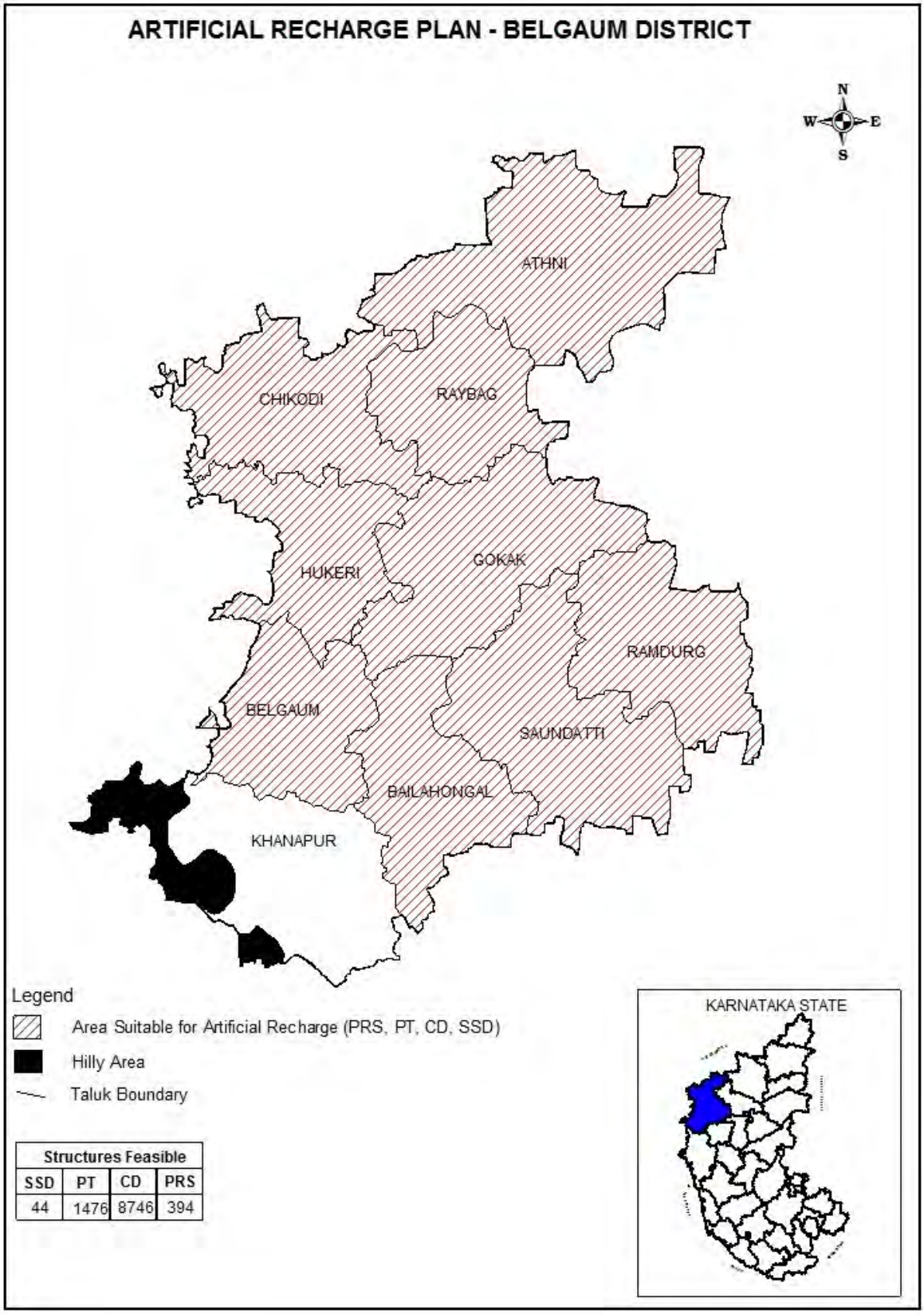
6.0 Groundwater Related Issues & Problems

Canals and lift irrigation schemes along major rivers are irrigating nearly 131712 hectares of land in the district that constitutes 28.3 % of the irrigated area. Although, the area irrigated from these sources is only 16.5 % of the net sown area, it has been observed that large tracts of land in canal command area are facing water logged conditions and groundwater salinity. The problem is more acute in Ghataprabha and Krishna river command areas, as is evident from Figure- 11. There is an urgent need to tackle this issue by way of conjunctive use of surface and sub-surface water in canal command areas.

