जल वर्ष 2007 Water Year 2007

स्वच्छ सुरक्षित जल – सुन्दर खुशहाल कल

CONSERVE WATER - SAVE LIFE

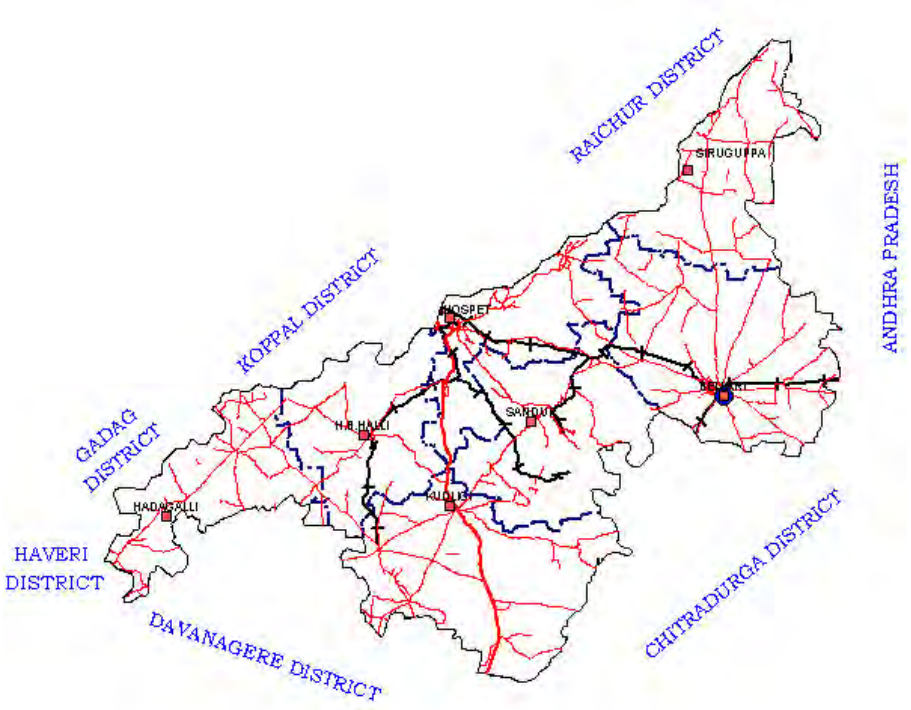
GOVERNMENT OF INDIA

MINISTRY OF WATER RESOURCES

CENTRAL GROUND WATER BOARD

GROUND WATER INFORMATION BOOKLET

BELLARY DISTRICT, KARNATAKA STATE



SOUTH WESTERN REGION

BANGALORE

AUGUST 2012

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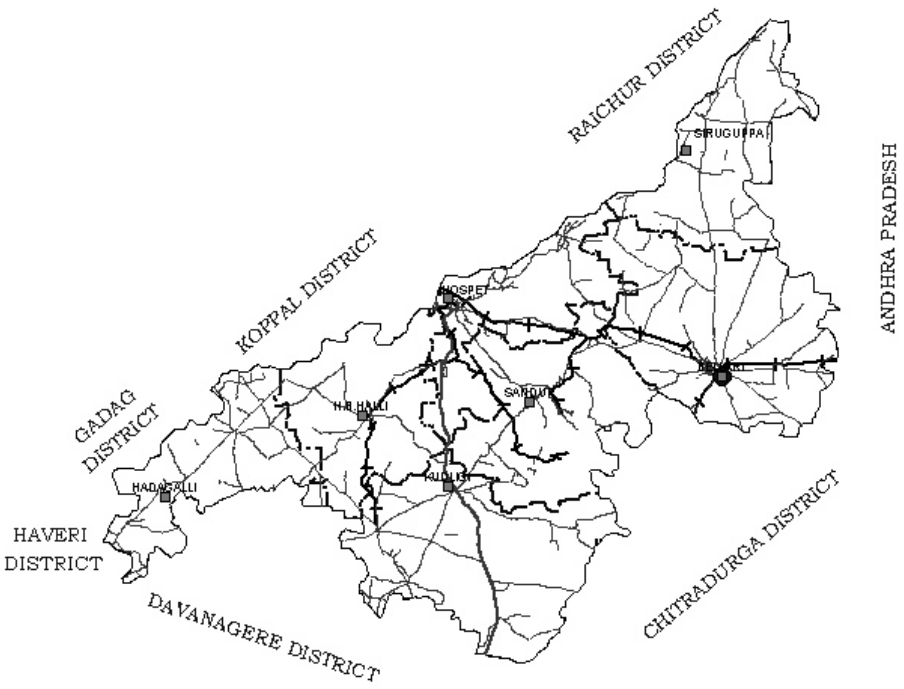

SOUTH WESTERN REGION

BANGALORE

AUGUST 2012

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अध्यक्ष
भारत सरकार
केन्द्रीय भूमि जल बोर्ड
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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 Bellary 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 L.J.Balachandra, Scientist-C, Central Ground Water Board, South Western Region, Bangalore. The figures were prepared by Sri. J. Sivaramakrishnan, Assistant Hydrogeologist and 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 and manage the water resources in a better way in the district.

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sd/-

(Dr. K.Md.Najeeb)
Regional Director

BELLARY DISTRICT AT A GLANCE

Sl. No.	Items	Statistics	
1	**General Information**		
	i. Geographical area (sq. km)	8420	
	ii. Administrative Divisions	1	
	iii. Number of Taluks	7 (Bellary, Hadagali, H.B.Halli, Hospet, Kudlugi, Sandur & Siruguppa.)	
	iv. No. of Panchayats /Villages :	189/554(524 Inhabited+30 uninhabited)	
	v. Population (As on 2011 Census)	25,32,383	
	vi Annual normal rain fall (2001-2010)	671.57 mm	
2	**Geomorphology**		
	Major Physiographic Units	Northern maidan region, monotonous, treeless and expansive plateau landscape. Sandur hills are the main physical features dividing the district into eastern and western parts. The principal hill ranges are Kumaraswamy hills, Ramanmalai, and Jambunatha hills. The highest peaks of the hills are in kumaraswamy hills with 1084m amsl. The average altitude of the district is 493.71m amsl.	
	Major Drainage	Drained by Tungahadra river, which runs along the border and forms the boundary of the district for about 300 kms. Chikkahagari & Hagari/Vedavathy are tributaries drains south to north of the district. The drainage pattern is dendritic to subdendritic.	
3	**Land use (ha)**		
	Forest area (District at a glance 2009-10)	97017	
	Net area sown (District at a glance 9-10)	436077	
4	**Major soil types**	Sandy loam soil along the stream beds, Red soil in elevated places, black soil in irrigated land and in other parts.	
5	**Area under principal crops (2009-2010) in ha**	**Crop** Paddy Maize Bajra Jower Ragi Wheet **Total cereals** Gram Tur Other pulses	**Area** 120414 100517 14083 55548 3449 1174 **295185** 45705 8938 11299

		Total Pulses	**65942**
		Sun flower	67595
		G. nut	70932
		Others	5132
		Total oil seeds	**143659**
		Cotton	25269
		Sugar cane	3923
		Tobacco	466
		Others	3171
		Total Cash crops	**32829**
6	**Irrigation by different sources (Minor irrigation census-2001)**	**Number**	**Area (ha)**
	Dug wells	1232	7159
	Bore wells	22137	53256
	Tanks/ Ponds	-	2054
	Canals	2+Branch canals	79706
	Lift	5345	11943
	Other Sources	**-**	7115
	Net Irrigated Area (ha)	188359	
	Total sown area (ha)	273298	
7	**Number of ground water monitoring stations of CGWB (as on 31-03-2009**)		
	Number Dug wells	37	
	Number of Piezometers	23 (10 VRB project+13 Hydrology Project)	
8	**Predominant geological formations**	The major geological formation is granitic gneiss, Younger granites and schist. Recent alluvium along the river course.	
9	**Hydrogeology**		
	Major Water Bearing Formations		
	Shallow aquifers of alluvium along the stream courses up to 10m and weathered zones of gneisses Granites and occur between the depths of 9 to 25m bgl.		
	Deeper aquifers of jointed and fractured gneisses, granites and Schists occur between the depths of 30 to 197 m bgl.		
	Pre-monsoon Water Levels during 2011	1.61 – 12.05 m bgl (average 5.30m)	
	Post-monsoon Water Levels during 2006	1.26– 13.20 m bgl (average 5.40m)	
	Long term water level trends (2002-2011) in m/year: NHS (Dug wells**)**	From National Hydrograph Stations (NHS) water levels have shown rising trend in the range of 0.013 to 0.967 & average rise of 0.297 m/year, while at 2 NH Stations water levels have recorded falling trend in the range of 0.017 to 0.071 with the average of 0.044 m/year.	

		NHS (Piezometers)	At four National Hydrograph Stations (Piezometers) water levels have shown rising trend in the range of 0.040 to 2.085 with the average of 0.568 m/year, at one piezometer water level have shown falling trend to the tune of 0.018 m/year.
10	**Ground water exploration by C.G.W.B. (as on 31-03-2007)**		
	No of wells drilled-VRB Project Regular exploration program (2001 to 2003) Hydrology project		EW: 47, OW: 12, PZ: 12 EW:21, OW: 12 PZ:13
	Depth range-VRB Project Regular exploration program (2001 to 2003)		09 to 90 m bgl 181 to 197m bgl
	Discharge- VRB Project Regular exploration program (2001 to 2003)		0.22 to 11.20 litres / second 0.00 to 5 litres / second
	Transmissivity (Overall)		1 to 350 m^2 / day
11.	**Ground water quality**		
	Presence of chemical constituents more than the permissible limit		Chemical quality of Ground water is suitable for all purposes in major parts of the district with low sodium type of ground water except in few pockets where Nitrate & Chloride concentration is high in few pockets (parts of Hospet, Siruguppa, Hadagali & south of Kudlugi taluks). SAR ranged 0.1 to 9.4 and % Sodium ranged from 27.47 to 75.37.
	Type of water		Low sodium type
12.	**Dynamic Ground Water Resources** (ham) (2009)		
	Net Annual Ground Water Availability		65277 ham
	Existing gross Ground Water Draft for all use		28572ham
	Projected demand for Domestic and Industrial uses up to 2025		6502 ham
	Stage of Ground Water development as on March 2004 (%)		43.77
13.	**Awareness and Training Activity**		
	Mass Awareness Programmes organised		1 at Bellary
	Water Management Training Programmes organised:		Nil
14.	**Efforts of artificial recharge & rain water harvesting**		
	Projects completed by CGWB (No and amount spent)		Nil

	Projects under technical guidance of C.G.W.B (numbers)	Nil
15.	**Ground water control and regulation**	
	Number of OE Blocks Number of Critical blocks Number of blocks notified	Nil Nil Nil
16.	**Major ground water problems and issues**	Water logging conditions in Tungabhadra command areas especially in Tungabhadra low level and high level canal area which are showing rising water level trends, salinity due to water logging and soil deterioration due to intensive irrigation and extensive use of fertilizers. Power cut, shortage/ fluctuation is another burning issue in lifting available ground water.

BELLARY DISTRICT

1.0. INTRODUCTION

1.1. General

The new Bellary district was formed in 1997. It is famous for its world heritage site at Hampi as listed in UNESCO, which has splendid ruins of ancient city/capital of Vijayanagar spread in an area of 26sq. kms. on right bank of Tungabhadra river. Tungabhadra River forms the natural boundary dividing the district on the west from Dharwar and on the north the Raichur district. Agriculture is the main occupation and 75% of the labour force is dependent on agriculture. Bellary district consists of two widely differing natural divisions-the eastern division is flat and almost treeless, Western division with constant succession of wild, rugged hills and comparatively having high elevation.

The population in the district is around 25, 32,383 (as per 2011 census), out of which rural population is 1613038 (63.70%). The density of population is 300 per square kilometres. The Scheduled caste population is 18.5 percent and Scheduled tribe population is 18.00 percent. The sex ratio is 978 females for every one thousand males. The irrigation in the district is mainly is from surface water source wherein about 61.67 % (District at a glsnce-2009-10) of the area is irrigated from canals, tanks, and lift irrigation. However about 35.06% of the total irrigated area is coming from ground water source mainly through bore wells followed by open wells respectively. The district falls in Krishna river basin. The area sown was 438594ha (2006-2007 Minor irrigation census) out of which 124056 hectares (28.28%) is irrigated. The district is bestowed with good surface water resources provided by rivers, canals, and tanks. The river Tungabhadra is having good potential for multipurpose, major, medium and minor irrigation projects. The water of Tungabhadra are reputed for its sweetness and made use for water supply. The total number of minor irrigation schemes in the district is about 28883 covering 549 villages in the district. Out of 28883, 1232 are dug wells, 22137 are shallow tube wells, 169 are surface flow structures and 5345 are lift irrigation indicating surface water as main source of irrigation.

1.2. Location

The district Bellary is elongated from south-west to north-east and is located in the eastern part of the Karnataka state and lies between the north latitude 14^0 $30^{'}$: 15^0 $47^{'}$ east longitude 75^0 $40^{'}$: 77^0 $11^{'}$. The geographical area of the district is about 8420 Sq.kms. The district is having south-west to north-east spread of about 186.7 kms. And east west spread of 161 kms respectively. Physiographically it is occupied by hills in the central part with plains on the east and west. Bellary district is bounded on the north by Koppal and Raichur districts, on the west by Gadag and Haveri district, on the south by Davanagere and Chitradurga districts of Karnataka state and on the east by Anantapur and Kurnool districts of Andrapradesh. The Sandoor hills are the main physical features in the district which starts from Mallapuram on the bank of Tungabhadra and runs 48 kms in the south easterly direction up to Bellary. A map showing administrative set-up of the district is given in figure-1.

