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
MYSORE DISTRICT, KARNATAKA

SOUTH WESTERN REGION
BANGALORE
September 2012

FOREWORD

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

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

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

Sushil Gupta
Chairman

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 Sri. K.N.Nagaraj, Scientist D, 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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(Dr. K.Md.Najeeb)
Regional Director

MYSORE DISTRICT AT A GLANCE

Sl. No.	ITEMS	STATISTICS	
1	**GENERAL INFORMATION**		
	i) Geographical area (Sq Km)	6763.82	
	ii) Administrative Divisions		
	Number of Tehsils / taluks	7, H.D.Kote, Hunsur, K.R.Nagar, Mysore, Nanjangud, Periyapatna, T. Narasipur	
	No. of Panchayat /Villages :	235/1216 + 124	
	iii) Population (As per 2011 Census)	29,94,744	
	iv) Average annual rain fall (1901-70)	782 (697 – 904) mm	
2	**GEOMORPHOLOGY**		
	Major Physiographic Units	The district is classified as uplands area. However the south-western parts of the district falls under semi-malnad category with elevation ranging from 2200 to 3150 mamsl, where as the general elevation of uplands is 700-900 m amsl. The malnad region is covered under forest.	
	Major Drainages	Drained by 5 perennial rivers namely East flowing Cauvery, Kabini, Nugu, Gundal and Lakshmanthirtha The major drainage in the district is the east flowing Cauvery River.	
3	**LAND USE (ha) 2009-10)**		
	Forest area	69420	
	Net area sown	380541	
	Cultivable wasteland	2568	
	Area sown more than once	238433	
4	**MAJOR SOIL TYPES**	Red sandy soils, Red loamy soils And Deep black soils	
5	**AREA UNDER PRINCIPAL CROPS (2004-2005) in ha**	**Crop** Paddy Ragi Jowar Pulses Oilseeds Fruits & Vegetable Sugar cane Tobacco Cotton Others **Total**	**Area** 118084 79824 19819 119016 25551 9572 9535 59482 71938 69785 **582606**
6	**IRRIGATION BY DIFF. SOURCES** Dug wells Bore wells Tanks/ Ponds Canals Lift Other Sources	**Area (Ha)** 10323 5795 17377 87685 375 -	**Number** - - -
	Net Irrigated Area	**121555**	

7	**NUMBER OF GROUND WATER MONITORING STATIONS OF CGWB** (As on 31-03-2007) Number Dug wells Number of Piezometers		 53 12
8	**PREDOMINANT GEOLOGICAL FORMATIONS**		
	Recent		Alluvium
	~~ U n c o n		f o r m i t y ~~~~~~~~~~~~~~~~~~~~
	Pre-Cambrian (Intrusives)		Closepet Granites, Ultra basic / Basic Intrusives
	Lower Pre-Cambrian		Metavolcanics, Metasediments
	Archaean		Gneisses and Charnockites
9	**HYDROGEOLOGY**		
	Major Water Bearing Formations -		
	Shallow aquifers of alluvium along the stream courses and weathered zones of Granites and gneisses occurring between the depths of 8 to 14 m bgl.		
	Deeper aquifers of jointed and fractured Granites, gneisses and Charnockites occurring between the depths of 25 to 200 m bgl.		
	Pre-monsoon Water Levels during 2011		1.110 – 13.28 m bgl
	Post-monsoon Water Levels during 2011		1.00 – 9.750mbgl
	Long term water level mean (2001-2010) in m/year:	Pre-monsoon	National Hydrograph Stations (NHS) water levels mean 1.010m to9.931mbgl.
		Post-monsoon	NH Stations water levels have shown mean water levels are
10	**GROUND WATER EXPLORATION BY C.G.W.B.** **(As on 31-03-2007)**		
	No of wells drilled		EW: 34, OW: 18,
	Depth range (m)		35.00 – 92.00 m bgl
	Discharge (litres / second)		<1.0 – 8.0 Litres / second.
	Storitivity (S)		
	Transmissivity (m2/day)		20 – 900 m^2 / day.

11	**GROUND WATER QUALITY**	
	Presence of chemical constituent more than the permissible limit	Chemical quality of Ground water Suitable for all purposes in Major parts of the district.
12	**DYNAMIC GROUND WATER RESOURCES** (mcm) (2009)	
	Annual replenish able Ground Water Resources	42944.34
	Net annual Ground Water Draft	23822.33
	Projected demand for Domestic and Industrial uses up to 2025	6133.36
	Stage of Ground Water development as on March 2009 (%)	63%
13	**AWARENESS AND TRAINING ACTIVITY**	
	Mass Awareness Programmes Organized	One
	Date Place No of participants	February 2004 Mysore 325
	Water Management Training Programmes organised:	Nil
14	**EFFORTS OF ARTIFICIAL RECHARGE & RAIN WATER HARVESTING:**	Nil
	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	1, Mysore (P) --- Nil
16	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Groundwater development has reached 63% for the district as a whole. As groundwater level, is declining in some parts, revitalising by cleaning and deepening the dug wells will help in augmenting the yield. Adopting watershed treatment is a good option to control in augmenting the natural recharge.

1.0 INTRODUCTION

1.1 General:

Mysore city was the capital of the former princely State of Mysore and on independence it became part of Madras presidency. On the linguistic reorganisation of the States in 1956 a new state named Mysore State was formed with its headquarters at Bangalore in which Mysore was a district. Later, on the first of November 1973, the state was renamed as Karnataka. The then Mysore district comprised of 3 sub-divisions viz. Mysore, Hunsur and Nanjangud which were sub divided into 11 taluks with a total area of 11954 sq.km. The district was bifurcated with the creation of a new district viz. Chamarajanagar, with its headquarters at Chamrajanagar by taking out the taluks, Chamarajanagar, Gundlupet, Kollegal, and Yellandur. Thus the district at present consists of 7 taluks with a total area of 6269 Sq.km.

1.2 Location:

Mysore district falls in the survey of India degree sheet Nos. 48P, 57D, 57H and 58A. The district is bounded by north latitudes 11^0 45' - 12^0 40' and east longitudes 75^0 59' -77^0 05' covering an area of 6269 Sq. km. The district is one of the southern most districts of the state and is bordered by Kodagu district in the west, Chamarajanagar district in the south and south east, Mandya district in the north, Hassan district in the north west and the Cannanore district of Kerala state in the south west.

1.3 Administrative Set up:

Mysore district is divided into 7 taluks namely H.D.Kote, Hunsur, K.R.Nagar, Mysore, Nanjangud, Periyapatna, and T. Narasipur for administrative purposes. The district comprises 1216 inhabited villages with 235 grama panchayats and nine townships/ municipalities. In addition to this there are 124 uninhabited villages as per 2001 census. A map showing administrative set-up of the district is given as Fig-1 and table 1.1

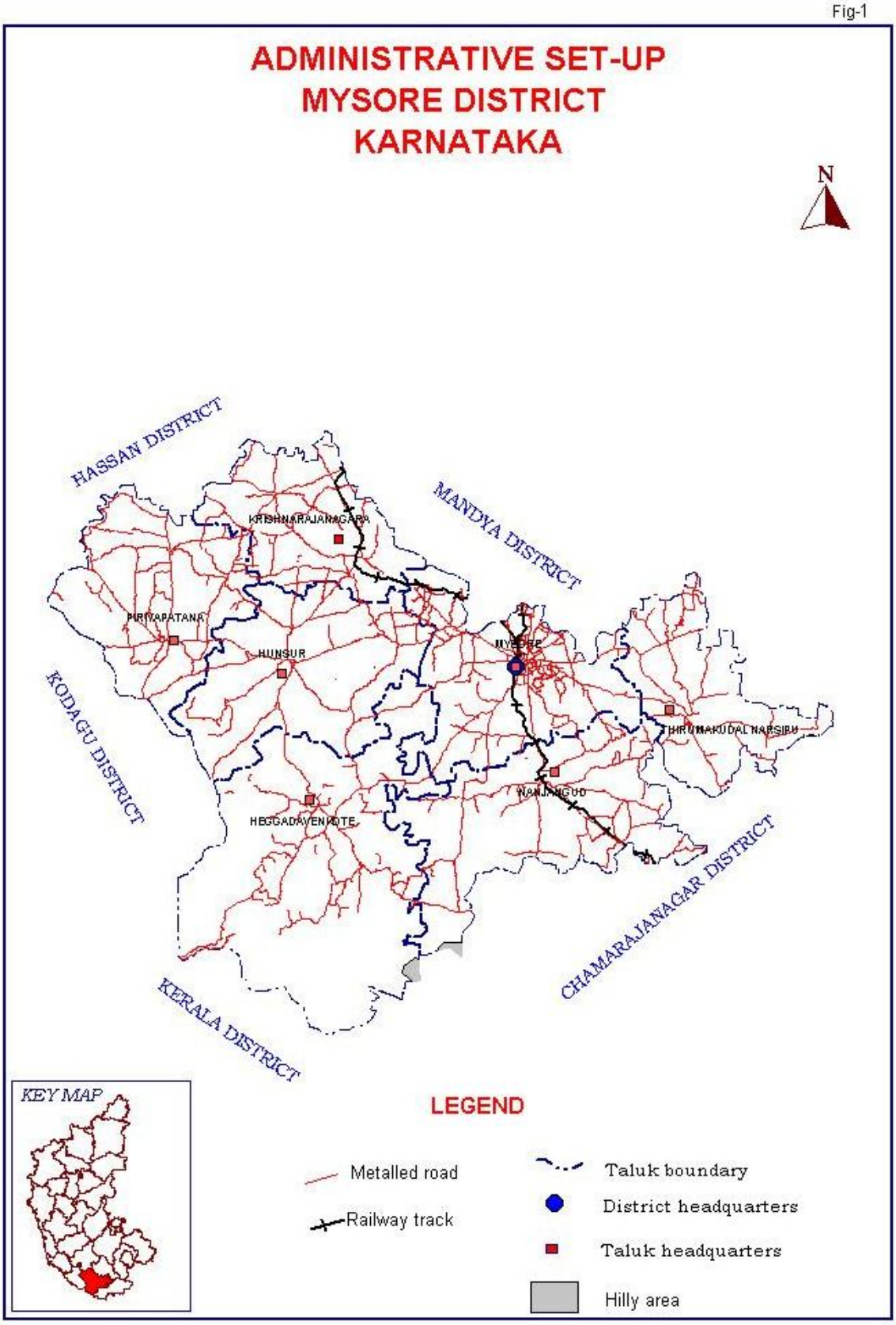
Table.1.1 Administrative set up of mysore district.