During drilling operations it has been observed that in areas underlain by sandstones and quartzites of Kaladagi formation which is highly fractured in nature and especially in areas where Deccan traps are underlain by such a formation, normal DTH rig is not capable of drilling due to caving. It is therefore suggested that in such areas DTH rig with Odex attatchment may be employed. Such areas are located in Ramdurg, Gokak and Saundatti taluks.

In areas where long-term trend of water level indicates depletion of water levels, drilling of deeper boreholes to tap deeper aquifers may not be the practical solution for irrigation. As any withdrawal from the aquifer is limited to its recharge, unless of course the recharge area of the deeper aquifer is situated

Fig: 13



Structures Feasible			
SSD	PT	CD	PRS
44	1476	8746	394

elsewhere in a more favourable location than that of the shallow aquifer. It is therefore suggested, that areas where long-term trend of water level indicates depletion, drilling deeper wells is not in the interest of the public in general in the long run.

7.0 Awareness and Training Activity:

Central Ground Water Board has been conducting mass awareness programs in order to educate the public, the necessity of conservation of groundwater resources and also training state government officials in the management of these resources from time to time. In this direction CGWB has conducted these programs in Belgaum district as given below.

7.1 Mass awareness programme by CGWB (MAP):

Mass awareness training program has already been conducted in Bailhongal and Chikkodi towns of Belgaum district.

7.2 Water Management Training program by CGWB (WMTP):

Water management training program has been conducted twice in Zilla panchayat hall for the benefit of the state government officials and NGO's.

8.0 Areas Notified by CGWB/CGWA

Although some taluks are overdeveloped, no area has yet been notified so far in the district.

9.0 RECOMMENDATIONS

Taking into account the prevailing scenario of the groundwater resources and development, the following recommendations are made for the optimal utilisation of ground water resources for sustainable irrigation structures in the district**.**

1. Groundwater development is on high scale in the eastern, low rainfall areas, and is on low key in the southwestern high rainfall area. In view of major areas of the district registering high stage of ground water development, it is recommended that in areas falling under Semi critical category, further development should be taken up cautiously and in areas under critical and OE categories, any development of ground water should be accompanied by ground water conservation measures.

2. The well spacing should be maintained. The distance between two groundwater structures should not be less than 200 m to avoid the interference during simultaneous pumping of wells tapping the same aquifers.

3. Adoption of conjunctive use techniques of ground water and surface water can improve the ground water scenario.

4. Making ground water users aware of the groundwater conditions of the area and encourage its judicious and economical use so as to make the availability of ground water, sustainable.

5. 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.

6. 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.

7. It is further suggested that ground water recharge and rain water harvesting techniques, may be adopted, especially in over-exploited areas of taluks so as to avoid further groundwater depletion as suggested in Figure-11.
8. In basaltic terrain, which has poor to medium infiltration characteristics, recharge to groundwater will not be affective, until and unless it is coupled with point recharge structures that directly recharge the aquifer systems.

9. Existing bore wells / dug wells especially the abandoned ones and recharge pits can also be used as point recharge structures.

10. In areas that are underlain by sandstones, limestones, granites and gneisses etc. existing techniques can continue to be employed.

11. Moderate to high sloping, undulating terrain comprising the western parts of Khanapur taluk is suitable for artificial recharge structures such as contour bunds and contour trenches.