Fig-1

ADMINISTRATIVE SET-UP
BELLARY DISTRICT
KARNATAKA

LEGEND

- Metalled road
- National Highway
- Railway track
- Taluk boundary
- District headquarters
- Taluk headquarters
- Hilly area

1.3. Administrative set up

The district comprises of seven taluks namely Bellary, Hadagali, H.B.Halli, Hospet, Kudlugi, Sandur and Siruguppa. Among the seven taluks Bellary taluk is the largest having an area of 1689sq kms. This is 20% of the total area of the district. Hospet taluk is the smallest with total geographical area of 934 sq. kms. The district is having one revenue sub division at district head quarter at Bellary (Figure-1).

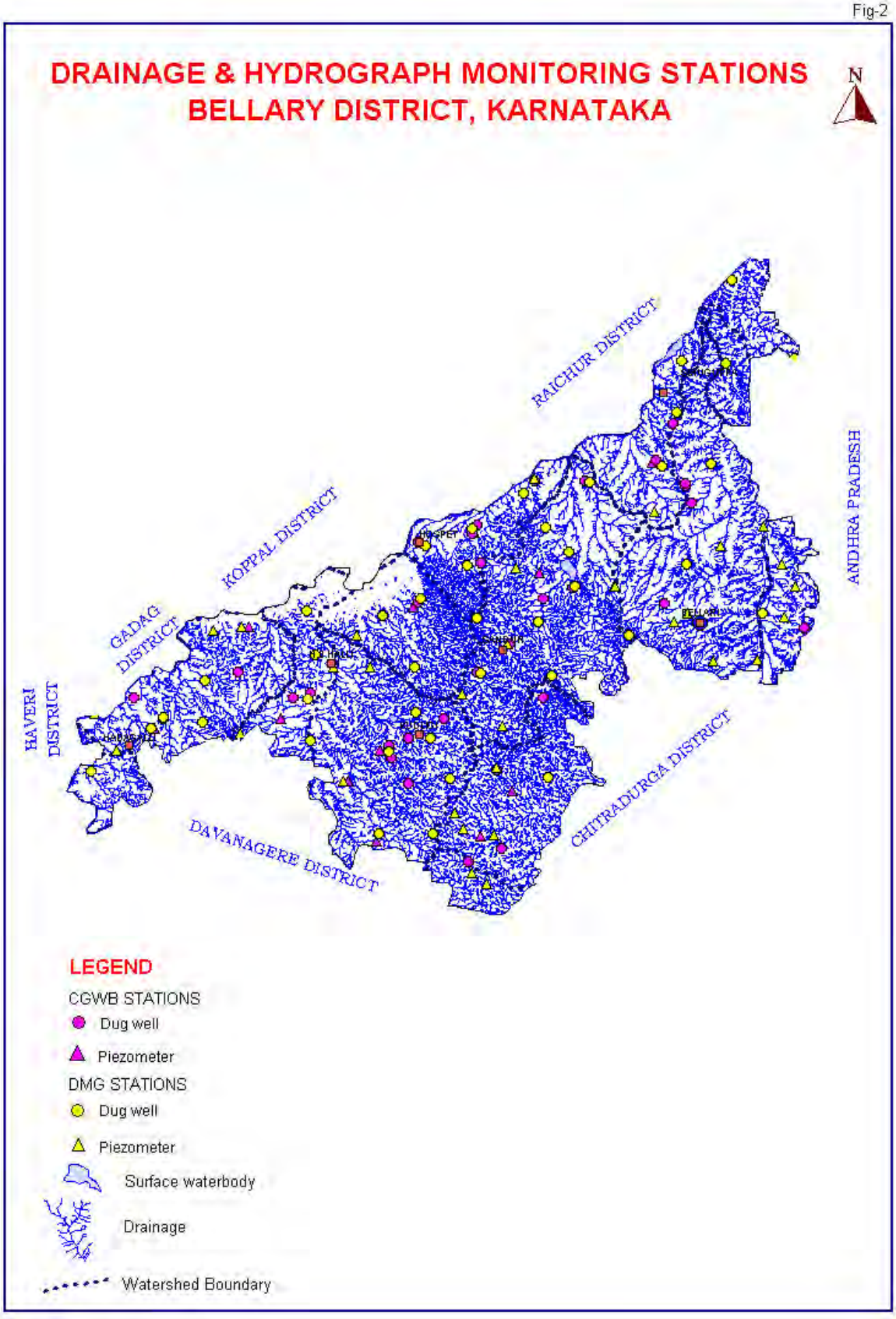
1.4 Communication

The district is well connected by high ways and other main roads. Fairly good network of roads exists connecting taluk head quarters with the district head quarters and hoblis to various taluk head quarter. Total there are 181.0 kms of NH, 996.38kms of SH, 1031.54 kms of major district roads and village road length of 2853.0 kms serves as communication system. Added to this the South Central railway line (Hubli-Guntakal) passes through Hospet and Bellary. Overall 310 kms length of railway roads falling in all the taluks except in Hadagali and Siruguppa taluks adds the communication network.

1.5 Drainage

The district falls in Krishna basin. The Tungabhadra perennial river forms major drainage system in Bellary district. Chikka Hagari and Hagari/Vedavathi are the tributaries of Tungabhadra which runs south to north from the southern tip of the district. These are seasonal rivers flows during monsoon season. Chikkahagari River originates in Guddada Ranganahills near chitradurga and drains into bellary district and flows south to north and joins Tungabhadra at Mallapuram after a travel of 64 kms in the district. A Medium irrigation project across this river exists at Malavi in H.B.Halli taluk. Hagari/Vedavathy the other tributary originates near Mallaianagiri hills in chikmagalur distyrict and enters the eastern part of the Bellary district and drains Hadagali and Kudlugi taluks before joining to Tungabhadra after travelling 92 kms at Bagavadi village in Siruguppa taluk. Number of minor streams which rises locally and ultimately drains into Tungabhadra. Naarihalla is one among them which is damed (medium irrigation project) at Taranagar in Sandur taluk useful for irrigation in the taluk. The drainage in the district is dendritic to sub-dendritic in nature. Dense drainage is noticed in the eastern and western part of the district and sparse drainage is noticed in the central part. The drainage analysis in Hagari, Garanihalla, Chinnahagari and Vedavathy river/stream indicates that the length of the streams ranged from 96 to 172 sq.kms. and the drainage area ranged from 3522 to 7329 sq.kms. with 5th and 6th order stream. The drainage map of the district is in the figure-2.

Fig-2


DRAINAGE & HYDROGRAPH MONITORING STATIONS
BELLARY DISTRICT, KARNATAKA
N
RAICHUR DISTRICT
ANDHRA PRADESH
KOPPAL DISTRICT
GADAG DISTRICT
HAVERI DISTRICT
DAVANAGERE DISTRICT
CHITRADURGA DISTRICT
HOSPET
BELLARY
SIRUGUPPA
HARAPANAHALLI
LEGEND
CGWB STATIONS
Dug well
Piezometer
DMG STATIONS
Dug well
Piezometer
Surface waterbody
Drainage
Watershed Boundary

1.6 Crops and irrigation practices

As per 2009-2010 'district at a glance' publication, 86.95% of land holdings are having less than 4ha, which is about 56.56% of the total area. The major crops grown are the cereals with an area 295185ha which comprise Paddy (40.79%), Maize (34.05%), Jower (18.81%), and Bajra (4.77%) are the major cereals. This follows the cash crops in an area of 28906ha in which cotton and sugarcane are the major crops. This follows oil seeds with an area of 143659ha in which groundnut is the major crop. Lastly pulses with an area of 65942ha in which other pulses and gram are the major crops. The net sown area comprises 53.62% of the total geographical area, in which 30.63% of the area is being sown more than once. As per the records about 26.00% of the net sown area is irrigated through surface water source, and about 15.87 of the area are irrigated through groundwater. The surface water irrigation practices is mainly through canals with the total length of 456 kms from T.B. major irrigation project and two medium irrigation projects (Hagaribommanahalli and Naarihalla) with the other surface water sources like tanks and lift irrigation. As per the minor irrigation census records (2006-2007), the district has 28883 minor irrigation schemes, of which 1232 pertains to dug wells, 22137 schemes pertains to shallow tube wells, 169 surface water flow schemes and 5345 lift irrigation schemes.

1.7 Activities carried out by CGWB

Bellary district had been covered under Vedavathi River Basin Project studies during 1971 to 1980. The main objective of this project was to improve the methodology of Ground Water Resources Evaluation and to establish parametric indices for optimum development of scarce ground water resources and to bring out necessary user maps. Under this project 47 exploratory wells, 12 observation wells and 10 pizometers were constructed. The depth of the wells ranges between 27 and 97 m with water bearing fractures between the depths from 16 to 36m and from 64 to 95m. The discharge range between 0.22 to 11.20 lps. Central Ground Water Board has carried out Systematic Hydrogeological surveys, Reappraisal Hydrogeological surveys and Groundwater Exploration in the district. The deep drilling up to 200m depth was carried out under Ground Water Exploration program during 2001 to 2003. Overall 21 Exploratory wells and 12 Observation wells and one pizometer were drilled. The groundwater exploration revealed the existence of potential zones at deeper depths, between 181 and 197m with discharge up to 5lps. Total 13 numbers of piezometers were constricted in the district during 1998-99 for continuous water level monitoring. Besides this, Central Ground Water Board maintains a good network of observation wells (NHS) in the district, which are monitored periodically to keep a close vigil on the water level variations.

2.0 RAINFALL AND CLIMATE

The climate of Bellary district is quite moderate and is dry in major part of the year with a hot summer from March to May. June to September is the southwest monsoon period with temperature in the range of 19.7°C to 35.1°C. October and November represents the post monsoon retreating monsoon season with clear bright weather with the mean daily temperature ranging from 14.4°C to 31.1°C. During December to February weather remains dry and comparatively cool season. The clouded sky or overcast is observed during southwest monsoon. During October and November some of the depressions and cyclonic storms originates in Bay of

Bengal moving in a westerly to north westerly direction which passes through the district causing wide spread heavy rains and high winds. The mean maximum temperature in the district is 40.4°C. and the mean minimum temperature is 14.3°C (January month). Relative humidity ranges from 48 to 74% in the morning and in the evening it ranges from 27% to 61%. The winds are light to moderate with some strengthening during the south west monsoon. During October to April, the winds blow from directions between north east and south east and are calm in the morning. Winds blows southwest and northwest direction during May to September with an average velocity of 12 kmph. These high winds combined with higher temperature result in high degree of evaporation to the tune of 12.5 mm/day in May against a minimum of 5.4 mm/day in the month of December.

Bellary district receives rainfall from southwest monsoon from June to September and northeast monsoon from October to December. Overall, on an average, there are 43 normal rainy days (1901-1970), where minimum in Bellary taluk with 33 rainy days, maximum in Sandur taluk with 56 rainy days. Actual rainy days recorded during the year 2009 ranged from 41 to 57. Whereas in Bellary taluk it is the minimum with 41 rainy days and the maximum is in Sandur taluk with 57 rainy days. As per 20years rainfall data analysis, the precipitation during southwest monsoon accounts for 60% of the total rainfall and during northeast monsoon it is 24% and the remaining 11.62% is sporadic during summer season. September is the wettest month in the year. The analysis of the last ten years rainfall data (2001-2010) shows that the highest rainfall occurred in Sandur taluk with 831mm and the lowest at Bellary with 566mm and over all annual normal rain fall in the district is 671.57mm. Deficiency in rainfall is observed in the four taluks for the last ten years in the range of 7.67% (Kudlugi taluk) to 15.72% (Bellary taluk). and excess rainfall is observed in the range of 9.14% (Hospet taluk) to 23.73% (Sandur taluk).

3.0 GEOMORPHOLOGY AND SOIL TYPES

The district may be classified as Northern Maidan region with monotonous, treeless, and expansive plateau landscape. The step like landscape, hills and ridges are the general features of the northern maidan region. The central part of Bellary district is occupied by hills with plains on either side of the hill range in the east and west. The Sandur hills run North West of the district dividing the district in to two distinct parts. The eastern part consists of Hospet, Bellary and Siruguppa taluks. The western part consists of Hadagalli, Hagaribommanahalli, Kudlugi and Sandur taluks. The Tungabhadra River forms the eastern and northern boundary of the district. The average elevation of the district is 493.71m amsl. The Sandur hills are the main physical features with valley and its lush green forest. It extends from Mallapuram on the bank of river Tungabhadra and runs for 48 kms in the south easterly direction up to Bellary. The highest elevation in the ridge is the famous Kumaraswamy hills which is 1084m amsl. Ramanmalai (993.1m amsl) and jambunatha hill (908 m amsl) are the major ridges in the district. The other ridges in the district are Ramagod (1058 m amsl) and Donimalai (1027m amsl). Some of the isolated peaks in the district are Kallahalli gudda (836m amsl), Narasimhadevaragudda (775 m amsl), Gudekote (836m amsl) and Bellary hills (602m amsl). The sandur hills, the mallappanagudi and kallahalli gudda ranges are of dharwar schists while the rest of the hills are of older granitic formation.

The soils of the district are derived from Granites, Gneisses and Schistose rocks. The Sandy loam soil mixed with black and grey soils occurs along the stream beds. These are originated from gneisses and granites. They are permeable and mildly alkaline in nature. The thickness of the soil varies from 0.2 to 1.00m. The Red soil are the major type of soil in the district, found mainly at elevated places especially along fringes of hills due to decomposition of rocks and surrounding granitic and gneissic hills. These soils are with high permeability and neutral PH. Black soil with high initial infiltration rate when dry and cracked on getting wet cracks will close and infiltration rate will be very low. These are derived from schistose rocks. The Black soil is found in the prolonged submerged areas and canal command areas having low Permeability. It is calcareous and mildly alkaline in nature.