Sl.no	Taluk	Hoblies	Grampanchayaths	Inhabited villages	Uninhabited villages
1	h.d.kote	5	32	243	38
2	Hunsur	4	30	192	21
3	k.r.nagar	6	31	156	22
4	Mysore	4	35	131	12
5	Nanjangud	5	45	176	14
6	Periyapatna	4	26	197	6
7	T.Narasipura	5	36	121	11
8	Total	33	235	1216	124

1.4 Communications:

The district is well connected by all weather roads. The state highway connects the district headquarters with the state capital and other important cities of the district. The broad gauge railway line passes through Mysore and the taluk

Fig-1


ADMINISTRATIVE SET-UP
MYSORE DISTRICT
KARNATAKA
N
HASSAN DISTRICT
MANDYA DISTRICT
KODAGU DISTRICT
KERALA DISTRICT
CHAMARAJANAGAR DISTRICT
KRISHNARAJANAGARA
PIRIYAPATANA
HUNSUR
MYSORE
THIRUMAKUDALNARSIPU
NANJANGUD
HEGGADAVENKOTE
KEY MAP
LEGEND
Metalled road
Railway track
Taluk boundary
District headquarters
Taluk headquarters
Hilly area

headquarters of KR Nagar. All the other taluk headquarters and other towns are connected by all weather roads thus making all parts of the district accessible throughout the year.

1.5 Drainage

Mysore district is endowed with a number of perennial and non-perennial rivers. The Cauvery, which is the major river system of the district, traverses the Mysore plateau from northwest to east along with its tributaries, Kabini, Suvarnavathi, Laxmanathirtha and others.

The Cauvery rises at Talacauvery in Kodagu district and flows along the boundary of Periyapatna taluk, enters into the district through K R Nagar taluk. It further moves into T. Narasipur and Kollegal before reaching Tamil Nadu.

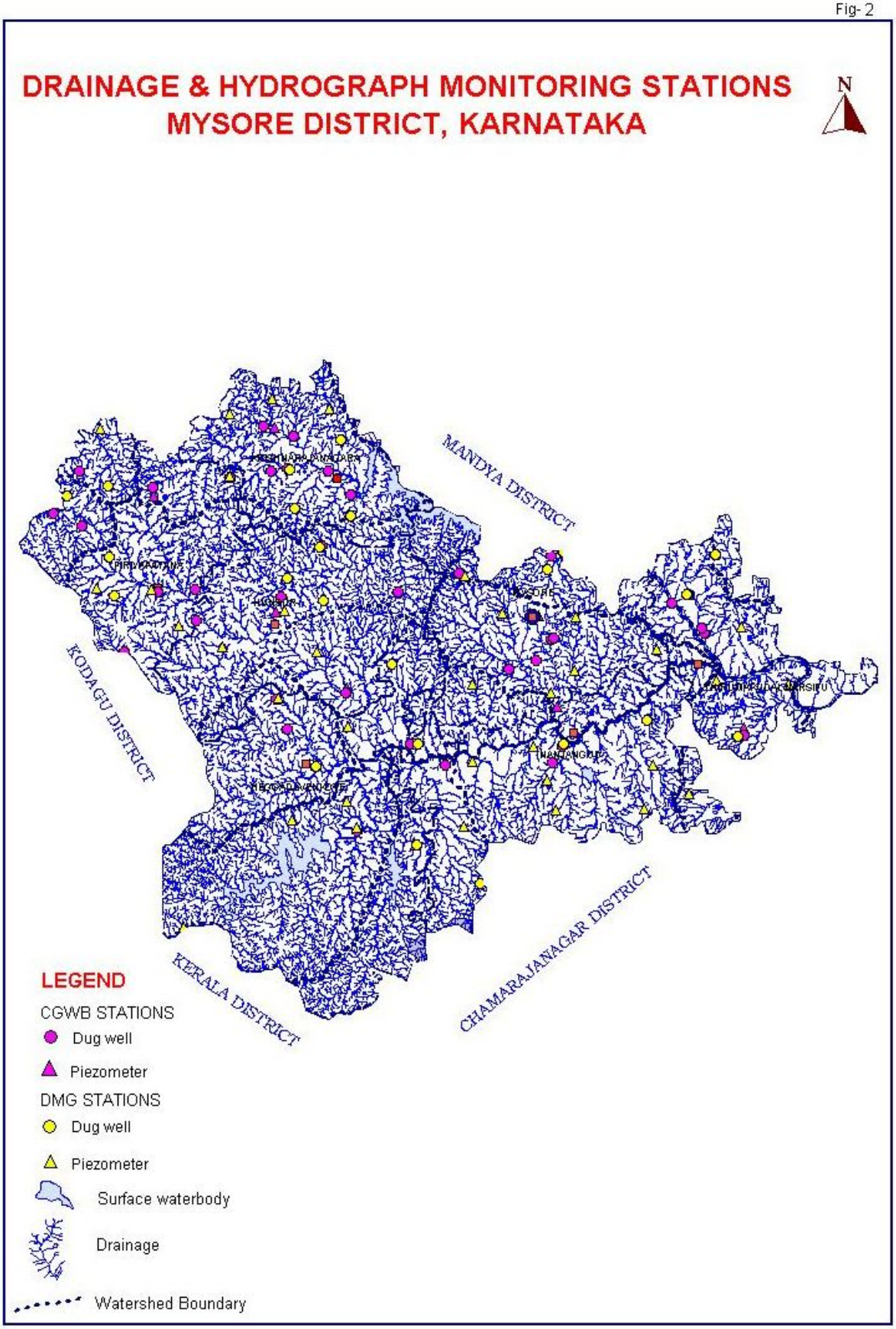
The total catchment area of the river is the second largest in the State and it covers nearly 18 per cent of the land area of the State. It is the only river which has been harnessed for irrigation from ancient times and it is estimated that as much as 95 per cent of its surface flow is put to use before it enters into the Bay of Bengal. The drainage pattern is sub-dendritic to dendritic type in nature and is shown in fig 2.

1.6 Crops and Irrigation Practices:

The net sown area comprises 72% of the total geographical area, of which about 20% is sown more than once. Paddy is the major crop in the district and is grown in favourable areas totalling about 1107 km^2, followed by pulses and Ragi which are cultivated in 913 and 722 km^2 respectively. Other major crops grown in the district are Cotton, Sugarcane, Jowar Tobacco and Oilseeds. About 17% of the total geographical area is under irrigation in the district, comprising of the command area of K.R.Sagar and Kabini Projects. The right bank high level canal of K.R.Sagar known as the Varuna canal passes through Mysore, T. Narsipur, Nanjangud, & H.D.Kote taluks. Out of the total area of 1180 km^2 under irrigation about, 11% is irrigated from groundwater by dug wells and bore wells. While canals account for 81% of the total area under irrigation, tanks account for approximately 7% of the total area irrigated.

Agriculture is the predominant occupation of people in Mysore district. Of the total geographical area of 676382 ha. in the district, about 342852 ha. is cultivable area. There are 379670 Land holdings in the district; of them, 86763 are small(less than 2 ha.), 237060 are marginal(< 1 ha) and others are medium (2-10ha.) and large (>10 ha.) holdings. Besides, the district has about 1.65 lakh agricultural labourers. Based on rainfall, soils and crops grown, the district is classified into two agro climatic zones viz., Southern Dry Zone (Krishnarajanagar, Mysore,T.Narasipur and Nanjangud) and Southern Transitional Zone (H.D.Kote, Hunsur and Periyapatna)

Fig- 2


DRAINAGE & HYDROGRAPH MONITORING STATIONS
MYSORE DISTRICT, KARNATAKA
N
MANDYA DISTRICT
KODAGU DISTRICT
KERALA DISTRICT
CHAMARAJANAGAR DISTRICT
MYSORE
HUNSUR
NANJANGUD
LEGEND
CGWB STATIONS
Dug well
Piezometer
DMG STATIONS
Dug well
Piezometer
Surface waterbody
Drainage
Watershed Boundary

1.7 Activities carried out by CGWB:

Central Ground Water Board has carried out Systematic Hydrogeological surveys, Reappraisal Hydrogeological surveys and Groundwater Exploration in the district. The hydrogeological investigations and groundwater exploration during the first phase have revealed the existence of potential zones within 100 meters depth in granitic and gneissic formations. The report on Hydrogeological Conditions in Mysore district was prepared in the year 1992. The report contained the details of old Mysore district inclusive of present Chamarajanagar district.

2.0 RAINFALL AND CLIMATE

Mysore district receives an average rainfall of 776.7 mm. There are 53 rainy days in the district on an average and about 50% of the annual rainfall occurs during the southwest monsoon period (table 2.1). The rainfall generally decreases from west to east. The coefficient of variation is around 30% in the west to above 35% in the east, indicative of consistent rainfall in the west as compared to the east. The pre-monsoon rainfall is more consistent than the post-monsoon rainfall. The southwest monsoon had been normal from 1994 onwards till 1999, excessive during 2000 and deficient thereafter. The northwest monsoon is much better as being excessive to normal during the recent past. Over all on an annual basis, there are more normal rainfall years than excessive and deficient ones. While during 1997, 1999, 2000 and 2005, the district received excess rainfall, 1998, 2001, 2002, 2003 and 2004, it received Normal except for 2006, during which the district received deficient rainfall.

The average minimum and maximum temperatures vary from 34 to 21.4 ^{o}C in April to 16.4 to 28.5 ^{o}C in January. Relative humidity ranges from 21 to 84%. Wind speed ranges from 7.9 in October to 14.1 kmph in July. Annual potential evapo-transpiration is 1533.5 mm. The PET is less than the monthly mean rainfall during the months of July, September and October in different taluks, indicating availability of water surplus for recharge to ground water.