4.0 GROUND WATER SCENARIO

4.1 Hydrogeology

Hydrogeologically, the district forms a part of hard rock terrain comprising granitic gneiss, younger granites and schistose formation of Archean age. The alluvium occurring in old river course and in flood plains of granitic and gneissic terrain, which are noticed in Hagari river course in Kudlugi, Bellary and Siruguppa taluks. The dug wells constructed in these areas tap alluvial aquifers with perporated cement ring and are generally fitted centrifugal pumps. Even cavity wells were noticed near kottur area. The granitic gneiss and gneissic granite which form major aquifers in the district recorded a weathered and semi weathered zone up to 25m. Schistose formation has weathered formation with less granular and fracture openings than granites and gneisses. Occurrence and movement of ground water are controlled by the degree of weathering, fracturing and the geomorphologic set up in the area. The hydrogeological details of the district are presented in figure-3.

4.2.1 Occurrence of ground water

Groundwater occurs under phreatic and semi confined conditions in weathered and fractured rocks. The principal rock types are granites, gneisses, and schist which has no primary porosity but possess fractures and joints as secondary porosity that forms water bearing and yielding properties of these rocks. Ground water in the above rock formations have potential aquifers with fracture down to the depth of 138mbgl in the gneissic and granitic rocks. Whereas, schistose rocks holds less potential zones due to its compactness and clay filled fracture zones. Alluvial aquifers with the thickness up to 25 m yields copious water as observed in wells at PD halli. The deep-seated fracture is common in the depth range of 80 to 110m along major lineaments. The principal source of recharge is rainfall. In command areas seepage from reservoirs canals and percolation from applied irrigation water form additional recharge sources.

4.2.2 Depth to water level

Out of 22 National Hydrograph Stations (NHS-dug wells) located in Bellary district, the depth to water levels recorded during May-2011 was in the range of 1.61 to 12.05m bgl. The depths to water levels recorded during post monsoon period (November 2011) were in the range of 1.26 to 13.20m bgl. The average depth to water level during pre-monsoon is 5.30m and in post monsoon it is 5.40m. The pre-monsoon and post-monsoon depth to water levels is depicted in Figure-4 and Figure-5. Further the depth to water level between 0.00 to 5.00m in both pre and

post monsoon periods were observed in parts of Hospet taluk, most of the part of Siruguppa taluk and in some parts of west and North West of Bellary in Bellary taluk due to Tungabhadra canal irrigation activity. The major portion of the district shows 5.00 to 10.00m water level during May as well as November 2011. The major part of Kudlugi taluk, part of Hadagali and sandur taluk and east of Bellary taluk is covered either with hill ranges or partly bad land topography. Such areas are left out for want of sufficient control over the water level data. In the remaining part, due to uneven topography, the depth to water level changes within short distance. The water levels in 9-piezometers ranged from 3.68 to 32.51m bgl during May 2011 and 2.27 to 34.56m bgl during November 2011.

4.2.3 Seasonal water level fluctuation

Consequent upon seasonal rainfall, the water levels record a rise indicating the build up of storage in ground water reservoir. During the non-monsoon period, this gets depleted due to exploitation and natural discharge. Therefore, the water levels, in general show a receding trend from December to May. The seasonal water level fluctuation for the year 2011 is available for 21dug well national hydrograph network stations. Where 52.38% of the NH Stations have shown a rise in water level in the range of 0.15 to 1.89 m and 47.71 percent of the stations have recorded a fall in water levels in the range of 0.21 to 4.27m. The seasonal water level fluctuation for the year 2011 is available for 9 piezometer hydrograph network stations, where rise in water level in 5 piezometers in the range of 0.46m to 6.61 m and fall in water level at 4 pizometers in the range of 0.10 to 2.07 m is observed. The average water level fluctuation in pizometers during 2011 is 2.27m and average fall is 1.39m. The water level fluctuation in May 2001 and November 2011 with respect to decadal means of the same periods is given in figure 6 and 7.

4.2.4 Long-term water level trend

The long term water level trend is analyzed in 37 NH Stations for the period from 2002 to 2011, where 35 stations have shown rising trends in the range of 0.013m/y to 0.967 m/y and the average rise in water levels is 0.297 m/y. Similarly falling trends were observed in 2 national hydrograph network stations in the range of 0.071m/y to 0.204 m/y with an average fall of 0.137 m/y. The average maximum rise in water levels over the years is observed in hadagali taluk is 0.493 m/y and the least 0.155 m/y in Bellary taluk. Maximum fall in water levels are observed in Siruguppa taluk with 1.204 m/y and minimum fall is in Sandur taluk with 0.071 m/y. Similarly the water level trend in 13 piezometers over the years for the period 2002 to 2011 show rise in water level in all 12 piezometers in the range of 0.040 to 2.085m/y with the average rise in water level is 0.568 m/y. Similarly fall in water level in 1 piezometer with 0.018m/y.

The last ten years (2001 to 2010) Pre monsoon water level data indicates that mean pre monsoon water level is in the range of 1.457m to 15.868m with an average of 6.369m. However, rise in pre monsoon water level were observed in 20 stations in the range of 0.003m/y to 0.722 m/y with an average of rise of 0.255 m/y. Further fall in pre monsoon water levels were observed at 1 station with 0.603 m/y. Similarly the mean post monsoon water levels in the district for the last ten years are in the range of 1.722m to 12.573m. However rise in water levels in 29 stations are in the range of 0.006 m/y to 1.323 m/y with an average rise of 0.364 m/y.

Fig-3

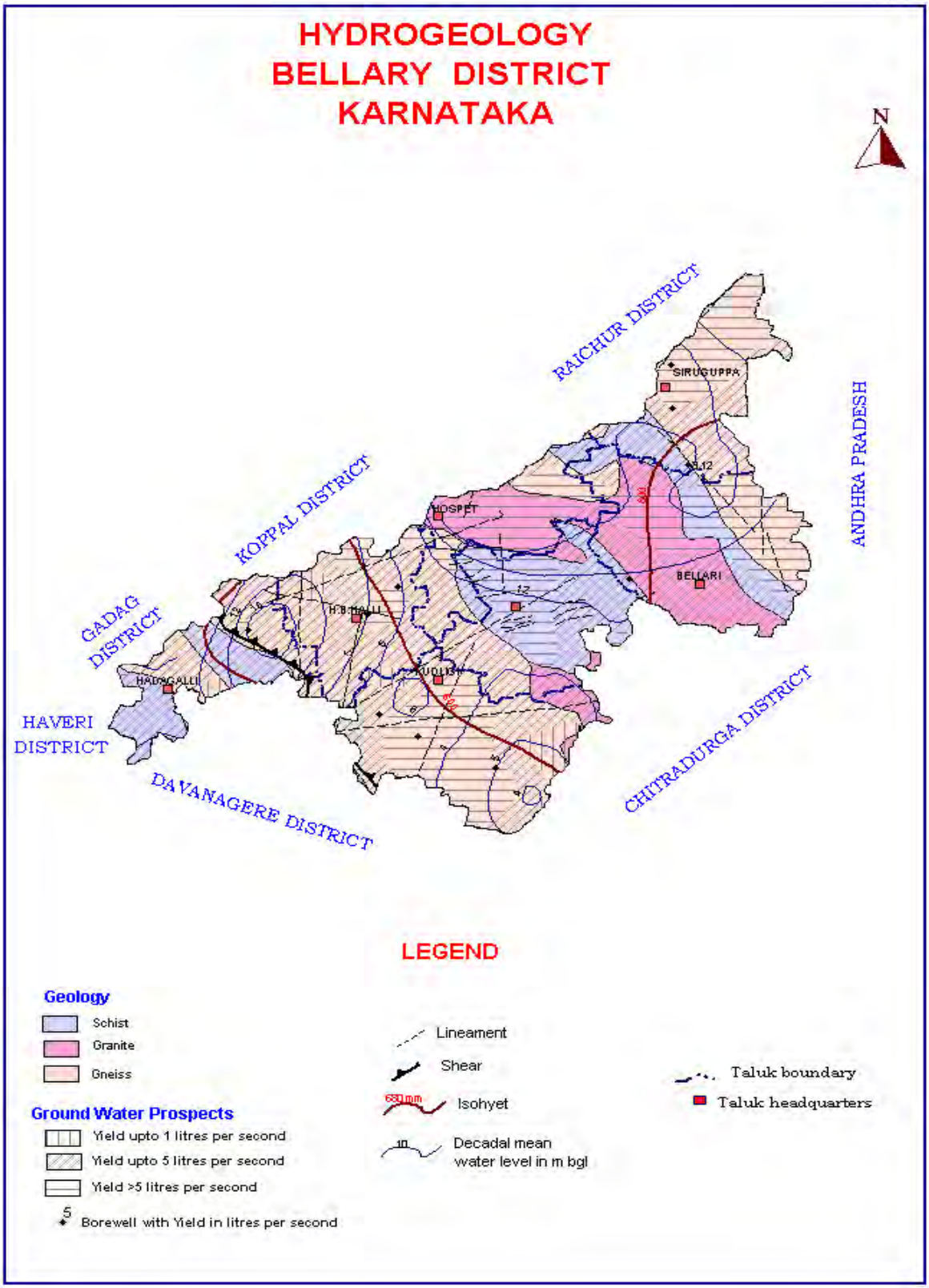

HYDROGEOLOGY
BELLARY DISTRICT
KARNATAKA
N
RAICHUR DISTRICT
ANDHRA PRADESH
KOPPAL DISTRICT
GADAG DISTRICT
HAVERI DISTRICT
DAVANAGERE DISTRICT
CHITRADURGA DISTRICT
SIRUGUPPA
HOSPET
BELLARI
HADAGALLI
LEGEND
Geology
Schist
Granite
Gneiss
Ground Water Prospects
Yield upto 1 litres per second
Yield upto 5 litres per second
Yield >5 litres per second
Borewell with Yield in litres per second
Lineament
Shear
Isohyet
Decadal mean water level in m bgl
Taluk boundary
Taluk headquarters

Fig 4

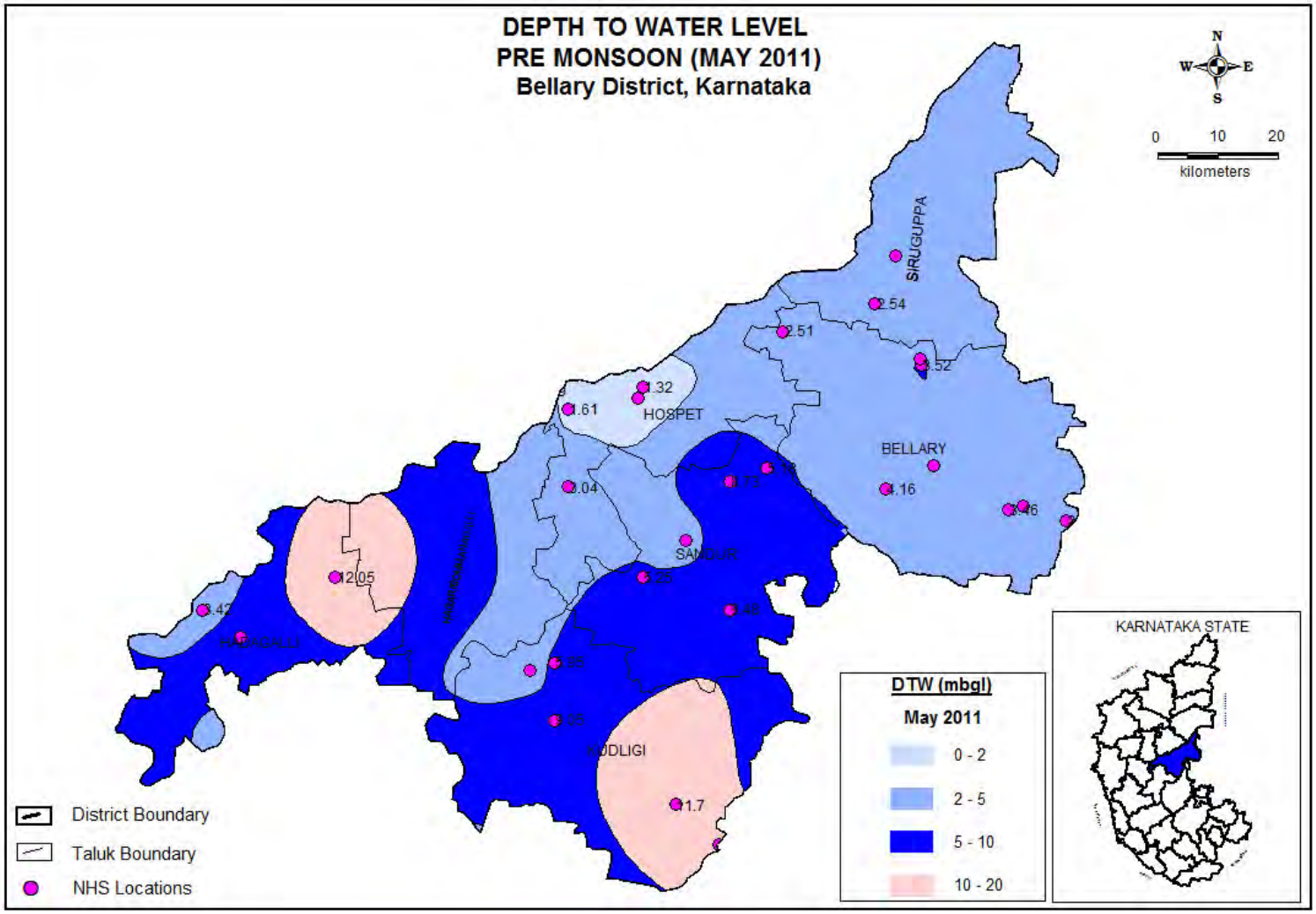

DEPTH TO WATER LEVEL
PRE MONSOON (MAY 2011)
Bellary District, Karnataka
N
W
E
S
0
10
20
kilometers
SIRUGUPPA
2.54
2.51
3.52
3.32
1.61
HOSPET
BELLARY
4.16
3.04
SANDUR
12.05
HADAGALLI
KUDLIGI
1.7
District Boundary
Taluk Boundary
NHS Locations
DTW (mbgl)
May 2011
0 - 2
2 - 5
5 - 10
10 - 20
KARNATAKA STATE