Table-2.1 Taluk-wise Rainfall data of Mysore district

Sl. No.	Taluk	Number of Rain gauge Stations	Normal Rainfall mm (1941-90)	Actual Rainfall mm 2008	Rainy days	
					Normal (1941-90)	Actual (2005)
1	H.D. Kote	7	832	789	59	85
2	Hunsur	7	739	719.2	55	90
3	K.R. Nagar	7	800	735.2	48	59
4	Mysore	6	784	709.8	55	60
5	Nanjangud	4	870	737.6	49	72
6	Periya Patna	6	830	835.0	62	77
7	T. Narasipura	6	712	770.4	45	67
Total/Average		42	767®	756.8®	51®	57®

Source: District at a glance- 2008-09 {®- district average (taluk centres)}

3.0 GEOMORPHOLOGY, GEOLOGY AND SOIL TYPES

Geomorphologically, the district is classified as denudational uplands with about 85 to 90% of the district falling in this category. The next important geomarphological unit is older flood plains mainly in the H.D Kote taluk and parts of Mysore taluk. Ridges and valleys form the third important unit and are mainly restricted to the Nanjangud and H.D Kote taluk and north western part of Mysore taluk. Flat valleys are not very common except for isolated appearances. The general elevation in the district ranges from 700-800 m amsl except for the denudational hills and ridges. However, the H.D Kote taluk in the southern parts of the district has higher elevation ranging from 2200-3150 m amsl. The Mullur betta with an elevation of 3150 m amsl falls in the area. The Hekkan betta (3732 m amsl) of the Naganpur Reserved Forest, the Shigebetta (3724 m amsl) of the Ainurmarigudi Reserved Forest and the Jainbaribetta (3231m amsl) of the Bedrampadi reserved forest mark the water divide making the southern boundary of H.D. Kote taluk and also of the district.

The soil types of the district are grouped in to three viz., the red sandy soils, red loamy soils and deep black soils. Almost entire district is covered by red sandy soil except for small parts of T. Narapur taluk. The soils are having high permeability and are neutral with a pH of 7. The thickness of the soil varies from less than a meter to 6 m. North-eastern part of T. Narasipur taluk comprises of red loamy soil. It is characterized by clayey content mixed with sand. It is less permeable compare to the sandy soil. It is having good moisture holding capacity and is fertile. The thickness varies from less than a meter to 16 m. Deep Black soils occur in south-western part of T. Narasipur taluk in a small area. These soils are dark brown, dark greyish brown to very dark grey or black in colour. The texture is usually clayey throughout the profile. These soils are fertile and generally produce good yields. Adequate soil and water management practices and drainage facilities are essential to obtain sustainable yields; otherwise salinity and water logging conditions may develop. These soils need to be flushed once in 3-5 years with good quality water.

Geology

Geologically, the district is mainly composed of igneous and metamorphic rocks of Pre-Cambrian age either exposed at the surface or covered with a thin mantle of residual and transported soils. The rock formation in the district falls into two groups, charnockite series and granite gneiss and gneissic complex. Pegmatite veins and dolerite dykes are commons intrusives in the area. The flat and low-lying areas are covered by a thick mantle of fertile soil, while, the elevated portions and hills are capped by laterite. Pegmatite veins and dolerite dyke are common in the district and this has a bearing on the tectonic history of the area as well. Prominent lineaments seen in the district are oriented in a NNE –SSW direction, N-S as well as NW-SE direction. The foliation in the granitic gneiss is trending NE–SW to NNW-SSE with an easterly dip of 40° to 80° in general. Faults are observed trending E-W to NW- SE. Near Mysore town a big batholith is seen and is known as Chamundi granites. A fairly wide area of the district consists of charnokite series of rocks, particularly along the southeastern borders of Yelandur and Biligirirangana hills and also at the western border near Hangod in Hunsur Taluk. The intervening ground consists of granitic gneiss with thin beds, lenses of various hornblendic rocks, pyroxenites and

dunities containing chromate and magnesite. Dolerites are in large numbers to the west of Hunsur and Gundlupet taluks.

The Sargur schist belt in H. D. Kote taluk extends from Sargur to Mysore city for about 40 km. This belt was named as Sargur series. The series comprise of a complex series of meta sediments and basic igneous rocks. The garnet sillimenite gneiss and associated rocks occurring as patches within the genesis of southern Mysore represent the remnants of the older khondalite - charnockite system.

The area between Bettadabidu and Doddakanya is essentially a flat lying gneissic terrain with numerous enclaves of meta-sedimentary units consisting of quartzites, pelitic schists, crystalline limestone, calc-silicates and ferruginous quartzites into which the ultramafic and the basic rocks have been emplaced.

In the H. D. Kote and Gundlupet regions, the bands of highly altered rocks of kyanite, staurolite, siliceous schists and also bands of limestone and quartizites are found. These rocks are of great economic importance because of the presence of graphite, corundum and garnets in them. They extend from Bilikere region up to the southern border of the district in the south-southwest direction for nearly 50 km. Fine textured granite beds are found in Mysore taluk and around Mysore city.

SOIL

Soil is red sandy loam in most of the areas of the district.. The soils of the districts can be broadly classified as the laterite, red loam, sandy loam, red clay and black cotton soils. The laterite soil occurs mostly in the western part of the district while the red loam is found in the northwest. These two account for nearly half the area of the district. The black cotton soil is found mostly in the northeastern parts of the district. The red sandy loam soils are derived from the granites and gneisses. The western taluks of Periyapatna, H D Kote and Hunsur are covered with hilly terrain and contain red, shallow gravelly soils. In the taluks of T. Narasipura and Nanjanagud, there is deep red loam occasionally interspersed with black soils. The red soils are shallow to deep well drained and do not contain lime nodules. The black soils are 1 to 1.5 metre in bases with good water holding capacity for a longer time.

CLIMATE AND RAINFALL

Temperature

Temperature influences considerably the socio-economic activities in a region. The district in general enjoys cool and equable temperature. During the period from March to May, there is continuous rise in temperature. April is the hottest month with the mean daily maximum temperature at 34.5°C and the daily minimum at 21.1°C. On normal days, the day temperatures during summer may exceed 39°C. There is welcome relief from the heat when thunder showers occur during April and May. With the advance of the southwest monsoon in the beginning of June, the day temperatures drop appreciably and throughout the southwest monsoon period, the weather is pleasant. After mid-November, both day and night temperatures decrease progressively. January is the coldest month with mean daily maximum at 11°C.

Some days during the period from November to January, the minimum temperature may go below 11°C.

The highest maximum temperature recorded at Mysore was 39.4°C on the 4th of April 1917. The lowest minimum temperature was 10.6°C on the 13th of December 1945. The temperature remains nearly the same for several months but begins to rise in February and touches the peak in either April or May.

Humidity

Relative humility is generally high during the southwest monsoon season. It is about 70 per cent and over in the mornings throughout the year, while in the afternoons, it is comparatively lower except during the southwest monsoon. The period from January to April is the driest part of the year with relative humility of about 30 per cent and still lower in the afternoons.

Rainfall

The variation in the annual rainfall from year to year is not large during the 85 years from 1901 to 1985, the highest annual rainfall amounting to 156 per cent of the average annual rainfall had occurred in 1903 and the lowest occurred in 1918. It is observed that the annual rainfall in the district was between 600 mm and 900 mm in 66 years out of the 85 years.

Monthly Distribution of Rainfall

The rainfall distribution in the district is confined to the months of April to November. September is the rainiest month with 180.86 mm. January receives the lowest rainfall of 2.02 mm. The rainfall from June to September constitutes only about 55.07 per cent of the annual rainfall. The rainfall during the pre-monsoon months of April and May and during the post-monsoon months of October and November are as much as 25.37 percent and 15.13 per cent, of the annual rainfall respectively.

Distribution of Rainfall

H. D. Kote, Hunsur, and Periyapatna taluks are cool and moist during winter and rainy season and these taluks are located in the semi-malnad areas. The remaining taluks are comparatively dry (except for the regions of rivers) during the year. In 1960, the highest rainfall of 920.1 mm was recorded in H D Kote and the lowest of 762.8 mm in Hunsur taluk. The distribution of average annual rainfall in the district seems to be satisfactory with more than 762 mm. In 1965, the distribution of rainfall in the district was not satisfactory. The highest rainfall of 817 mm was recorded in H D Kote and the lowest of 420.9 mm in Nanjangud. In the year 1985, Less rainfall was recorded in the district. The amount of rainfall received has been considerable from 1980 to 1985. However, during 1985-86, 1021 villages out of 1,837 villages were declared as drought hit areas as the rainfall was much below the average. The H.D. Kote taluk had the highest annual rainfall during 2003 (811.8 mm) and K. R. Nagar had the lowest annual rainfall of 507.9mm.

Special Weather Phenomena such as depressions and cyclonic storms originate in the Bay of Bengal During October and November. Such depressions and storms pass through or remain in the neighborhood of the district causing widespread, heavy rains and high winds. Thunderstorms are common during the post-monsoon

months. Rainfall during the monsoon season is also sometimes associated with thunder.

4.0 GROUND WATER SCENARIO

4.1 Hydrogeology:

Hydrogeologically, the area forms a part of hard rock terrain comprising of granites, gneisses, charnockites and amphibolites. Pegmatite veins and dolerite dykes are common intrusive in the area. The flat and low-lying areas are covered by a thick mantle of fertile soil, while, the elevated portions and hills are capped by laterite. The occurrence and movement of ground water depends on the secondary porosities like weathering, fracturing, faulting and other lineaments. This has a bearing on the tectonic history of the area as well. Prominent lineaments seen in the district are oriented in a NNE –SSW direction N-S as well as in NW-SE direction. The foliation in the granitic gneiss is trending NE–SW to NNW-SSE with an easterly dip of 40° to 80°. Faults are observed trending E-W to NW- SE, especially in the southern part of the district. There are alluvial aquifers of limited aerial extent and thickness having primary porosity occurring along river courses. The river sections contain sand, silt and gravel in varying proportions. Hard rocks do not posses primary porosity and the ground water occurs under phreatic conditions in weathered zones of granites and gneiss. Water is under semi-confined to confined conditions in joints and fractures of these rocks at deeper levels. In granites and gneisses, weathering has given rise to thick sandy residuum down to the depth of 2.0 and 20.0 m. and forms important phreatic aquifers in the district. These aquifers are developed by dug wells and dug-cum-bore wells. The depth of dug wells in the district range from 5.28 to 17.59 mbgl. and cross sectional area varies from 5.39 to 115.31 m^2. The specific capacities of these wells range from 23 to 966 lpm/m and the discharges range from 4.5 to105.6 m^3/hour. The draw-downs range between 0.65 and 4.44 m. The specific capacities in alluvial areas are higher ranging from 131 to 884 lpm/m.