Fig 5

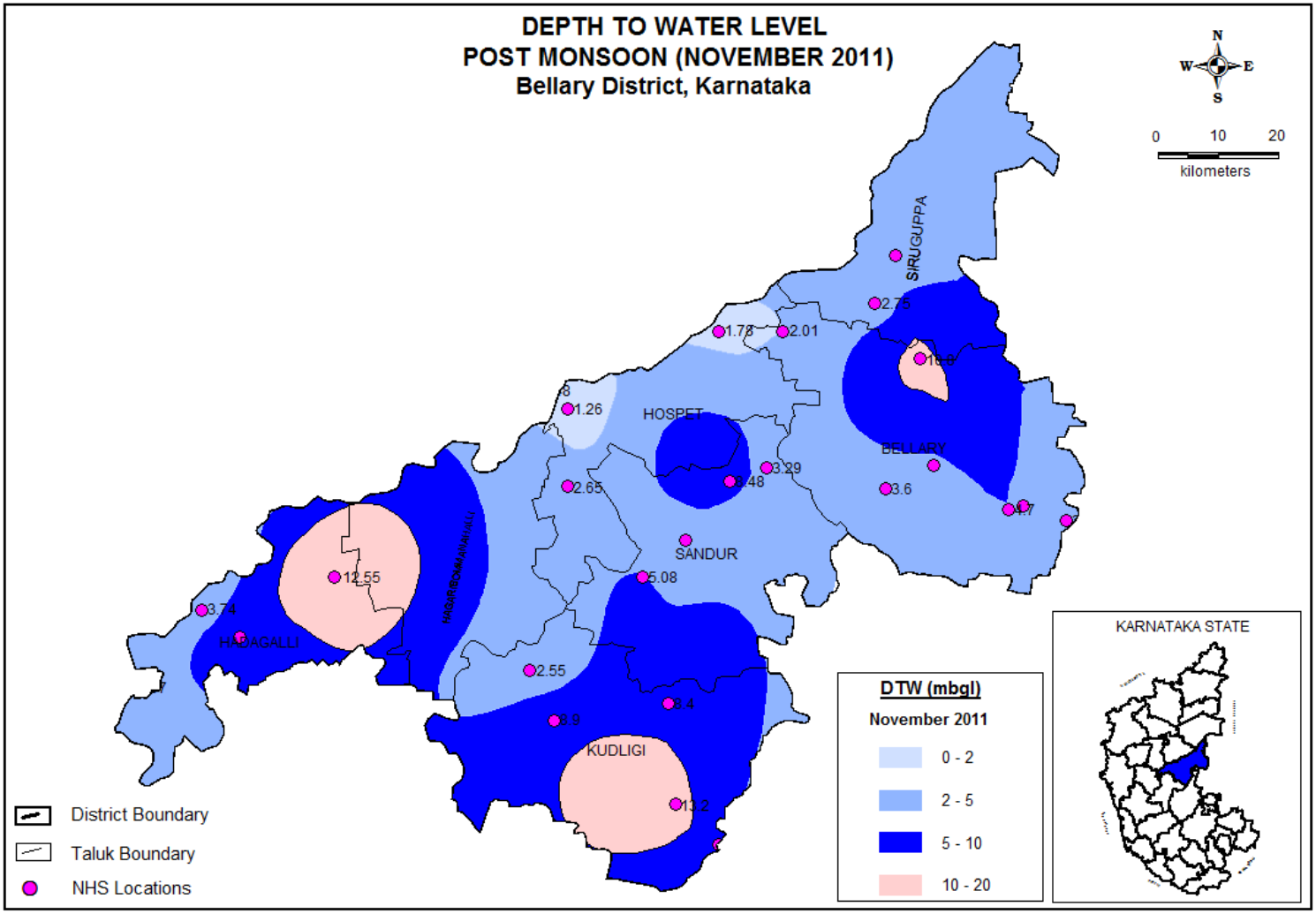

DEPTH TO WATER LEVEL
POST MONSOON (NOVEMBER 2011)
Bellary District, Karnataka
N
W
E
S
0 10 20
kilometers
SIRUGUPPA
HOSPET
BELLARY
SANDUR
HADAGALLI
KUDLIGI
1.78
2.01
2.75
1.26
2.65
3.29
3.6
5.08
12.55
3.74
2.55
3.4
2.9
11.2
DTW (mbgl)
November 2011
0 - 2
2 - 5
5 - 10
10 - 20
KARNATAKA STATE
District Boundary
Taluk Boundary
NHS Locations

Fig-6

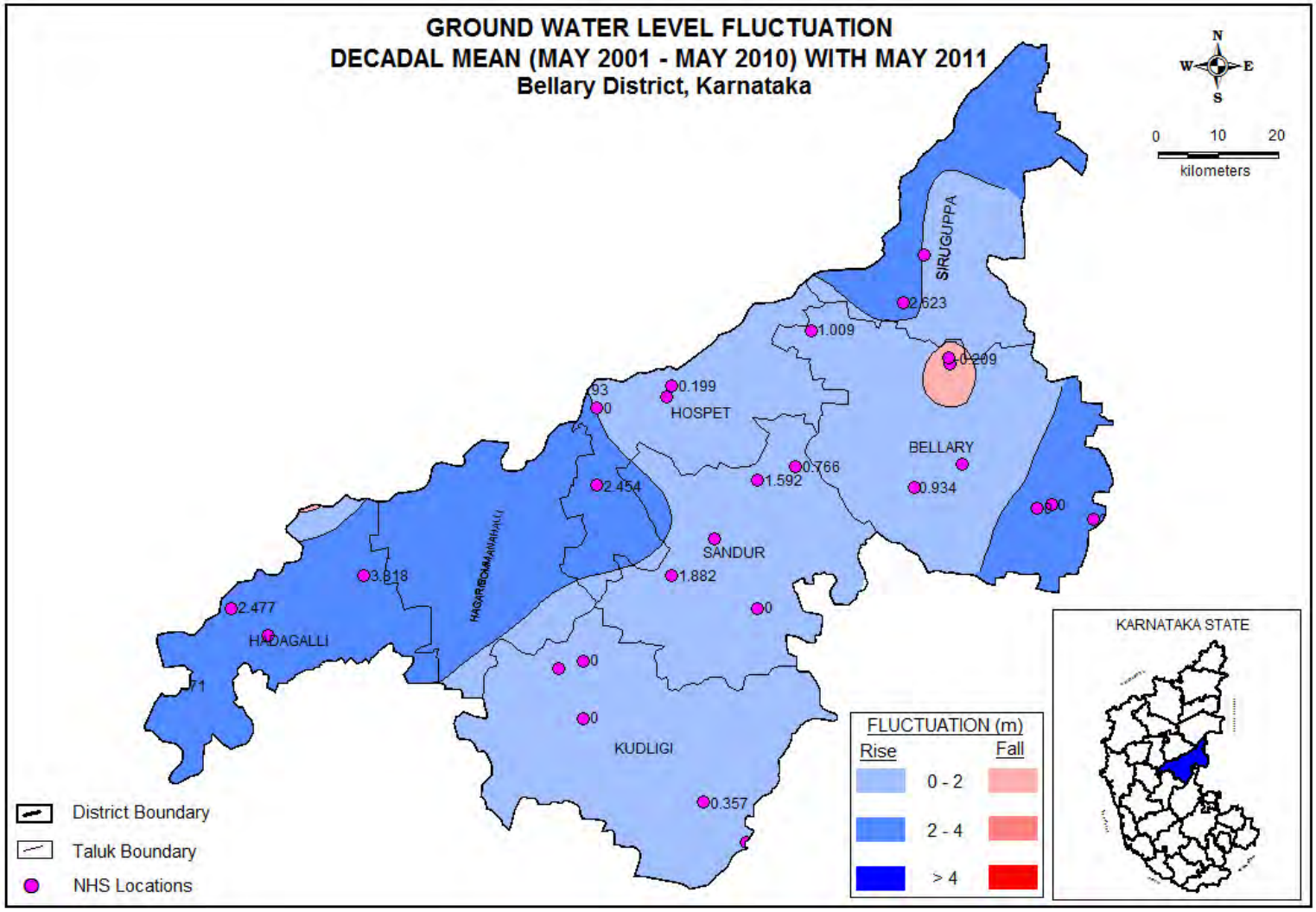
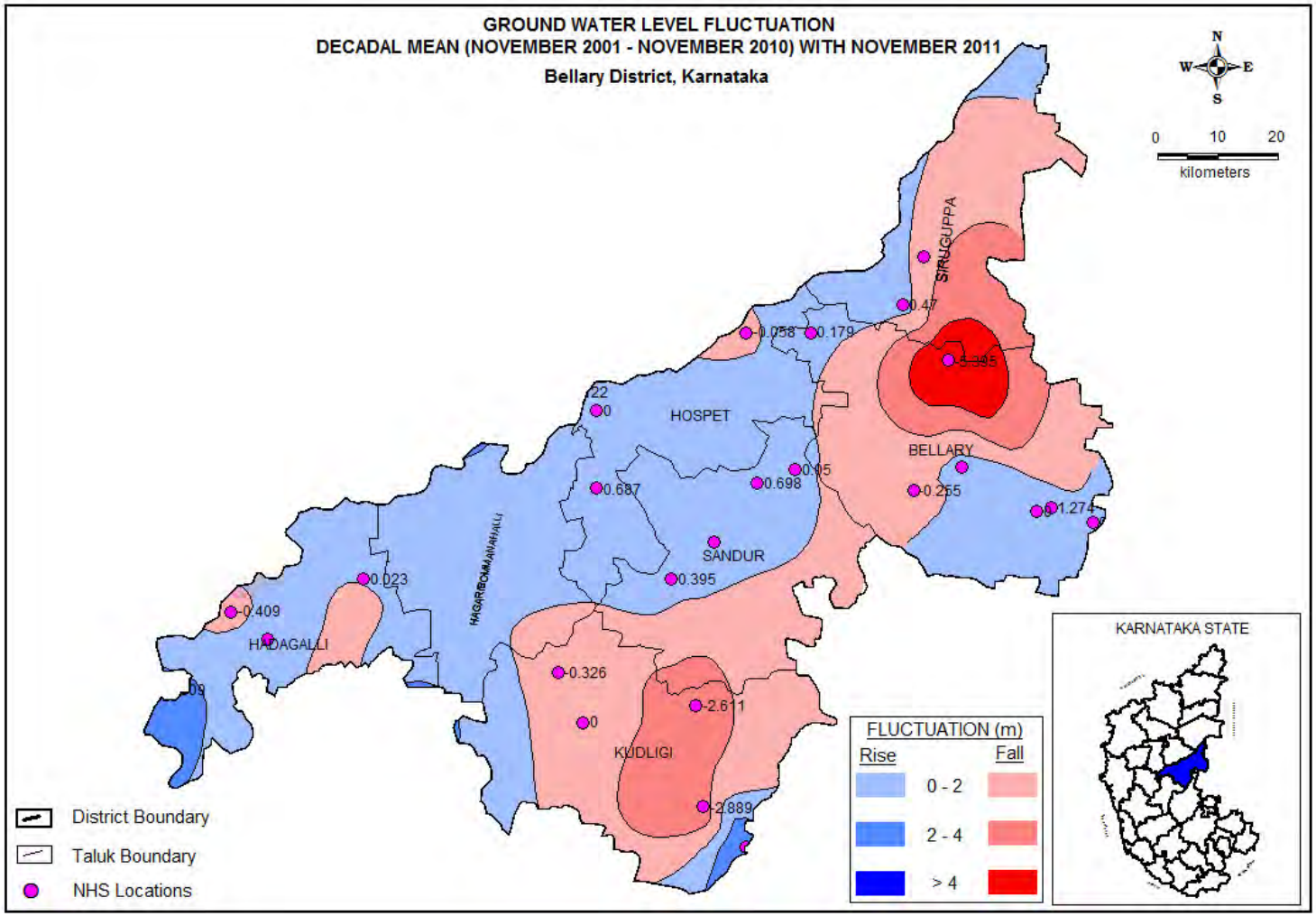

GROUND WATER LEVEL FLUCTUATION
DECADAL MEAN (MAY 2001 - MAY 2010) WITH MAY 2011
Bellary District, Karnataka
N
W
E
S
0 10 20
kilometers
SIRUGUPPA
2.623
1.009
0.209
0.199
HOSPET
BELLARY
0.766
1.592
2.454
0.934
SANDUR
1.882
3.818
2.477
HADAGALLI
KUDLIGI
0.357
FLUCTUATION (m)
Rise
Fall
0 - 2
2 - 4
> 4
KARNATAKA STATE
District Boundary
Taluk Boundary
NHS Locations

Fig 7


GROUND WATER LEVEL FLUCTUATION
DECADAL MEAN (NOVEMBER 2001 - NOVEMBER 2010) WITH NOVEMBER 2011
Bellary District, Karnataka
N
W
E
S
0
10
20
kilometers
SIRUGUPPA
0.47
0.058
0.179
5.385
22
0
HOSPET
BELLARY
0.05
0.687
0.698
0.255
1.274
SANDUR
0.395
0.023
0.409
HADAGALLI
HAGARIBOMMANAHALLI
0.326
2.611
0
KUDLIGI
2.889
KARNATAKA STATE
FLUCTUATION (m)
Rise
Fall
0 - 2
2 - 4
> 4
District Boundary
Taluk Boundary
NHS Locations

4.2.5 Aquifer systems encountered in the area

The study of aquifer geometry and parameters have been attempted in Bellary district by Central Ground Water Board, South Western Region, Bangalore, under its systematic and reappraisal hydrogeological surveys, ground water exploration programme and in Vedavathy River Basin Project through drilling exploratory bore wells at select places. Overall 18 exploratory wells, 2 observation wells, 11 piezometers and 28 water table wells were drilled in VRB project. And in regular exploratory drilling program between 2000 and 2003, 21 exploratory wells, 12 observation wells were constructed in seven taluks of the district. The aquifer zones are weathered / fractured & jointed granites, gneisses and schists occurring at various depths from 7to 197m bgl.