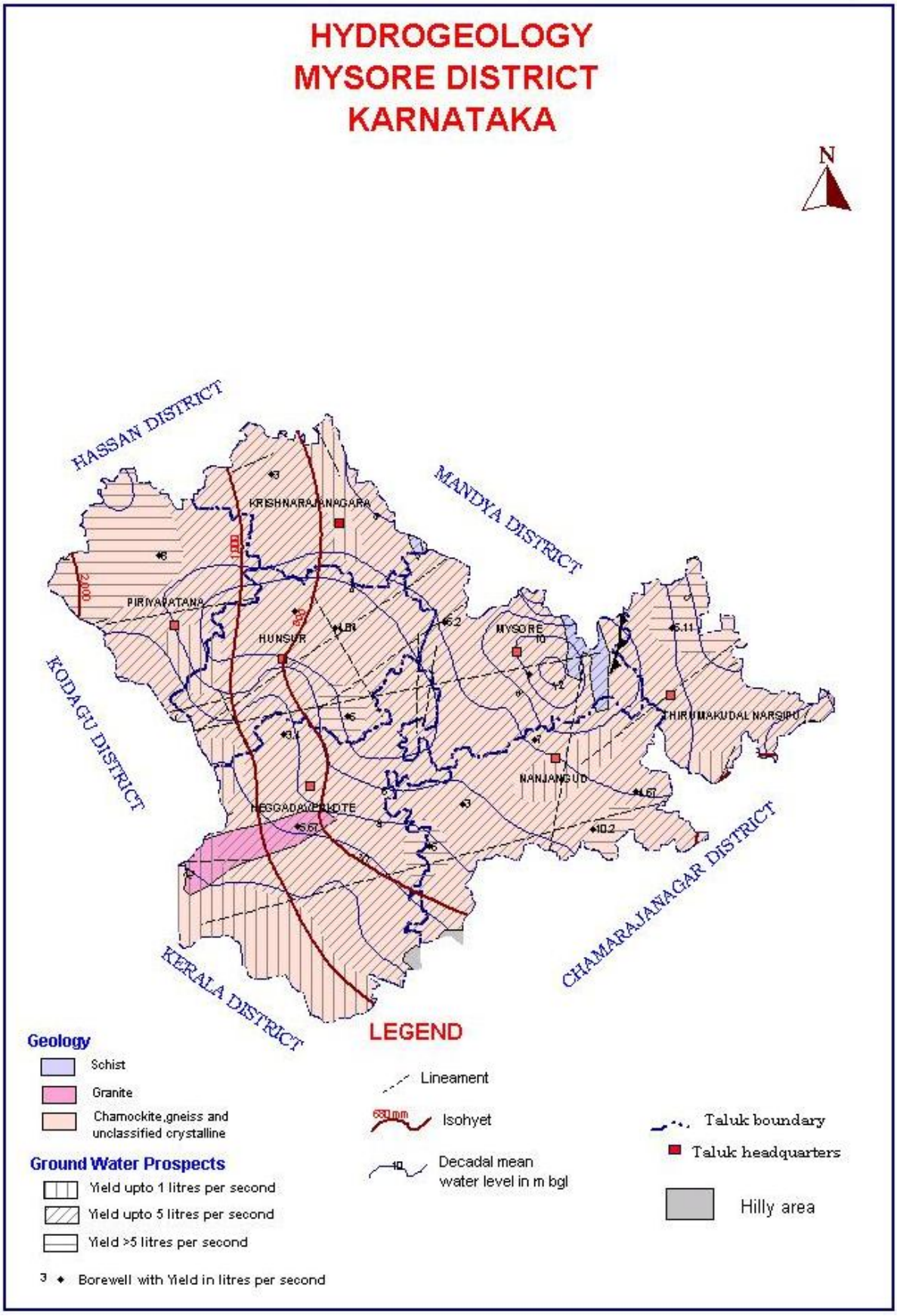
Fractured granites and gneisses form prolific deeper aquifers in some parts of the district. In charnockites, specific capacities are in the range of 23 to 115 lpm/m while the major rock type viz granites and granite gneisses have recorded specific capacities in the range of 42 to 966 lpm /m. The transmissivities range between 21 and 912 m²/d. It is observed that the aquifers falling in about 90% of the district yield up to 5 lps. There are small patches of areas where yield is less than one lps. There are small areas having high yield up to 30 lps. The Hydrogeological map of the district is presented in Fig 3.

4.1.1 Aquifer systems encountered in the area

The study of aquifer geometry and parameters have been attempted by Central Ground Water Board, South western Region, Bangalore, under its ground water exploration programme through drilling exploratory bore wells at selected places. Ground water occurs under phreatic conditions in the weathered rocks, top-soils and in river alluvium. Occurrence and movement of ground water is controlled by degree of weathering and fracturing in the weathered zone. These aquifers are developed by dug wells, dug-cum-bore wells and shallow tube wells. The depth of dug wells in the district range from 5.28 to 17.59 m bgl. Cross sectional area of dug wells vary in the range of 5.39 to 115.31 m2. The specific capacity of these wells in the area ranges

from 23 to 966 lpm/m and the discharge ranges from 4.5 to 105.6 m3/hr. The draw down varies from 0.65 to 4.44 m.

Fig-3



Ground water occurs under semi-confined to confined conditions in fractures and joints below the zone of weathering. The occurrence and movement of ground water is controlled by intensity of fracturing and their inter connection. This zone is developed by bore wells. Depth of aquifer in this zone ranges from ranges from 25 to 90 m. Discharge ranges from less than one to 8 lps. Drawdown ranges from 0.5 to 23 m for pumping duration of 100 minutes. The transmissivity ranges from 0.5 – 819 m^2/day/m. It is observed that the fracture aquifer system falling in about 90% of the district yields upto 5 litres/second (lps). There are small patches of areas where yield is less than one lps and high yields of up to 30 lps.

4.1.2 Occurrence of ground water

Ground water in the district generally occurs under unconfined to semi-confined conditions. In the shallower zones it is under phreatic conditions and in deeper zones it is under semi-confined conditions. Within the depth range of 10.00 to 20.00 m bgl ground water is being exploited through dug wells and from 30.00 to 92.00 m bgl through dug-cum-bore wells or bore wells. Exploration has proved the presence of prolific aquifers at greater depths.

4.1.3 Depth to Water Level

The water levels at National Hydrograph Stations are monitored by the Central Ground Water Board regularly to keep a constant watch on ground water regime. While preparing this report, water level data of these NH Stations for the past ten years were analyzed.

The depth to water levels in the district during premonsoon 2011

During the premonsoon period (May 2011) in a major part of the district the water level is within the ranges of 2-5m and 5 to 10 m and is shown in figure 4. The water level data from national hydrograph stations were used to generate the map. Water levels below 2m and above 10 m are observed in isolated patches in the northern and southern part of the district respectively.

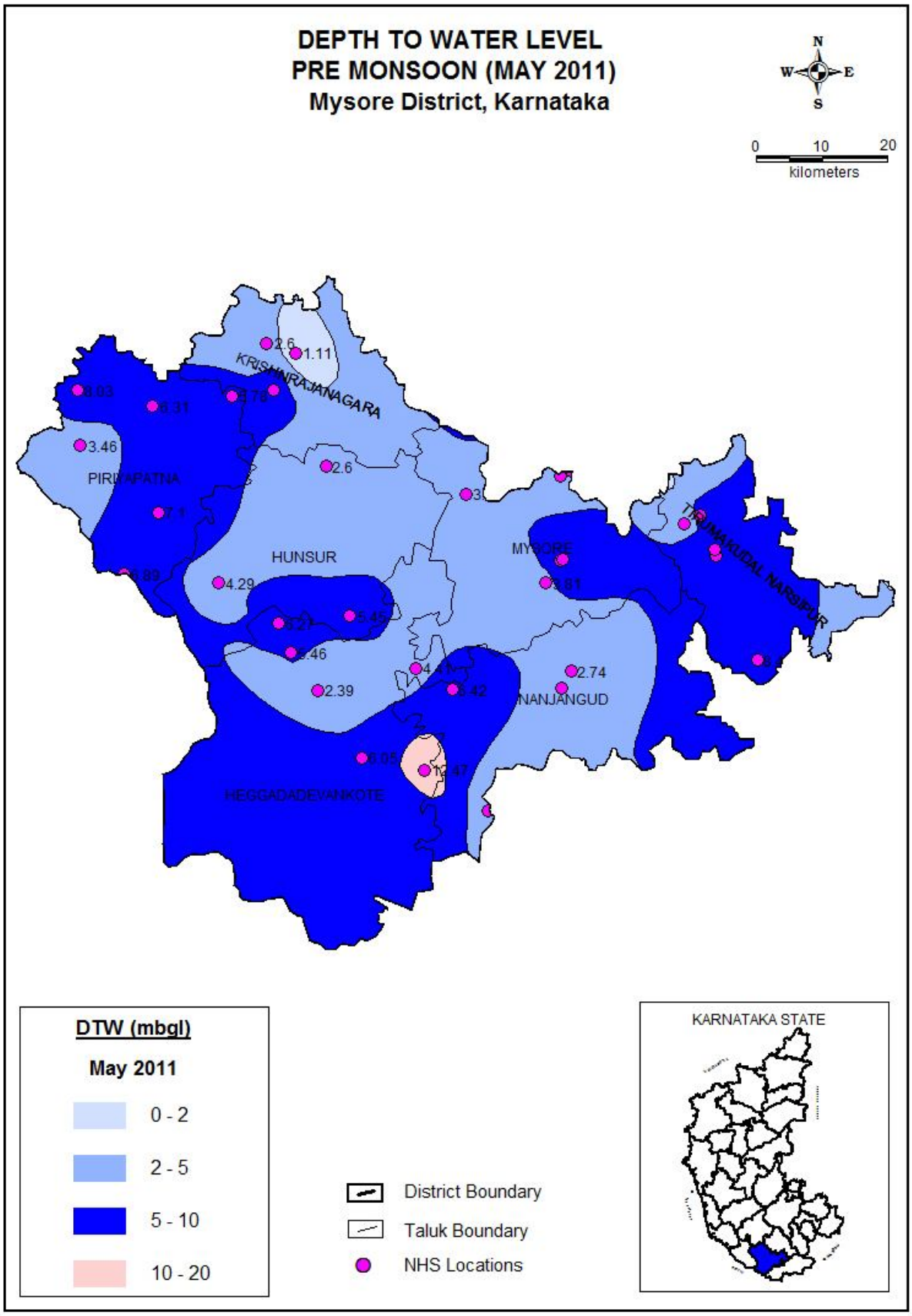
Post-monsoon season (Nov 2011)