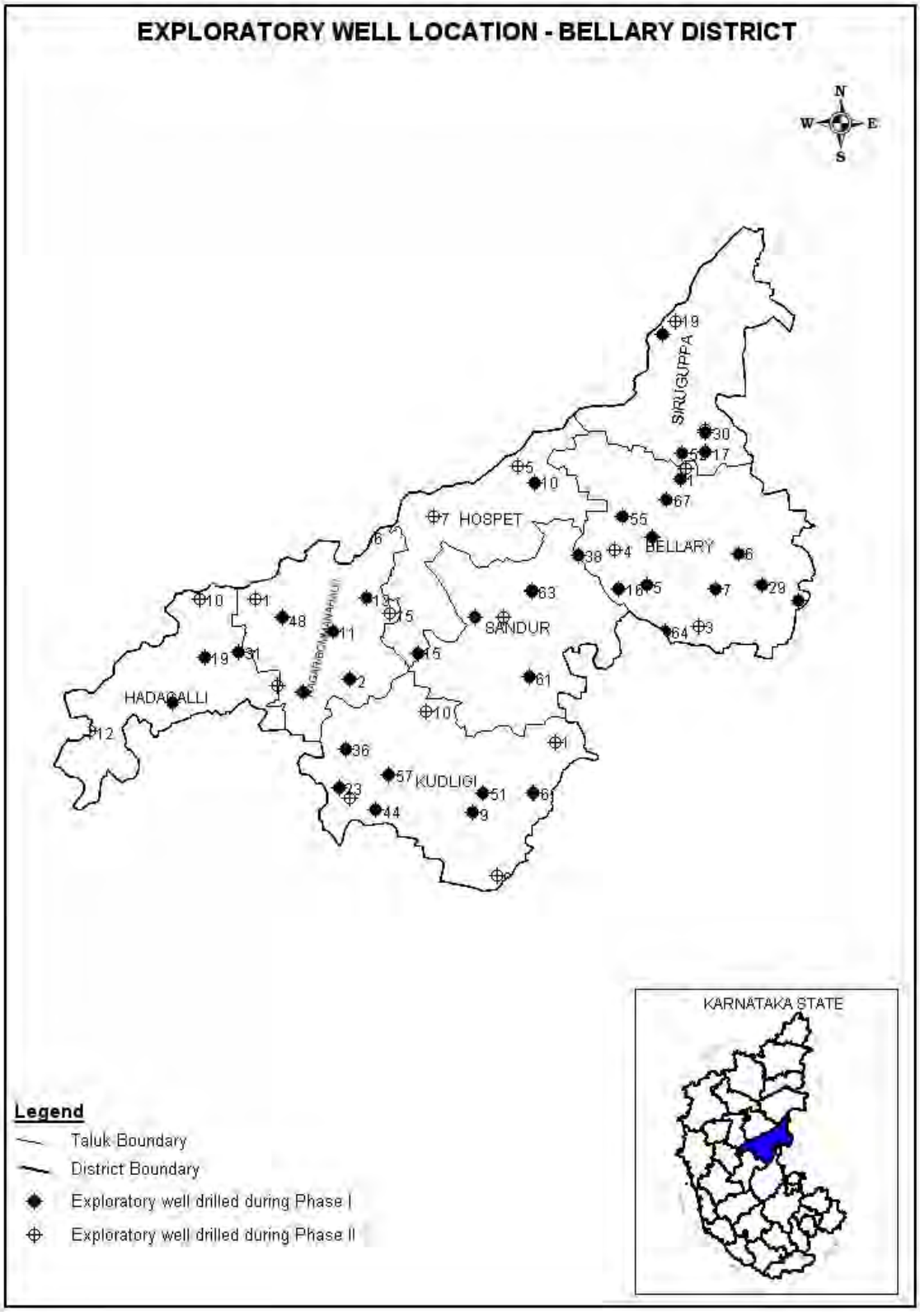
The aquifer geometry in shallow zone is limited to 25 m, it has exploited through dug wells from the weathered mantle of the formation. The dug well has shown the specific capacity ranges from 0.50 to 727.86m^3/day/m/dd. The transmissivity in granites/gneiss ranged from 0.24 to 292.38m^2/day. The findings of VRB project indicates the fractured rock transmissivity ranged from 50 to 350m^2/day and fractured block transmissivity is ranged from 40 to 50m2/day. In schistose formation it ranged from 1 to70 m^2/day. The gross storativity of the fractured block is of the magnitude of 10^{-3} in granites and 10^{-4} in schist.

The exploratory bore wells drilled in the district where depths ranging from 96 to 200.00m bgl (Figure-8). The discharge ranges from <1.0 to 8.20 lps. The yield-cum-recuperation tests conducted on the wells show that the drawdown range of 1.20m to 30.61m, Specific capacity ranged from 2.06 250 m^3/day/m/dd, transmissivity of aquifer material in general range from 1.54 to 345 m2/day and the static water level recorded is in the range of 1.68m to 32.15m bgl.

4.3 Ground water resources

Ground water resources for Bellary district is estimated taluk wise and presented in the table-1, which indicates that the Net annual ground water availability in the district is 65277 ham, Gross ground water draft is 28572ham, and Ground water balance available for future ground water development is 35539 ham. Taluk wise data viz. Net ground water availability, Existing ground water draft for irrigation, Existing gross groundwater draft for domestic and industrial water supply, Existing gross ground water draft for all use, Allocation for domestic and industrial use for next 25 years, Net ground water availability for future irrigation development, Balance of ground water irrigation potential and the Stage of ground water development is shown in the table.

Fig-8


EXPLORATORY WELL LOCATION - BELLARY DISTRICT
N
W
E
S
SIRUGUPPA
HOSPET
BELLARY
SANDUR
HADAGALLI
KUDLIGI
KARNATAKA STATE
Legend
Taluk Boundary
District Boundary
Exploratory well drilled during Phase I
Exploratory well drilled during Phase II

Based on the stage of ground water development, 100% area in Hospet taluk, and Siruguppa followed by almost 95 % of the area in Sandur taluk 83 percent in Bellary taluk falls in safe category where there is scope for further ground water development. In H.B.Halli and Kudlugi taluks it ranged from 20 to 40% of area falling in safe category, where proper graound water management practices to be followed for further ground water development. Hadagali taluk falls in OE category where it is required to recharge ground water with artificial recharge methods and further ground water development is to be avoided. 50% of the area in Kudlugi and 30 percent in H.B.Halli taluks falls in Semi critical where it is to adopt proper management practices for avoiding further critical stage. Bellary about 17% and H.B.Halli 50% of the area not covered under canal irrigation falls under OE which also requires attention. Similarly in Kudlugi 10 % of the area falls in OE where proper ground recharge schemes to be implemented. Taluk wise stage of ground development computed as on March 2009 is presented in the table and status of ground water utilization is in figure-9.

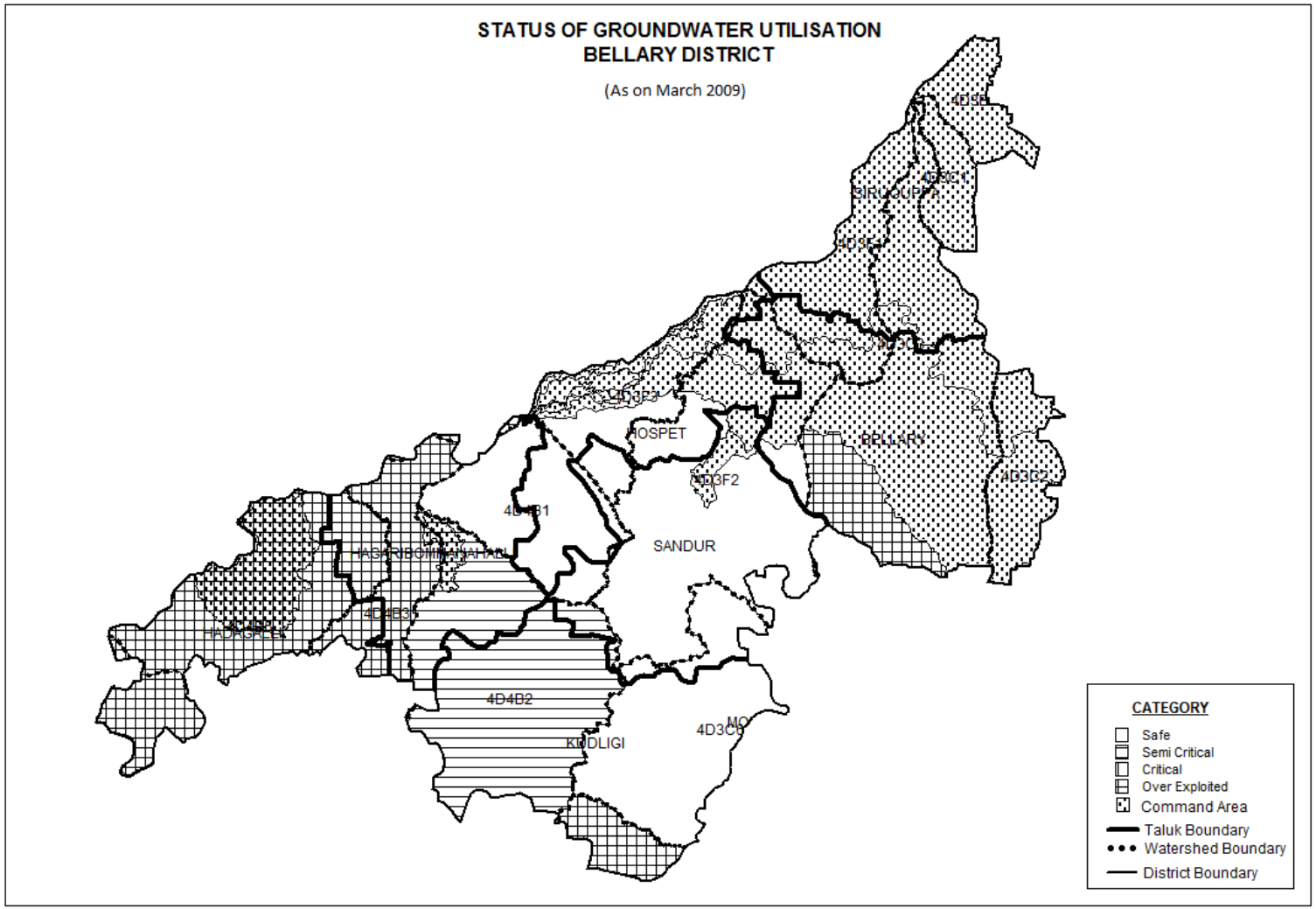
Table-1 Taluk-wise Groundwater Resource of Bellary district as on March 2009

TALUK	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	ALLOCATION FOR DOMESTIC AND INDUSTRIAL USE FOR NEXT 25 YEARS	WATER AVAILABILITY FOR FUTURE IRRIGATION	STAGE OF GROUND WATER DEVELOPMENT IN CERCENTAGE	CATEGORISATION (%)			
								SAFE (%)	SEMI-CRITICAL (%)	CRITICAL (%)	OE (%)
	HAM	HAM	HAM	HAM	HAM	HAM	%	%	%	%	%
Bellary	15326	3844	998	4842	1871	9630	32	83			17
Hadagali	6078	5769	612	6381	631	207	105				100
H.B.Halli	5223	4940	418	5358	460	610	103	20	30		50
Hospet	10408	2525	586	3112	1236	6651	30	100			
Kudlugi	4914	3375	319	3694	415	1123	75	40	50		10
Sandur	7065	2972	646	3618	848	3245	51	95	5		
Siruguppa	16263	1149	418	1567	1041	14073	10	100			
Total	65277	24574	3997	28572	6502	35539	43.77				

4.4 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 its susceptibility to various stress factors the district wise vulnerability map is prepared on a regional scale considering the following factors viz.

Fig-9


STATUS OF GROUNDWATER UTILISATION
BELLARY DISTRICT
(As on March 2009)
4D5B
4D5C1
SIRUGUPPA
4D5A
4D3C
4D3F1
HOSPET
BELLARY
4D3F2
4D3C2
4D4B1
SANDUR
4D4B3
4D4D2
KUDLIGI
4D3C1
CATEGORY
Safe
Semi Critical
Critical
Over Exploited
Command Area
Taluk Boundary
Watershed Boundary
District Boundary

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. In Bellary district Fluoride concentration intensive irrigation and application fertilizers/pesticide contamination is common in command areas and Nitrate contamination in other parts. The area vulnerable to groundwater is given in figure 10.

4.5 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 Bellary district the unit area annual recharge is in the (fig-11)

Fig-10

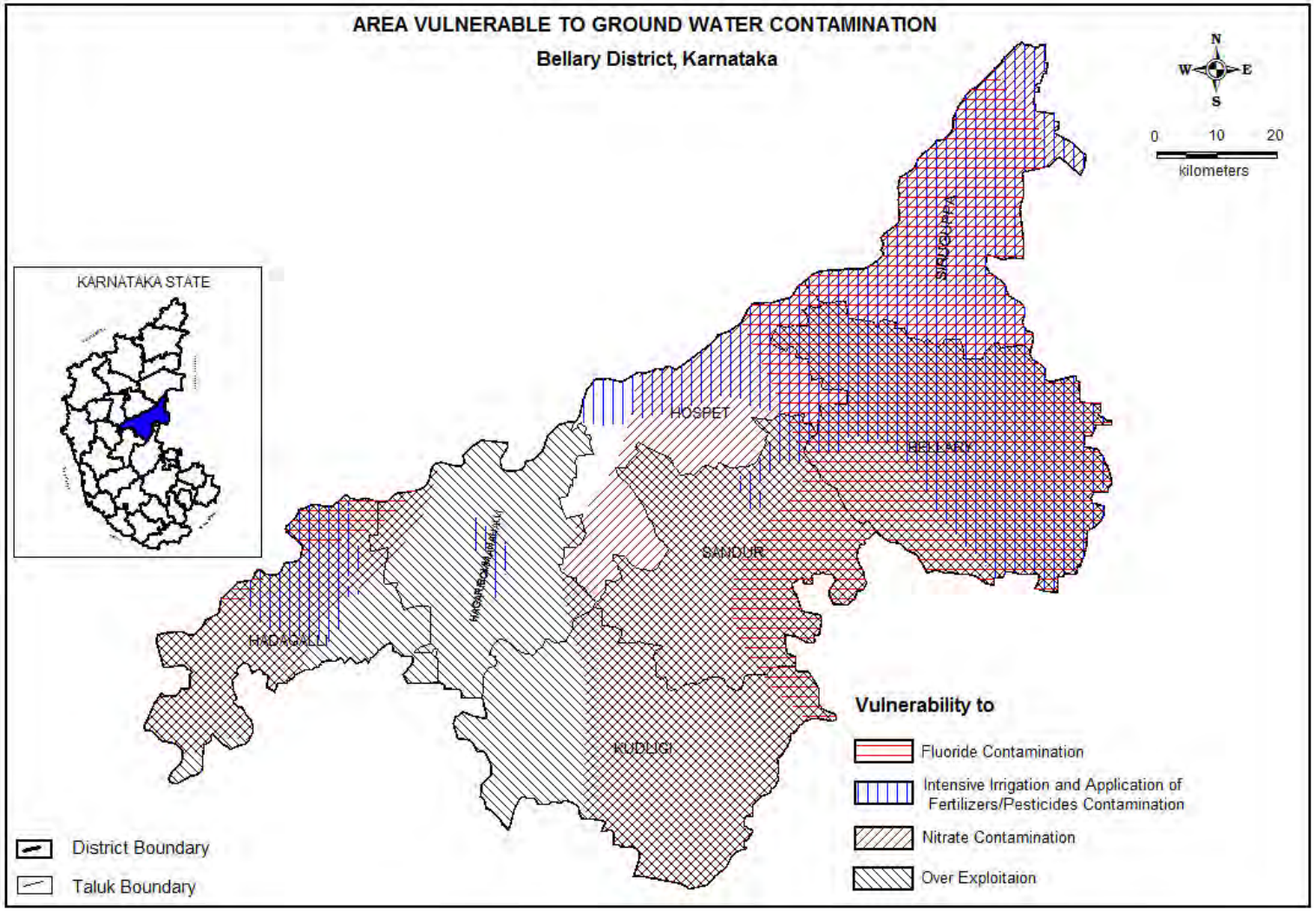
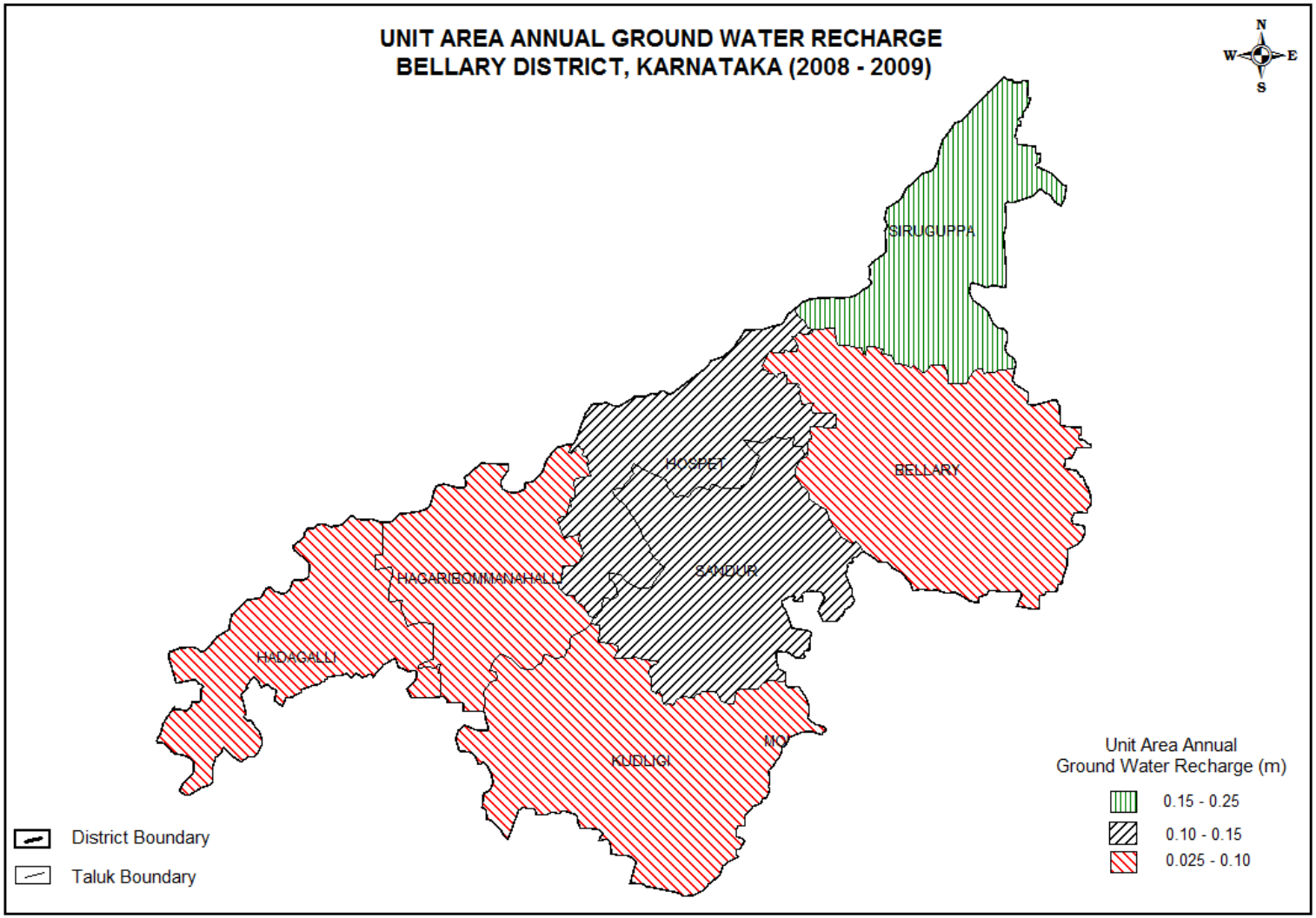

AREA VULNERABLE TO GROUND WATER CONTAMINATION
Bellary District, Karnataka
N
W
E
S
0
10
20
kilometers
KARNATAKA STATE
SIRUGUPPA
HOSPET
BELLARY
SANDUR
HADAGALLI
HAGARIBOMMANAHALLI
KUDLIGI
Vulnerability to
Fluoride Contamination
Intensive Irrigation and Application of Fertilizers/Pesticides Contamination
Nitrate Contamination
Over Exploitaion
District Boundary
Taluk Boundary

Fig-11

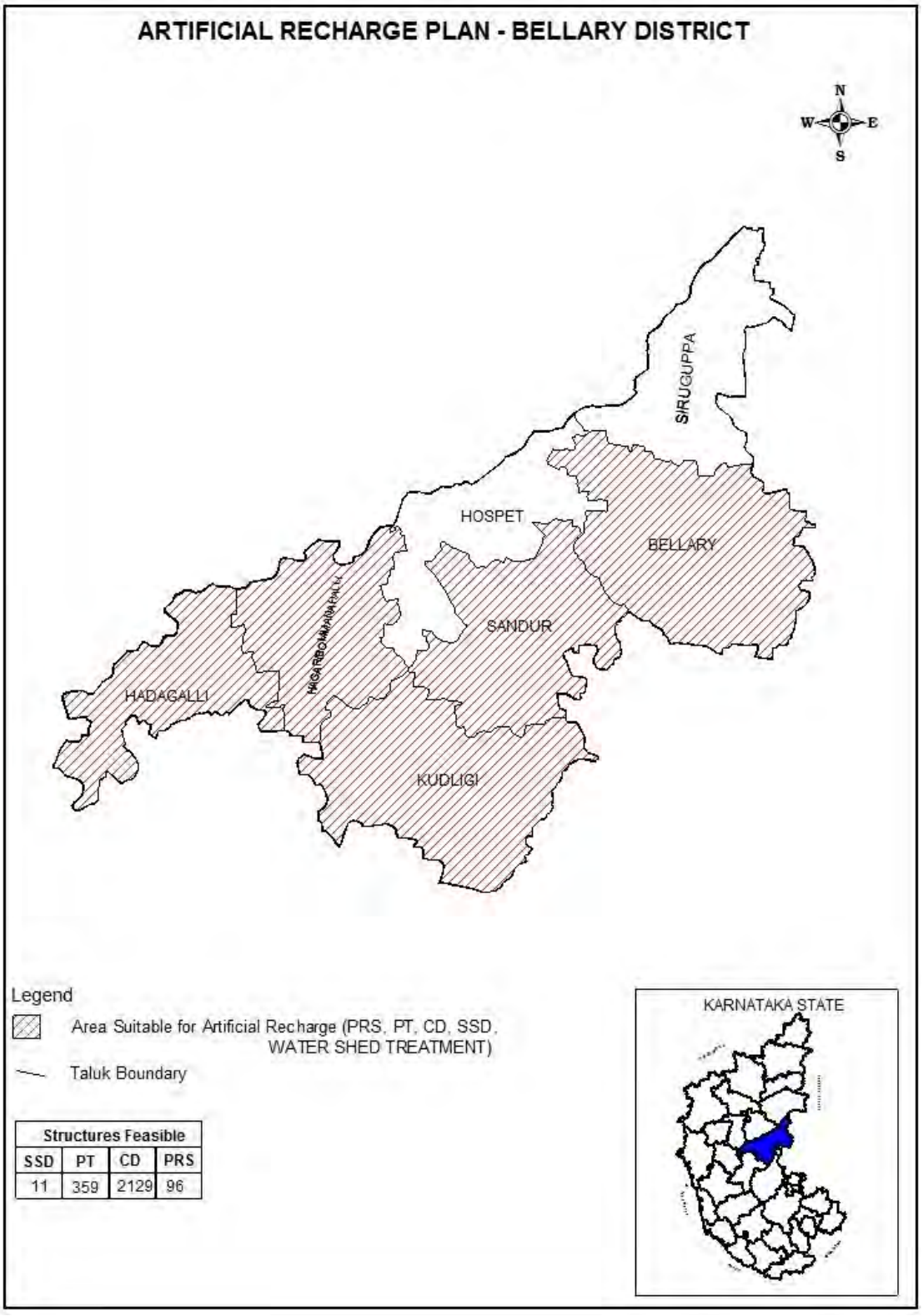

UNIT AREA ANNUAL GROUND WATER RECHARGE
BELLARY DISTRICT, KARNATAKA (2008 - 2009)
N
W
E
S
SIRUGUPPA
HOSPET
BELLARY
HAGARIBOMMANAHALLI
SANDUR
HADAGALLI
KUDLIGI
MO
Unit Area Annual
Ground Water Recharge (m)
0.15 - 0.25
0.10 - 0.15
0.025 - 0.10
District Boundary
Taluk Boundary

As per Ground water Resource Estimation 2009**,** the areas falling in Hadagali (100%), H.B. Halli (50 %), Bellary (17%), Kudlugi (10%) taluks are falling in Overexploited category. In such areas Artificial recharge structures such as Percolation tanks (PT), check dams (CD), Point recharge structures etc are planned for artificial recharge of ground water (Fig-12).