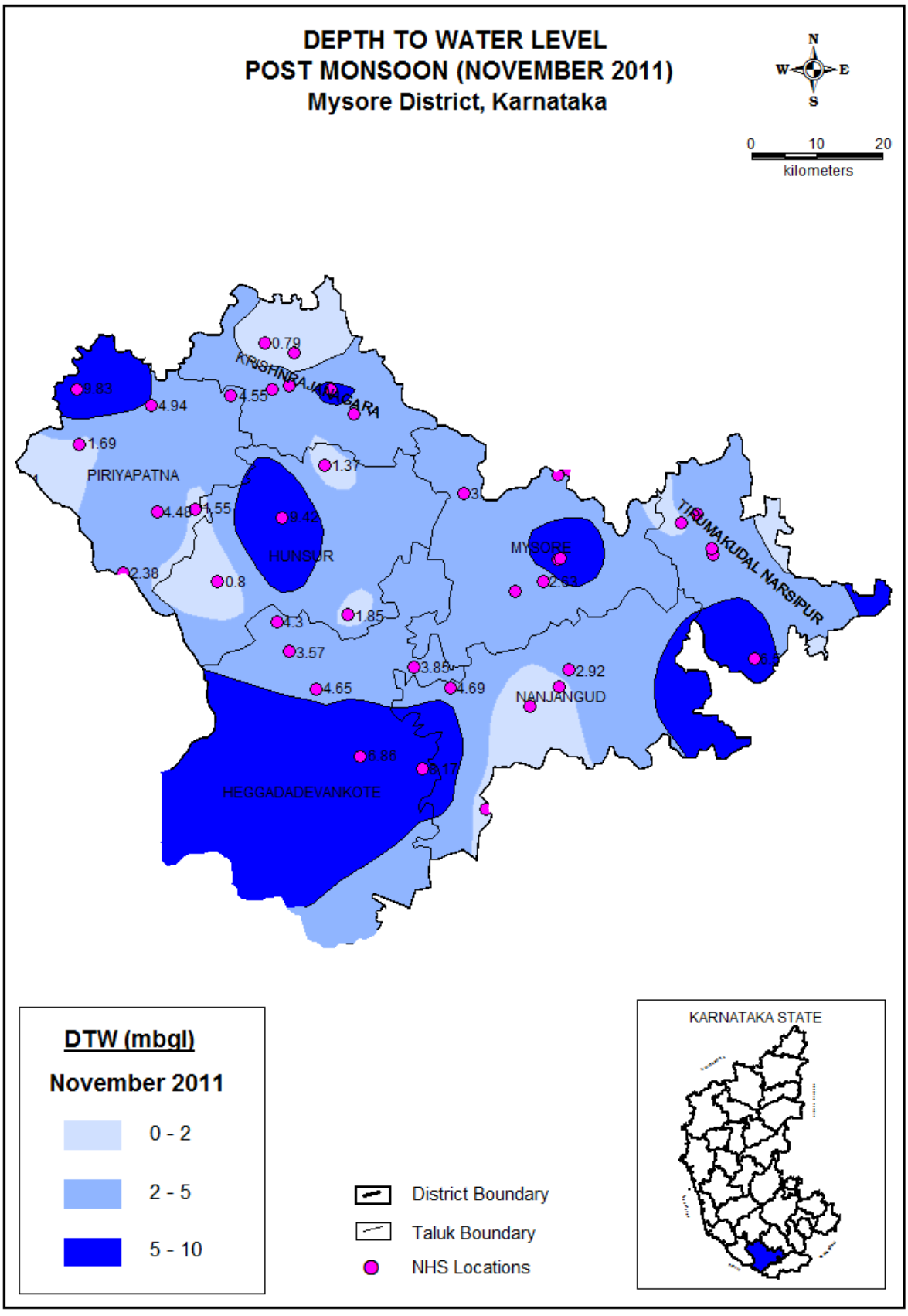
During the post monsoon period groundwater levels within the range of 2 to 5m is recorded in major part of the area. Depth to water level between o to 2m and 5-10m are observed in isolated patches as shown in figure 5.

Seasonal fluctuation in water level

Consequent upon 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. Therefore, the water levels, in general show, a receding trend from December to May. As far as seasonal fluctuation is concerned, rise in water levels is observed throughout the district (except for a lone well in Nanjangud taluk) and it is in the range of 0.53 m to 10.65 m. The extent of seasonal fluctuation in the district indicates that good recharge of the phreatic aquifer is taking place under prevailing conditions

Fig.4


DEPTH TO WATER LEVEL
PRE MONSOON (MAY 2011)
Mysore District, Karnataka
N
W
E
S
0
10
20
kilometers
KRISHNARAJANAGARA
PIRIYAPATNA
HUNSUR
MYSORE
NANJANGUD
TIRUMAKUDAL NARSIPUR
HEGGADADEVANKOTE
2.6
1.11
3.46
2.6
4.29
5.45
2.74
2.39
5.42
6.05
12.47
DTW (mbgl)
May 2011
0 - 2
2 - 5
5 - 10
10 - 20
District Boundary
Taluk Boundary
NHS Locations
KARNATAKA STATE


DEPTH TO WATER LEVEL
POST MONSOON (NOVEMBER 2011)
Mysore District, Karnataka
N
W
E
S
0
10
20
kilometers
0.79
9.83
4.94
4.55
1.69
PIRIYAPATNA
1.37
4.48
4.55
9.42
HUNSUR
2.38
0.8
MYSORE
2.63
TIRUMAKUDAL NARSIPUR
1.3
1.85
3.57
3.85
2.92
4.65
4.69
NANJANGUD
6.86
3.17
HEGGADADEVANKOTE
DTW (mbgl)
November 2011
0 - 2
2 - 5
5 - 10
District Boundary
Taluk Boundary
NHS Locations
KARNATAKA STATE

The long term mean water level for May and November months is being compared with the present scenario. Ground water level fluctuation in May 2011 with respect to decadal mean (may2001-may2010) is shown in figure 6. Major part of the district shows 0- 2m rise while western part of the district recorded 2-4 rise. Very small area shows more than 4m rise and small patches are noticed with 0-2m and 2-4 m fall and more than 4m fall is not recorded.

Ground water level fluctuation in November 2011 with respect to decadal mean(November2001- November 2010) is given in figure 7. Major part of the district shows 0-2- rise, However, a significant part of the district shows 0-2mfall also.

4.2 Ground water Resources:

Net annual ground water availability in the district is 41143.06 ham and the total annual ground water draft is 23822.33 ham. The resource available for future development is 17761.65 ham, which can create additional ground water irrigation potential of 19577.35 ha. The ground water development in the district is 63%. When considered taluk wise, the ground water development is highest (about 88%) in Mysore taluk, followed by Nanjangud (73%), T. Narasipura (71%), Hunsur (57%), Periyapatna (42%), K.R. Nagar (39%) and H.D. Kote (37%) taluks.

The taluk-wise groundwater resource (2008-09) is given in the table-4.1. The perusal of this table indicates that, the annual ground water recharge for the whole district is 42944.34 ham. The maximum being 9963 ham in H.D. Kote taluk and the least of 3357.35 ham in T. Narasipura taluk.

The annual draft for domestic and industrial uses in Mysore district, is 3915.16 ham and the draft for irrigation purposes is 19922.70 ham. It is further observed that the total ground water draft during the year 2004 was 23822.33 ham. It is also observed that highest draft is recorded in Mysore taluk (5962.30) and the least in K.R. Nagar taluk (1259.23 ham). The taluk-wise stage of ground water development details computed for the district in the ground water estimation studies for the year 2004 is given in table-4.1.

4.3 Unit area annual groundwater recharge

4.3 Unit Area Annual Ground Water Recharge

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

Fig. 6

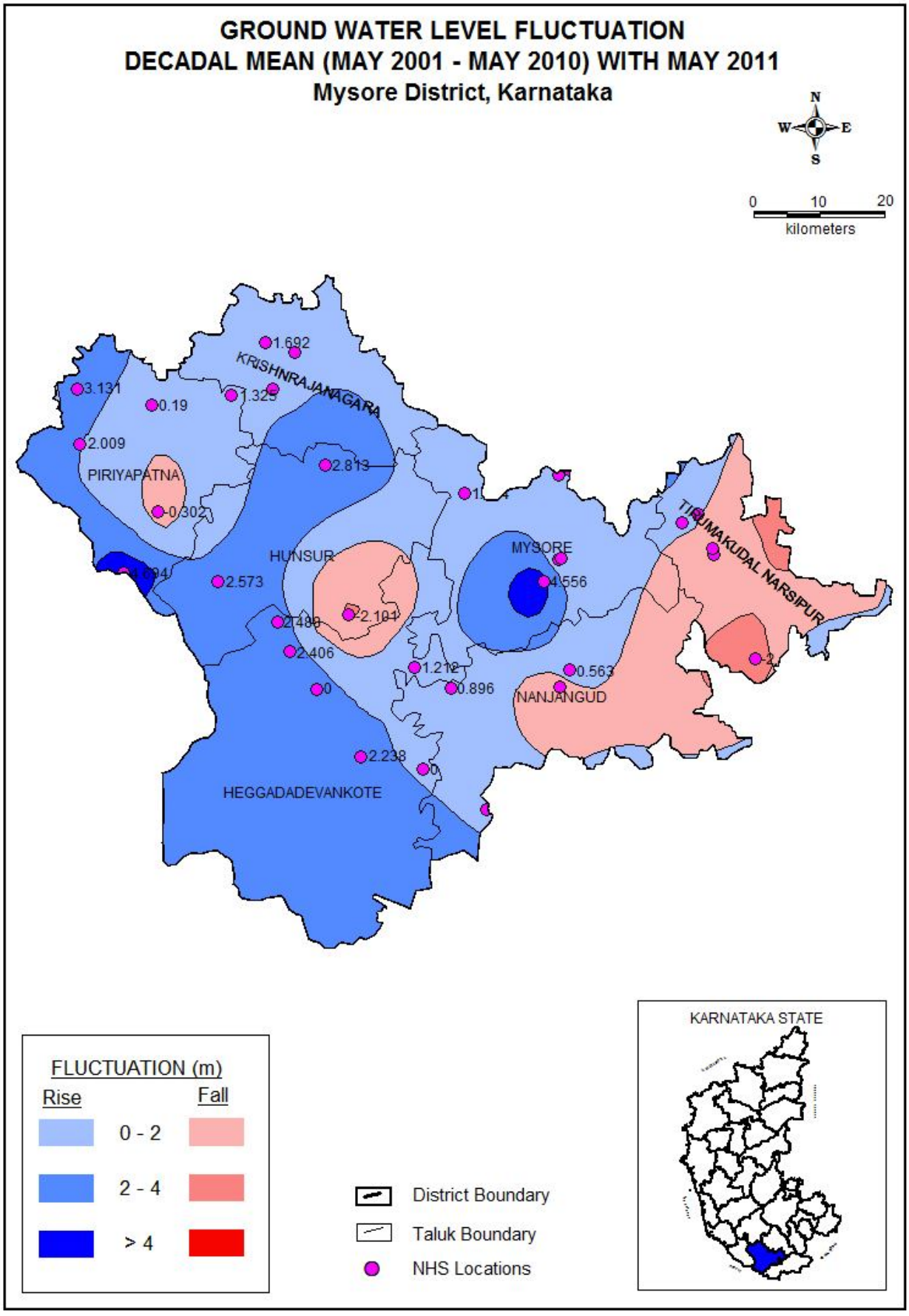

GROUND WATER LEVEL FLUCTUATION
DECADAL MEAN (MAY 2001 - MAY 2010) WITH MAY 2011
Mysore District, Karnataka
N
W
E
S
0
10
20
kilometers
KRISHNRAJANAGARA
PIRIYAPATNA
HUNSUR
MYSORE
NANJANGUD
TIRUMAKUDAL NARSIPUR
HEGGADADEVANKOTE
1.692
3.131
0.19
1.325
2.009
2.813
0.302
2.573
2.101
2.406
1.212
0.896
0.563
2.238
4.556
FLUCTUATION (m)
Rise
Fall
0 - 2
2 - 4
> 4
District Boundary
Taluk Boundary
NHS Locations
KARNATAKA STATE