4.6 Ground water quality

The water samples from National Hydrograph Stations were analysed to decipher the shallow aquifer water quality. The results indicate that the water is alkaline in nature with average P^H value of 8.6 and overall range between 7.8 to 9.1. The average values of other important parameters like Ca-74 ppm, Mg-68.88 ppm, TH-469 ppm, Cl-401ppm, F-1.18 ppm etc., which are falling in desirable to permissible class as per "Indian standard drinking water specification'' except pH value is slightly higher, which falls beyond permissible limit. The Nitrate and Chloride contents are found more in few pockets in Hospet, Sirguppa and parts of Hadagali, and south of Kudlugi taluks. This is due to intensive irrigational activities in the command area especially in Hospet and in siruguppa taluks where farmers use maximum Nitrogen, Phosphate and sulphate fertilisers. It is observed Nitrate concentrations are beyond 100 ppm in the range of 106 to 380 ppm and the average Nitrate concentration is 144.33 ppm. Similarly, Chloride concentrations are observed in the range of 78 to 923 ppm with an average of 401 which falls in permissible class. However most part of the Bellary district where Chloride is exceeding the desirable limit of 250 ppm. Fluoride concentration ranged from 0.2 to 3.2 ppm with an average of 1.18 which is well within the permissible limit but exceeding the desirable limit and many samples exceed the permissible limit of 1.5 ppm. Considering the ground water quality in the district for irrigation purposes it is found that the Specific conductance ranged from 870 to 4760 (average 2189 m mhos/cm at 25° c), Sulphate is in the range of 38 to 826ppm (average 241.83 ppm) and sodium is in the range of 41 ppm to 449 ppm (average 241.16). The Sodium Adsorption ratio calculated ranged from 0.1 to 9.4 indicating Low Sodium Type of ground water falling in excellent class. Based on percent Sodium it ranged from 27.47 to 75.37 falling desirable to permissible class. The Residual carbonate values calculated indicates less than 1.00 where it is excellent for irrigation purposes.

Fig-12



Structures Feasible			
SSD	PT	CD	PRS
11	359	2129	96

4.5 Status of ground water development

4.5.1 Bellary taluk

The Bellary taluk with 99 villages with a population 625494 where besides surface water, ground water also is the source of drinking water. The remaining part where surface water is not available, groundwater is the main source for both drinking and irrigation purposes. There are 990 bore wells fitted with hand pumps, 116 bore wells used for piped water supply schemes, 146 bore wells used for mini water supply schemes. These are the major abstraction structures for drinking water needs in the taluk. Bellary taluk having total geographical area of 169027 ha of which 87.13 % (147286ha) is of Total sown area /cultivable land, in which the net irrigated area, is about 52.18 % (76861ha). Out of 52.18% about 12.7% (18804ha) of the net irrigated area comes from ground water. So the ground water for irrigation is being developed from shallow dug wells, dug-cum bore wells and shallow tube wells. Thus as per 2006-2007 Minor irrigation census there are 2484 shallow irrigation bore wells are the major ground water development structures for irrigation purpose followed by 216 shallow irrigation dug wells. The ground water developed from these structures is utilized for irrigation through adopting sprinklers (11 shallow bore wells), drip irrigation (8 borewells), open channel (145 dug wells+1045 bore wells), underground channels (69 dug wells+1386 bore wells), through surface pipe (Dugwells 2+10 borewells) and others (24 bore wells). These are the major ground water development management practices in the taluk. The stage of ground water development is 32 % where 83% of the area is safe as the pre-monsoon mean (May-01 to May-2010) water level is in between 3.519 to 6.321 m over the area. Further 17% of the area is falling under OE category where it demands proper ground water augmenting projects to recharge the ground water system. Shallow zone ground water can be developed for irrigation through dug wells in topographic lows and through shallow/deep bore wells in the other areas. The four exploratory bore wells drilled by the CGWB under VRB project have yielded 1.31 to 3.54 lps for the drilled depth up to 90.00mbgl. The exploration for deeper aquifer during 2001 to 2002 have constructed 4 exploratory wells and two observation wells in the depth range of 188 to 200m where deeper aquifers being explored. The yield was in the range of 1.1 to 6.3lps is useful and facilitating drinking water needs.

4.5.2 Hadagali Taluk

Hadagali taluk is mainly rain fed. The surface water utilisation /availability are limited to western part of the taluk, which falls under irrigation scheme/minor irrigation schemes. Groundwater is the main source of drinking water and irrigational purposes in Hadagali taluk. In general, ground water developed through dug wells, dug cum bore wells and bore wells. Bore wells are the main ground water development structures for both drinking and irrigation purposes. The statistical analysis of ZP, the yield range of 0.5 lps to 2.5 lps and all the villages in the taluk have been provided with drinking water supply like piped water supply schemes, mini water supply schemes and hand pumps. There are 604 bore wells fitted with hand pumps, 99 bore wells used for piped water supply schemes and 160 mini water supply schemes through bore wells, fulfilling drinking water needs and support the above fact. Hadagali taluk having total geographical area of 94853ha of which 10307ha is of Total sown/cultivable land, in which the net irrigated area is about 11.36 % (12235ha). Out of 11.36% about 9.91% (10225ha) of the net irrigated area comes from ground water which is major and only 1.79 % of the net irrigated area fall under surface water irrigation in western part of Hadagali taluk. So the ground water

for irrigation is being developed from shallow dug wells, dug-cum bore wells and shallow tube wells. Thus as per 2006-2007 Minor irrigation census there are 3390 shallow irrigation bore wells are the major ground water development structures for irrigation purpose followed by 7 shallow irrigation dug wells. The ground water developed from these structures is utilized for irrigation through adopting drip irrigation (1 bore well), open channel (118 bore wells), underground channels (7 dugwells+3253 bore wells), surface pipe (12 bore wells) and others (6 bore wells). These are the major ground water development management practices in the taluk. The CGWB studies reported that the unit draft ranges for dug well 0.003 to 0.02 MCM. DCB are 0.008 to 0.025 MCM bore wells are 0.03 to 0.05 MCM. Considering the Annual ground water development and water level trend during various seasons over the period the Hadagali taluk is categorized under OE (Overexploited). The pre-monsoon mean (May-2001 to May-2010) water level is in between 5.897 to 15.868 m in over the area. Considering the OE category where it demands proper ground water augmenting projects to recharge the ground water system. The five exploratory bore wells drilled by CGWB under VRB project have yielded 0.13 to 5.55 lps for the drilled depth up to 65.00mbgl. The exploration for deeper aquifer during 2001 to 2002 have constructed 3 exploratory wells and two observation wells in the depth range of 144 to 200m, where deeper aquifers being explored. The yield was in the range of 0.25 to 5.1 lps is useful and facilitating drinking water needs through ground water.

4.5.3 Hagari Bommanahalli Taluk

H.B.Halli yet another taluk are of mainly rain fed. The surface water utilisation/availability is limited to 3005 ha (Department of information and statistics) area of the taluk, which falls under irrigation through Tungabhadra canal. Groundwater is the main source of drinking water and irrigational purposes in H.B. Halli taluk. In general, ground water developed through dug wells, dug cum bore wells and bore wells. Bore wells are the main ground water development structures for both drinking and irrigation purposes. All the villages in the taluk have been provided with drinking water supply like piped water supply schemes, mini water supply schemes and hand pumps. There are 488 bore wells fitted with hand pumps, 96 bore wells used for piped water supply schemes and 150 mini water supply schemes through bore wells, fulfilling drinking water needs and support the above fact. H.B. Halli taluk having total geographical area of 97599ha of which 57.21 % (55843 ha) is of Total sown/cultivable land, in which the net irrigated area is about 35.56 % (19861ha). Out of 35.56% about 30.18% (16858 ha) of the net irrigated area comes from ground water which is major and only 5.38 % of the net irrigated area fall under surface water irrigation through canals of Tungabhadra. So the ground water for irrigation is being developed from shallow dug wells, dug-cum bore wells and shallow tube wells. Thus as per 2006-2007 Minor irrigation census there are 5790 shallow irrigation bore wells are the major ground water development structures for irrigation purpose followed by 5 shallow irrigation dug wells. The ground water developed from these structures is utilized for irrigation through adopting sprinklers (0 dugwells+2 shallow bore wells), drip irrigation (0 dug wells+33 bore wells), open channel (1 dugwell+1941 bore wells), underground channels (4 dugwells+3731 bore wells), surface pipe with 15 bore wells and others (0 dugwells+68 bore wells). These are the major ground water development management practices in the taluk. Considering the annual ground water development and water level trend during various seasons over the period the H.B.

Halli taluk is categorised under Semi critical with 30 % and OE (overexploited) with 50% in non command areas. In this taluk almost all irrigation dug wells are dry during pre monsoon period with the water level of more than 16.00m below ground level. However the irrigation bore wells are in operation and the yield reduces as the summer months approaches. Considering the OE and semi critical category where it demands proper ground water augmenting projects to recharge the ground water system. Further while taking ground water developmental activities priorities needs to be given for meeting the drinking water requirements of rural and urban areas. The five exploratory bore wells drilled by the CGWB under VRB project have yielded 0.15 to 6.50 lps for the drilled depth up to 87.00 mbgl. The exploration for deeper aquifer during 2001 to 2002 have constructed 3 exploratory wells and two observation wells in the depth range of 200m where deeper aquifers being explored. The yield was in the range of 0.61 to 5.50 lps is useful and facilitating drinking water needs through ground water.

4.5.4 Hospet taluk

About 26.74 % of the total geographical area of Hospet taluk is covered by forest. In the remaining part where surface water is the main source for both drinking and irrigation purposes, to a lesser extent is from ground water source. The low level ground water development in the taluk is attributed to the Tungabhadra canal water irrigation available for entire area except pockets of uplands. There are 857 bore wells fitted with hand pumps, 64 bore wells used for piped water supply schemes, 108 bore wells used for mini water supply schemes. These are the major abstraction structures for drinking water needs in the taluk. Similarly, in the irrigation sector ground water is developed through dug wells, dug cum bore wells and shallow tube wells. Hospet taluk having total geographical area of 93374ha of which 49.32 % (46060 ha) is of total sown/cultivable land, in which the net irrigated area is about 56.13 % (25855 ha). Out of 56.13% about 6.82% (3145 ha) of the net irrigated area comes from ground water which is less when compared the surface water irrigation with 43.55 % (20060ha) of the net irrigated area through canals of Tungabhadra. So the ground water for irrigation is being developed from shallow dug wells, dug-cum bore wells and shallow tube wells. Thus as per 2006-2007 Minor irrigation census there are 2661 shallow irrigation bore wells are the major ground water development structures for irrigation purpose followed by 456 shallow irrigation dug wells. The ground water developed from these structures is utilized for irrigation through adopting sprinklers, drip irrigation, (0 dug wells+9 bore wells), open channel (86 dugwells+697 bore wells), underground channels (221 dugwells+1812 bore wells), surface pipe (3 dug wells+3 bore wells) and others (0 dugwells+140 bore wells). These are the major ground water development management practices in the taluk where the use of sprinklers and drip irrigation activities are negligible. Considering the annual ground water development and water level trend during various seasons over the period the Hospet entire taluk is categorised under Safe with the stage of ground water development is 30%. The Mean water level during pre monsoon period (May-2001 to May 2010) ranged from 1.457 to 10.322m. The long term water level trend (2001 to 2011 from NHS shows average rise 0.318 m/y. Considering the Safe category where Shallow zone ground water can be developed for irrigation through dug wells in topographic lows and through shallow/deep bore wells in the other areas. The one exploratory bore wells drilled by the CGWB under VRB project have yielded 0.70 lps for the drilled depth up to 86.00 mbgl. The exploration for deeper aquifer during 2001 to 2002 have constructed 3 exploratory wells and two

observation wells in the depth range of 200m where deeper aquifers being explored. The yield was in the range of 0.13 to 8.20 lps is useful and facilitating drinking water needs through ground water.

4.5.5 Kudlugi taluk

About 21.07 % of the total geographical area of Kudlugi taluk is covered by forest. Groundwater is the main source of drinking water and irrigational purposes in Kudlugi taluk. In general, ground water developed through dug wells, dug cum bore wells and bore wells. Bore wells are the main ground water development structures for both drinking and irrigation purposes. All the villages in the taluk have been provided with drinking water supply like piped water supply schemes, mini water supply schemes and hand pumps. There are 1171 bore wells fitted with hand pumps, 110 bore wells used for piped water supply schemes and 241 mini water supply schemes through bore wells, fulfilling drinking water needs and support the above fact. Kudlugi taluk having total geographical area of 159706ha of which 62.88 % (100432 ha) is of Total sown/cultivable land, in which the net irrigated area is about 13.30 % (13358ha). Out of 13.30% about 12.18% (12240 ha) of the net irrigated area comes from ground water which is major and negligible 1.11 % of the net irrigated area fall under surface water irrigation through localised tanks. So the ground water being the overall source for irrigation and being developed from shallow dug wells, dug-cum bore wells and shallow tube wells. Thus as per 2006-2007 Minor irrigation census there are 4736 shallow irrigation bore wells are the major ground water development structures for irrigation purpose followed by 224 shallow irrigation dug wells. The ground water developed from these structures is utilized for irrigation through adopting sprinklers (0 dugwells+3 shallow bore wells), drip irrigation, (0 dug wells+10 bore wells), open channel (124 dugwells+2587 bore wells), underground channels (24 dugwells+1942 bore wells), surface pipes (2 dug wells+140 bore wells) and others (74 dugwells+54 bore wells). These are the major ground water development management practices in the taluk. Considering the annual ground water development and water level trend during various seasons over the period the Kudlugi taluk is categorised under Semi critical with 50 % and OE (overexploited) with 10% in non command areas. Overal 40 % falls under Safe category having further scope for ground water development. Most of the irrigation dug wells are having deep water levels/ dry during pre monsoon period as observed in Gajanur, Kottur and Kudlugi. However the irrigation bore wells are in operation and the yield reduces as the summer months approaches. The long term water level trend (2002 to 2011) at NHS shows fall in the range of 0.0.071m/y to 0.204 m/y. Considering the 50 % under semi critical and 10 % OE category where it demands proper ground water augmenting projects to recharge the ground water system. Further while taking ground water developmental activities priorities needs to be given for meeting the drinking water requirements of rural and urban areas. The eleven exploratory bore wells and four observation bore wells drilled by the CGWB under VRB project have yielded negligible to 11.20 lps (C.J.Halli) for the drilled depth up to 58.00 m bgl. The exploration for deeper aquifer during 2001 to 2002 have constructed 3 exploratory wells and two observation wells in the depth range of 187 to 200m where deeper aquifers being explored. The yield was in the range of 0.03 to 4.0 lps is useful and facilitating drinking water needs through ground water.