Fig. 7

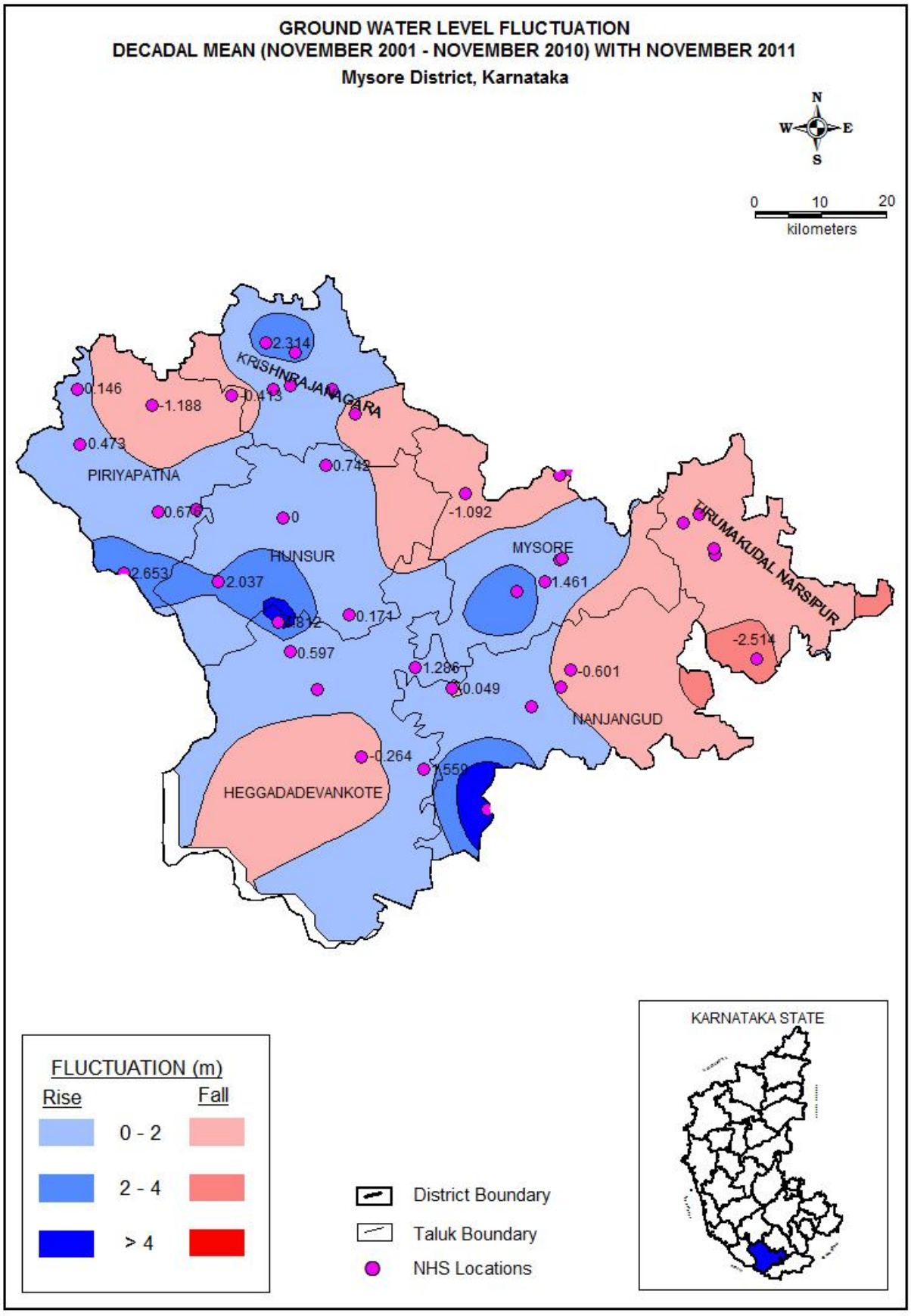

GROUND WATER LEVEL FLUCTUATION
DECADAL MEAN (NOVEMBER 2001 - NOVEMBER 2010) WITH NOVEMBER 2011
Mysore District, Karnataka
N
W
E
S
0
10
20
kilometers
2.314
KRISHNRAJANAGARA
0.146
-1.188
-0.413
0.473
PIRIYAPATNA
0.742
0.676
0
-1.092
HUNSUR
2.653
2.037
MYSORE
1.461
TUMAKURU
NARSIPUR
0.171
-2.514
0.597
1.286
-0.601
0.049
NANJANGUD
-0.264
HEGGADADEVANKOTE
KARNATAKA STATE
FLUCTUATION (m)
Rise
Fall
0 - 2
2 - 4
> 4
District Boundary
Taluk Boundary
NHS Locations

TABLE 4.1: TALUK WISE GROUND WATER RESOURCES AND CATAGORISATION OF MYSORE DISTRICT, KARNATAKA (2008-09)

SL NO	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	NET GROUND WATER AVAILABILITY FOR FUTURE IRRIGATION DEVELOPMENT	EXISTING STAGE OF GROUND WATER DEVELOPMENT	CATAGORISATION AS ON MARCH 2004			
									SAFE AREA (%)	SEMICRITICAL AREA (%)	CRITICAL AREA (%)	OVER-EXPLOITED AREA (%)
		HAM	HAM	HAM	HAM	HAM	HAM	HAM				
1	**H.D. KOTE**	8055	3404	441	3845	652	4111	48	69	19	-	12
2	**HUNSUR**	6376	2002	211	2213	268	4302	35	73	-	-	27
3	**K.R. NAGAR**	7319	2021	267	2287	637	4688	31	97	-	-	3
4	**MYSORE**	4211	3364	167	3520	181	784	84	27	-	-	73
5	**NANJANGUD**	10659	3904	405	4309	734	6040	40	-	80	-	20
6	**PERIYAPATNA**	6415	1289	235	1524	322	4804	24	SAFE	-	-	-
7	**T. NARSIPURA**	12933	3557	377	3934	631	8806	30	57	3	8	32
	TOTAL	**55968**	19541	**2093**	**21634**	**4056**	**33535**					

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 Mysore district the unit area annual recharge is in the range of 0.025-0.10m in H.D.Kote, Hunsur,K.R.Nagar and Periyapatna taluks and in the range of 0.1 to 0.15 in Nanjangud and Mysore taluks and in the range of 0.15 to 0.25m in T.Narasipura taluk as shown in figure. 8.

4.4 Status of Ground Water Development:

In most parts of the district, ground water is the major source for domestic and drinking purposes. Out of the total area of 1180 km^2 under irrigation, about 11% is irrigated using ground water through dug wells and bore wells. Farmers with small land holdings depend mainly on the rainwater and water available in the shallow wells. There are 4501 dug wells and 16478 bore wells in the district as per third MI census. Out of these 87 dug wells and 349 bore wells are not in use due to various reasons including drying up of the wells. Taluk-wise break up of these wells is presented in table –4.2.

Table-4.2 : Distribution of Wells according to status as per MI Census 2000-01

Sl No	Taluk	Wells in Use		Wells not in use	
		Dug Wells	Bore Wells	Dug Wells	BW
1	**H.D. Kote**	261	2506	21	47
2	**Hunsur**	853	2381	3	57
3	**K.R. Nagar**	621	823	11	22
4	**Mysore**	222	3155	9	50
5	**Nanjangud**	604	3077	17	81
6	**Periyapatna**	187	2033	13	78
7	**T. Narasipura**	1753	2503	13	14
Total		**4501**	**16478**	**87**	**349**

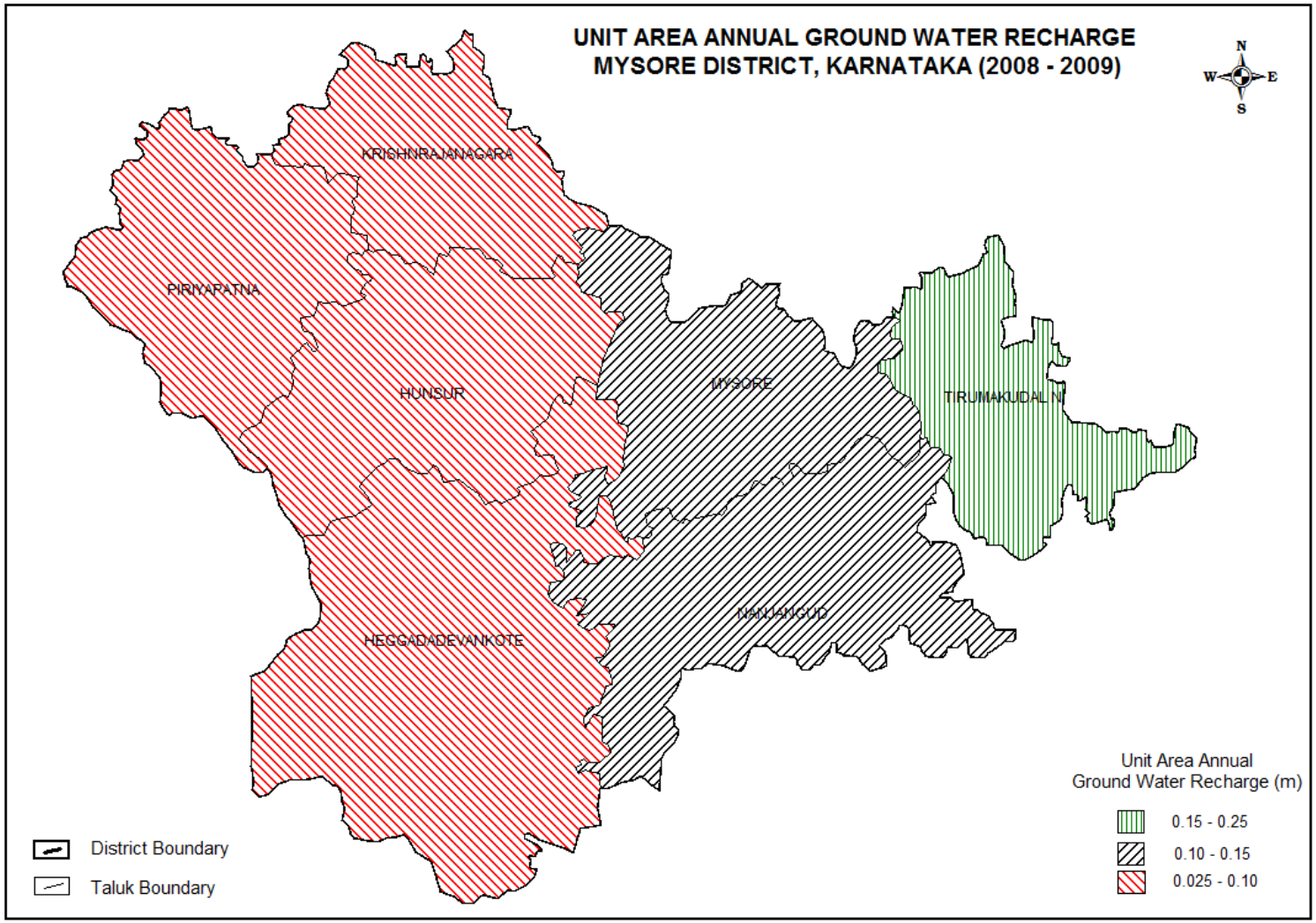
4.4.1 Water Lifting Devices

Water lifting devices used in the district are Electric motor, Diesel Pump, Wind Mill and manual / animal operated. Electric pump is the most common water-lifting device, being used in more than 90% of the wells as given in table 4.3.

Table-4.3 : Distribution of wells according to water lifting device as per MI Census 2000-01.

Lifting Device	Dug Well	Bore Well	Total
Electric Pump	4209	15188	19397
Diesel	263	535	798
Wind Mill	13	331	344
Solar	0	0	0
Manual / Animal Operated	3	10	13
Others	100	763	863
Total	**4588**	**16827**	**21415**

Fig. 8


UNIT AREA ANNUAL GROUND WATER RECHARGE
MYSORE DISTRICT, KARNATAKA (2008 - 2009)
N
W
E
S
KRISHNRAJANAGARA
PIRIYAPATNA
HUNSUR
MYSORE
TIRUMAKUDAL N
NANJANGUD
HEGGADADEVANKOTE
Unit Area Annual
Ground Water Recharge (m)
0.15 - 0.25
0.10 - 0.15
0.025 - 0.10
District Boundary
Taluk Boundary

4.4.2 Water Lifting Devices

Capacity of pumps used in the area to draw ground water ranges from less than 2HP to >10HP. While more than 85% of the wells are fitted with 4 to 6 HP motor, a very small number around 0.03% are fitted with more than 10HP motor. Distribution of wells according to Horse Power is given in table-4.4.

Table-4.4 : Distribution of Wells according to Horse Power

	Horse Power						
Type of well	**0 - 2**	**2 - 4**	**4 - 6**	**6 - 8**	**8 - 10**	**> 10**	**Not Specified**
Dug Well	37	229	3862	251	89	4	116
Bore Well	268	612	14461	311	68	3	1104
Total	305	841	18323	562	157	7	1220
Percentage	1.42	3.93	85.6	2.62	0.7	0.03	5.7

4.4.3 Drinking water Wells

As per the records, as on 31.3.2006, the domestic water requirement is catered through 994 numbers of Mini-water supply schemes, 1,489 numbers of piped water supply schemes through borewells along with 10,411 bore wells installed with hand pumps. In most parts of the district, ground water is major source for domestic and drinking purposes.

4.4 Ground Water Quality:

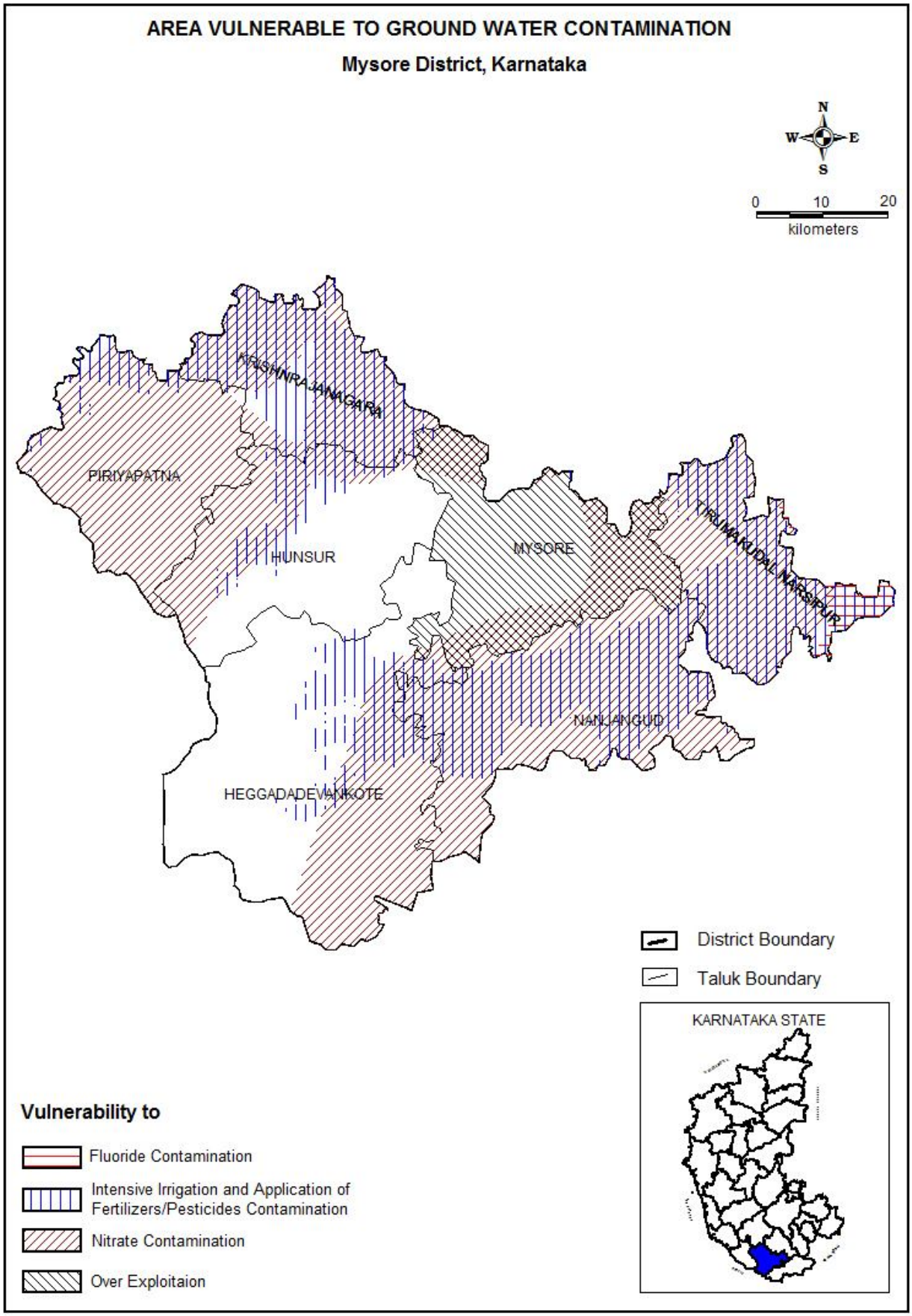
Quality of groundwater in the district, in general, is good and potable. Central ground Water Board monitors quality of ground water in phreatic aquifers in the district from a network of NH Stations every year. It is observed that ground water quality in the district in general is very good. However inland salinity is reported from isolated patches as in Saligram, Begur and Madhur where the EC is above permissible limits. North-eastern part of Piriya Patna, north-western part of K.R. Nagar, north-western part of Mysore, south-western part of T. Narsipur, eastern part of Nanjangud and central part of H.D. Kote have nitrate concentration above permissible limits. Nitrate is above permissible limits around Elivala, Bilikere, Hangod, Bettadapura, Hosur, Saligrama, Kalyanapuram, Palaya, Madhur, Muguru area also. Samples from exploratory bore wells represent water quality of deeper aquifer in the district. Analysis results of samples from these bore wells indicate that in general quality of ground water from semi-confined and confined aquifers in the district is good and potable. pH ranges from 7.38 to 8.81. EC ranges from 360 to 3268 µs/cm at 25^0C (Hebbalguppe). In major part of the district nitrate is within permissible limits except at Mugur, Thirakanur, Yelgundi, Gundip and Hebbalaguppe. Chloride is in permissible limits in the entire district. Except a small pocket in the southern part of Mysore taluk fluoride distribution is within permissible limits. Based on the groundwater quality the area vulnerable to groundwater contamination has been demarcated and given in figure. 9

5. GROUND WATER MANAGEMENT STRATEGY

5.1 Ground water development:

The average stage of ground water development in the district is 63% indicating that that there are areas where there is scope for further development. A hydro geological map showing water-bearing formations, yield potential, decadal mean water level and isohyets is shown in fig 3. Sustainability of ground water resource and its judicious use should be given prime importance while making

Fig. 9


AREA VULNERABLE TO GROUND WATER CONTAMINATION
Mysore District, Karnataka
N
W
E
S
0
10
20
kilometers
KRISHNARAJANAGARA
PIRIYAPATNA
HUNSUR
MYSORE
T.NARASIPUR
NANJANGUD
HEGGADADEVANKOTE
District Boundary
Taluk Boundary
KARNATAKA STATE
Vulnerability to
Fluoride Contamination
Intensive Irrigation and Application of Fertilizers/Pesticides Contamination
Nitrate Contamination
Over Exploitaion

development strategy. In critical and over-exploited areas, artificial recharge and rainwater harvesting measures are recommended to augment to ground water system. About 17761.65 ham of ground water resource is available in the district for further development. The development is recommended only in area categorised as safe and semi-critical **(Fig- 10).** In such areas, potential aquifers can be located by hydrogeological surveys aided by geophysical methods. Dug wells and filter-points are recommended only in river and valley banks where sufficient thickness of valley-fill is available, which gets saturated during rainy seasons. Ground water development in other feasible areas should be done by bore wells. Spacing norm of

200 m may be strictly adhered to avoid interference. Aquifer should be pumped as per crop water requirement.