4.5.6 Sandur taluk

About 25.55 % of the total geographical area of Sandur taluk is covered by forest. In the remaining part where Ground water is the main source for both drinking and irrigation purposes, to a lesser extent is from surface water source. The high level ground water development in the taluk is attributed to the limited availability of surface water from Tungabhadra canal. There are 555 bore wells fitted with hand pumps, 99 bore wells used for piped water supply schemes, 105 bore wells used for mini water supply schemes. These are the major abstraction structures for drinking water needs in the taluk. The irrigation sector the ground water being developed through dug wells, dug cum bore wells and shallow tube wells. Sandur taluk having total geographical area of 94359 ha of which 35.30 % (33310 ha) is of Total sown/cultivable land, in which the net irrigated area is about 18.57 % (6187 ha). Out of 18.57% about 14.80% (4931 ha) maximum of the net irrigated area comes from ground water when compared to the surface water irrigation with 956 ha (2.87 %) of the net irrigated area through canals of Tungabhadra and tanks. So the ground water for irrigation is being developed from shallow dug wells, dug-cum bore wells and shallow tube wells. Thus as per 2006-2007 Minor irrigation census there are 2341 shallow irrigation bore wells are the major ground water development structures for irrigation purpose followed by 233 shallow irrigation dug wells. The ground water developed from these structures is utilized for irrigation through adopting sprinklers, drip irrigation (0 dug wells+1 bore wells), open channel (227 dugwells+1781 bore wells), underground channels (6 dugwells+526 bore wells), surface pipe, and others (0 dugwells+33 bore wells). These are the major ground water development management practices in the taluk where the use of sprinklers and drip irrigation activities are negligible. Considering the annual ground water development and water level trend during various seasons over the period the Sandur entire taluk (95%) is categorised under Safe except 5 % falling under semi critical. The Mean water level during pre monsoon period (May-2002 to May 2010) is 7.13m. The long term water level trend (2002 to 202011) from NHS shows average rise 0.388 m/y. Considering the Safe category where Shallow zone ground water can be developed for irrigation through dug wells in topographic lows and through shallow/deep bore wells in the other areas. The three exploratory bore wells drilled by the CGWB under VRB project have yielded 0.12 lps to 2.9 lps for the drilled depth up to 90.00 m bgl. The explorations for deeper aquifer during 2001 to 2002 have constructed one exploratory well to the depth of 200m where deeper aquifers being explored. The yield was in the range of 1.05 lps is useful and facilitating drinking water needs through ground water.

4.5.7 Siruguppa taluk

Siruguppa taluk where considerable amount of ground water developed is in the urban areas for developmental activities and that the use of ground water for agricultural purposes is very limited except in the non command areas. The low level ground water development in the taluk is attributed to the Tungabhadra canal water irrigation available for entire area except pockets of uplands. There are 648 bore wells fitted with hand pumps, 83 bore wells used for piped water supply schemes, 131 bore wells used for mini water supply schemes. These are the major abstraction structures for drinking water needs in the taluk. In irrigation sector the ground water being developed through dug wells, dug cum bore wells and shallow tube wells. Siruguppa taluk having total geographical area of 104278 ha of which 80.21 % (83645 ha) is of Total sown/cultivable land, in which the net irrigated area is

about 40.65 % (34002 ha). Out of 80.21 % about 3.62 % (3035 ha) of the net irrigated area comes from ground water which is negligible when compared the surface water irrigation with 28343ha 33.88 % of the net irrigated area through canals of Tungabhadra. However the ground water for irrigation is being developed from shallow dug wells, dug-cum bore wells and shallow tube wells. Thus as per 2006-2007 Minor irrigation census there are 735 shallow irrigation bore wells are the major ground water development structures for irrigation purpose followed by 91 shallow irrigation dug wells. The ground water developed from these structures is utilized for irrigation through adopting sprinklers, drip irrigation, open channel (51 dugwells+150 bore wells), underground channels (10 dugwells+572 bore wells), surface pipe (30 dug wells+10 bore wells) and others (0 dugwells+3 bore wells). These are the major ground water development management practices in the taluk where the use of sprinklers and drip irrigation activities are negligible. Considering the annual ground water development and water level trend during various seasons over the period the Siruguppa taluk is categorised 100 % under Safe with overall stage of ground water development of 10%. The Mean water level during pre monsoon period (May-2001 to May 2010) 5.613m. The long term water level trend (2001 to 2010) from NHS shows average rise 0.0.386 m/y**.** Considering the Safe category where Shallow zone ground water can be developed for irrigation through dug wells in topographic lows and through shallow/deep bore wells in the other areas. Where as in non command areas where it demands proper ground water augmenting projects to recharge the ground water system. The two exploratory and one observation bore wells drilled by the CGWB under VRB project have yielded 5 to 7 lps for the drilled depth up to 76.30 m bgl. The exploration for deeper aquifer during 2001 to 2002 have constructed two exploratory wells in the depth range of 200m where deeper aquifers being explored. The yield was in the range of 1.73 to 2.34 lps is useful and facilitating drinking water needs through ground water.

5.0 GROUND WATER DEVELOPMENT

As per resource estimation overall stage of Ground water development is 43.77% where in different taluks it ranged from 10 to 105%. Hospet and Siruguppa taluks falling in Safe category with the stage of ground water development 30% and 10% where the balance ground water potential may be utilised with different abstraction structures suitable with reference to its topography and the aquifer geometry. The taluk like Sandur the ground water development reached almost saturation point with 95% falling in semi critical to OE category. Especially in Hadagali taluk which is falling in OE where almost all the dug wells are dry during pre monsoon period and water levels are deep during post monsoon period besides a large number of bore wells were drilled in these areas and putting stress on ground water potential. At these areas the farmers drilled the bore wells without taking into the consideration of the spacing criteria between well to well. This has to be educated and a proper farm management practice is to be adopted for judicial use of available ground water. The Groundwater Resource Estimation of the district indicates that the net ground water availability for future irrigation development is 35539 HAM. Based on this and the present status of ground water development i.e. through shallow dug wells and bore wells alone where the deeper aquifers are not much exploited, it is proposed that the ground water development structures viz. dug wells and dug cum bore wells and bore wells in those areas falling under Safe and semi critical category. Dug wells are the ideal structures in command areas of Hospet, Siruguppa, and Bellary

taluks. Dug cum bore wells and bore wells are suitable in the other areas. In case of DCB extension bores of 100 to 152mm drilled from the surface of the dug well, both these may be drilled up to a depth of 40 to 80m and to tap deeper aquifers it has to be drilled up to 200 m.

It may be taken into consideration while designing the various abstraction structures; emphasis for a farm budget model can be evolved for the structure with a designed discharge of 2 to 5 lps with an irrigable command of 1.25 to 3.00ha. Ground water development may also be considered on the banks of rivers and streams in Hospet, bellary and Siruguppa taluks in general.

5.2 Water Conservation and Artificial Recharge

The taluks Hospet, Siruguppa and parts of Bellary are falling in command area. These areas the water table is shallow, low rate of ground water exploitation and gradual rise of water table over the years resulting in ruling out of any Artificial Recharge schemes. As per the Resource estimation, 100% of the area in Hadagali taluk, 50% in H.B.Halli, 17% in Bellary and 10% area of Kudlugi taluks falls under Over Exploited category which requires immediate intervention by way of conservation and artificial recharge to ground water in order to arrest further declining trend in water levels. Artificial recharge through percolation tank, check dam and nalla bunds are the solutions to recharge ground water in the district Fig.12 Further Dug well Recharge schemes where the shallow dug wells are dry like in HB.Halli and Kudlugi taluks can be taken up so that available surface runoff in their field can be recharged into the groundwater system. Under Centrally sponsored Dug well recharge scheme initially proposed 2264 structures over the district, as on 31.12.2012 and out of which 328 structures were completed so far. Kudlugi taluk is the largest next to Bellary, where in predominately undulating and hilly comprising of undulating and rugged terrain where the runoff is high. Under these conditions, it is advisable to go for watershed treatment methods, which can help in augmenting the ground water resources. Further considering the topography, the structures like gully plugs, cement plugs, nalla bunds and contour bunds may be constructed by which runoff can be arrested and recharged in to the ground water. As per the statistical data the district has 74 ZP tanks distributed in Kudlugi, HBhalli, Sandur, Hadagali and Hospet taluks, of which Hadagali taluk falling in OE category having least number of surface water tanks with six, this is unusual considering its nature of large geographical area falling in non command area. There is a scope for further construction of percolation tanks, check dams and other artificial recharge structures to enhance the recharge in to the ground water system in Hadagali, H.B.Halli, and Kudlugi taluks. Most of the existing tanks are silted and dried up. Desilting the tanks and construction of additional tanks will help in recharging the phreatic zone. Sub surface dykes are suitable along the river course where ever thickness of alluvium is more.

6.0 GROUND WATER RELATED ISSUES & PROBLEMS

In command areas of Hospet, Siruguppa and Bellary taluks are having shallow water level between ground level to 3.00m during both pre and post monsson period especially in the areas of Tungabhadra low level and high level canal which are showing regular rising trend water table (Emmiganur and Tekkalakota) are water logged and in some places prone to water logging leading to ground water contamination. This is attributed to seepage from canal to shallow aquifer, less ground water exploitation, unrestricted canal water irrigation, no proper drainage system and major part of the surface water applied for irrigation is by flooding method in to the nallahs during the intensive irrigation period which are again causing water logging. Due to water logging quality deterioration where Peddavanka water shed in Siruguppa taluk reported higher salinity. In non command areas like H.B.Halli Kudlugi taluks and other areas ground water pollution is due to poor drainage, use of fertilizers in agriculture and indiscriminate dumping of domestic and agricultural waste on the land. The studies by CGWB reports that the ground water having Fluoride contamination which are geogenic in origin occurring in western and northern part of Hadagali and control points of Kudlugi taluks. The soils in canal irrigation and in some other parts are deteriorated due to intensive irrigation and extensive use of fertilisers. However the state government has taken up land development/treated through water shed development project in which it is identified an area of 431336ha are not available for irrigation due to bad soil. It is reported that 206008ha land were developed/treated through water shed development projects (as on 31.03.09) and still remains balance of 175749ha of land. This directly or indirectly contributes to ground water pollution. The other most common problem is power cut and voltage fluctuation in lifting the ground water for their irrigation purposes. In many of the villages water scarcity exists due to defunct domestic bore wells for want of proper maintenance.

7.0 AWARENESS & TRAINING ACTIVITY

Central Ground Water Board has organised Mass Awareness programme on “Protection and Conservation of ground water” at Zilla Panchayat meeting hall, Bellary on 10/03/2004. The program was inaugurated by Shri. S.N.Jayaram, IAS, Deputy Commissioner, Bellary district. Shri. G.S. Shivaswamy, KAS, CEO, ZP, Bellary presided over the function. Shri. Veeranna Joint Director, Depatment of Mines and Geology (Northern Circle), Governmant Karnataka, and about 200 representatives from Zilla Panchayat, Taluk Panchayat and Educational institutions were participated in the programme. As part of this programme, drawing competition was organised for school children and certificates were distributed. Working models of artificial recharge and rainwater harvesting were exhibited. Documentaries of ARS and rainwater harvesting with case studies and quality of ground water were shown.

8.0 AREAS NOTIFIED BY CGWA / SGWA

None of the taluks in the district are notified under CGWA / SGWA.

9.0 RECOMMENDATIONS

The major problem in command areas of Bellary district is water logging. So preventive measures/flush out excess irrigation water of water logging through construction of drains along canal seepage paths, exploitation of ground water, avoiding over irrigation to the crops, lining of canals, adoption of soil conservation methods and recommended cropping patterns. Further it is to take adequate measures to tap ground water in downstream through Jack wells/infiltration wells and practicing conjunctive use would improve both water logging and quality in major part of command areas. The state government has to speed up the projects on land development/treating of balance undeveloped soil of 175749ha through watershed development projects.

Desilting of surface water structures like tanks in non command areas is effective in augmented recharge to ground water. Judicious use of ground water in command areas especially in Hadagali, H.B.Halli and Kudlugi taluks is advised. Pilot experimental studies to recharge ground water in south and western part of Bellary traluk, H.B.Halli, Kudlugi and Hadagali taluks are suggested.

The Stage of ground water development is 100% OE in Hadagali, 50% in H.B.Halli and parts of Bellary. Semi critical condition exists in H.Bhalli and Kudlugi taluks (30% & 50 %) which demands construction of pizometers up to 100m to monitor water levels on long term basis so as to take timely remedial action if there is decline in ground water level and quality.

The present management practices for irrigation such as sprinklers, drip irrigation, underground channels etc. are appreciable and should be encouraged. The villages located in the undulating topography of the district are facing drinking water scarcity. Special source finding projects and construction of ARS may be taken up as these places are having enough scope for artificial recharge.

The abandoned bore well/dug wells can be utilised for recharging aquifers with surplus runoff during rainy days. Exploratory drilling in the district beyond 90.00m bgl is required to explore the deeper aquifers.