In areas, which are categorized as critical and over-exploited, growing crops like paddy, sugarcane etc, having high water requirement may be avoided. Advance irrigation methods like drip and sprinkler irrigation may be practiced.

In the command areas conjunctive use of surface and ground water may be practiced to avoid long-term hazards like water logging and ground water as well as soil salinity problems.

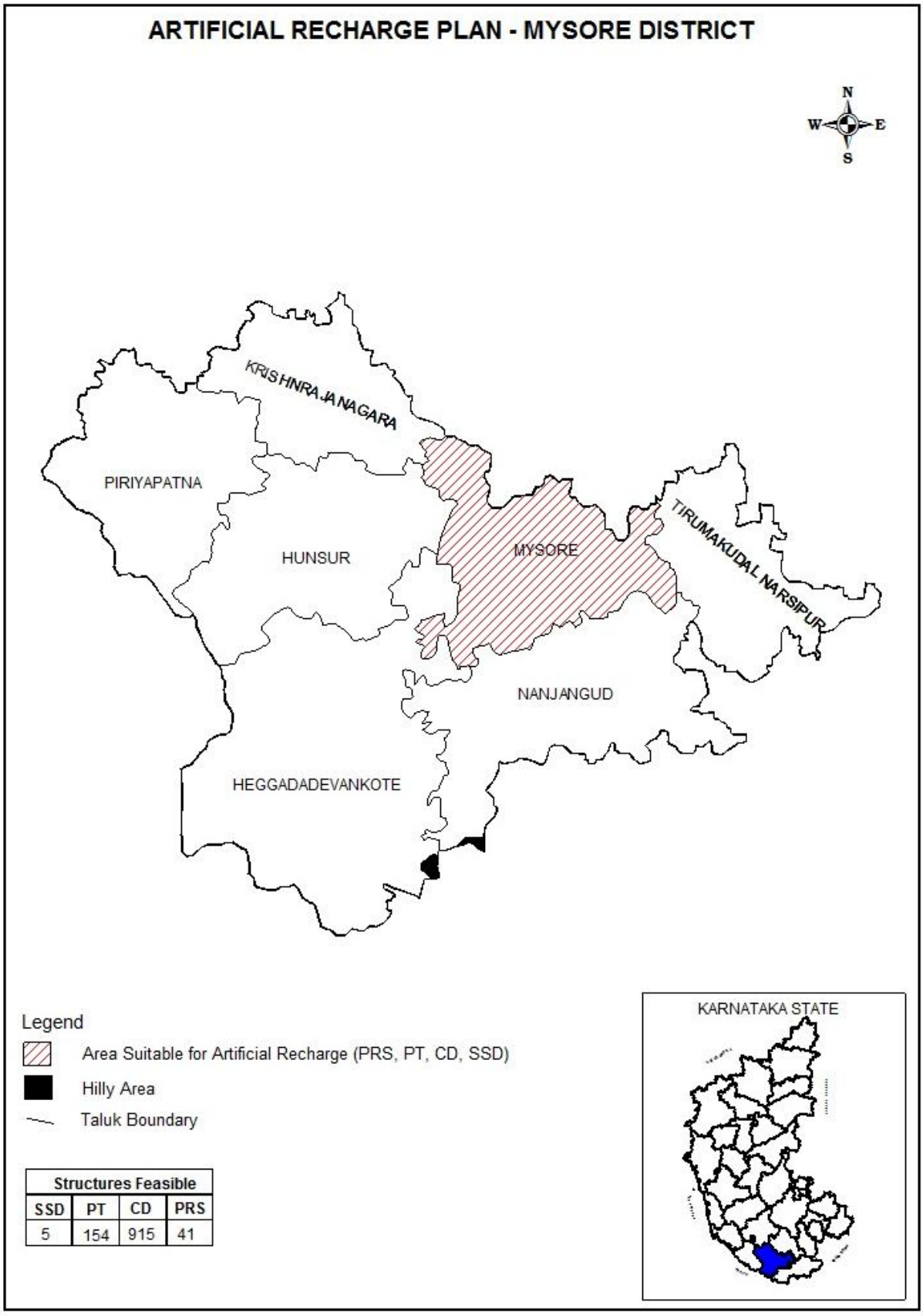
5.2 Water conservation and Artificial Recharge:

Groundwater in the district can be augmented by opting for rainwater harvesting and artificial recharge structures to harvest non-committed surface runoff. In the western part of the district where the topography is hilly and rugged artificial recharge structures like nalla and gully plugs contour bunds and contour trenches and nalla bunds may be constructed and in comparatively plain areas percolation tanks and point recharge structures like recharge shafts recharge pits and recharging through existing dug/bore wells may be practiced. In semi-urban areas in the district, lot of roof area is available for rooftop rainwater harvesting. So in these semi-urban areas rooftop rainwater harvesting practices may be encouraged. This will help in reducing the load on urban water supply systems. The area suitable for artificial recharge in the district is shown in figure 12.

6. GROUND WATER RELATED ISSUES & PROBLEMS

There is over exploitation of ground water resource in 73% area of Mysore, 32% area of T. Narasipura, 27% of Hunsur and 20% area of Nanjangud taluks. This over-exploitation has resulted in depletion of water levels. Artificial recharge measures are required to be taken up in these areas on priority basis. Mysore, the district headquarters is the only urban centre in the district. Presently the Ground water here is not under threat as the city is provided with piped water supply from surface water sources. Studies on the pollution aspects related to the urbanization didn't reveal any significant adverse effect in water quality. Nitrate concentration of more than permissible limit exists in many parts of the district. This may be due to indiscriminate use of fertilizer and biological contamination from decaying vegetation. Judicious use of fertilizer and proper care in disposing the biological waste coupled with artificial recharge (in favourable areas) can address this problem.

Fig. 11



Structures Feasible			
SSD	PT	CD	PRS
5	154	915	41

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7. AWARENESS AND TRAINING ACTIVITY

7.1 Mass Awareness Programmes (MAP):

Central Ground Water Board, South Western Region organized a Mass Awareness Pragramme on “Protection and Conservation of Ground Water” conducted at J.S.S.P.P.H Auditorium, S.J.C.E. Campus, Manasa Gangothri, Mysore. The participants included students, senior citizens, progressive farmers, advocates and representatives from NGOs. During the programme technical presentations on the theme of the programme were given by Scientists of Central Ground Water Board, South Western Region, Bangalore. An exhibition depicting various aspects of protection and conservation of water including various rainwater harvesting and artificial recharge techniques was also organized on the occasion.

7.2 Participation in Exhibition, Mela, fair etc:

CGWB has not participated in any Exhibition, Mela, Fair, etc. but organised Exhibition on its own as part of Mass Awareness Programme conducted at Mysore during February 2004.

8.0 AREAS NOTIFIED BY CGWA/SGWA

No area in the district is notified so far.

9.0 RECOMMENDATIONS

As already discussed the average stage of ground water development in the district is 63% indicating that there are areas where there is scope for further development. Categorisation of the areas is shown in Fig 6 . It may be noted that all command areas are under safe category. Categorization as shown in the fig is only for non-command areas. While K. R. Nagar and Periyapatna taluks are safe for ground water development, whereas in Nanjangud no area is safe except canal command. Rest of the taluks are partly safe and partly over-exploited. But all the command areas falling in the district are safe for further development. The dugwells, which penetrate partially the weathered, fractured zones of the aquifers, may be deepened further for the better productivity. Construction of check dams and sub surface dykes at appropriate places across the nallahs and streams in the water-table depleting areas of Mysore, T. Narasipura, Hunsur, H.D. Kote and Nanjangud taluks may be envisaged. A comprehensive programme has to be formulated to harvest the rain water through roof top, check dams, surface tanks, bunds and subsurface dykes to use the resources directly from the structures, which in turn will arrest the sub-surface flows and augment the groundwater resources. Ground water usage should be encouraged in topographic lows and valley areas of low water level fluctuations with adequate soil conservation measures to prevent the soil erosions. Constant monitoring of ground water quality should be carried out in the Canal command areas to prevent the pollution and related problems. Determination of trace elements and organic compound should be done to help in categorizing the quality of water. Ground water in canal command area is found under-developed therefore, it is strongly recommended to prepare an action plan to bring more area under conjunctive use of ground water and surface water irrigation. Conjunctive use of both Surface and Ground water practiced in the canal command area would improve the

quality of ground water, prevent the water logging conditions and availability of canal water to the tail end areas. The ground water development should be allowed only areas, which are categorised as safe and semi-critical with caution. Mass awareness programmes should be conducted for public awareness about the limited availability of ground water resource. For domestic purposes dug wells are ideal structures in denudational uplands and older flood plains while in the rest of the area the wate level is expected to be deep and may dry up in summer. For domestic purposes 2.5 m dia dug well down to 8-14 m will be ideal where as for irrigational purposes deeper dug wells with depth ranging from 14-18 m bgl with a dia of 5-6 m is recommended. The locations for bore wells are site specific and have to be pinpointed based on scientific investigations. In general the lineaments trending NE-SW and E-W are expected to be have higher yield. Sites for bore wells and dug wells should selected with the technical advice from technical qualified persons. The bore well may be constructed down to 200 m with a dia of 152 to 165 mm. Since potential fracture zones are encountered with in a depth zone of 100 m, small capacity DTH Rig is sufficient for drilling borewells for domestic purposes of 152 mm diameter. For irrigation bore wells a depth of 200 m with a diameter of 152 to 165 mm is recommended. The thickness of weathered formation hardly exceeds 22 m and hence there is no problem for lowering the casing pipes. However, at places loose boulders are encountered just above the bedrock thereby creating problems for proper sitting of casing pipe. In cases where boulder problems are encountered reaming of the borehole with mud circulation before lowering the casing is recommended. Cement sealing provided in the annular space ensures longer life of the well. Farmers should be educated to grow less water intensive crops and adopt micro irrigation system. Government should provide subsidy such irrigation systems. Artificial recharge structures should be constructed in feasible areas for augmenting ground water resource and to improve ground water quality.