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
SHIMOGA DISTRICT, KARNATAKA

SOUTH WESTERN REGION
BANGALORE
AUGUST 2012

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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.

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 Smt. Veena R.Achutha, Asst.Geophysicist. 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.

Sd/-

(Dr K.Md.Najeeb)
Regional Director

SHIMOGA DISTRICT AT A GLANCE			
Sl. No.	**Items**	**Statistics**	
1	**General information**		
	i) Geographical area (sq. km)	847784	
	ii) Administrative Divisions	2	
	Number of taluks	7	
	No. of Panchayat /Villages :	260/1530	
	iii) Population (As on 2011 Census)	17,55,512	
	iv) Average annual rain fall	1795mm (535 - 2828 mm with 89 rainy days	
2	**Geomorphology**		
	Major Physiographic Units	Western ghats occupying western part of the district. Eastern parts of the district is occupied by undulating plains.	
	Major Drainages	Tunga, Bhadra, Varada, Sharavati and Kumudavati.	
3	**Land Use (Ha.m)(as on 2006-07)**		
	Forest area	276855	
	Net area sown	259907	
	Fallow land	38831	
	Cultivable land	260961	
4	**Major soil types**	Brown clay loamy soil, Red soil, Sandy soil, Red sandy soil, Yellowish loamy soil, Lateritic soil and Mixed soil.	
5	**Area under principal crops (2006-07) (ha)**	Crop	Area(ha)
		Paddy	132682
		Ragi	2247
		Jowar	440
		Maize	183065
		Pulses	982
		Oil seeds	2082
		Suger cane	7666
		Cotton	9495
6	**Irrigation by different sources (2006-07)**	Area (ha)	
	Dug wells (6227 no.)	6416	
	Borewells(20181)	18061	
	Tanks/ Ponds	52639	
	Canals	45540	
	Other Sources	6436	
	Lift Irrigation	4690	
	Net irrigated area (ha)	133782	

7	**Number of ground water monitoring stations of CGWB (as on 31/03/2011)** Number Dug wells Number of Piezometers.		 38 7
8	**Predominant geological formations**		
	Quarternary		Alluvium
	Dharwar super group		Ultra mafic complex, Grewacke, Argellite, Quartz Chlorite schist with orthoquartzite
	Lower Precambrian		Metabasalt with thin Ironstone.
	Archaean formation		Granite Migmatites and Granodioritic to Tonolitic gneisses, Amphibolites and Pelitischists.
9	**Hydrogeology**		
	Major Water Bearing Formations:		
	• Shallow aquifers of alluvium along the stream courses and weathered zones of Grewacke, schist, Metabasalt Granite Migmatites gneisses, and Amphibolites occurring between the depths of 3 to 20 mbgl		
	• Deeper aquifers of fractured and jointed Grewacke, schist, Metabasalt Granite Migmatites gneisses, and Amphibolites, up to 200 mbgl.		
	• Premonsoon Water levels during 2011		1.05 – 17.37 mbgl.
	• Post-monsoon Water levels during 2011		0.45 – 13.56 mbgl
	Long term water level trends (2001-2011) in m/year:	Pre-monsoon	Out of long term data available for 34 national hydrograph stations, water levels have shown rising trends in the range of 0.004 to 1.332 m/year at 29 Stations, and only 5 wells have shown falling trends in the range of 0.003 to 0.216 m/year.
		Post monsoon	Out of long term data available for 38 national hydrograph stations, water levels have shown rising trends in the range of 0.009 to 0.965 m/year at 32 Stations, and 6 wells have shown falling trends in the range of 0.003 to 0.045 m/year.
10	**Ground water exploration by C.G.W.B: (Completed during 2007)**		
	• No of wells drilled		49
	• Depth range & Casing(mbgl)		70.95 – 200.10 & 8.5-48.50
	• Discharge (litres/second)		Negligible –18.9 lps.
	• Transmissivity (m^2/day)		Negligible -169

11	**Ground water quality**	
	• Presence of chemical constituent more than the permissible limit	Chemical quality of Ground water in general is suitable for all uses except in parts of Tungabhadra command area in Shimoga and Bhadravati taluks, where high salinity and high nitrate content is reported.
	• Type of water	Alkaline type
12	**Dynamic ground water resources (March 2009) (in Ha.m)**	
	Annual replenishable ground water resources	92617
	Net annual Ground water draft	28536
	Projected demand for domestic and industrial uses up to 2025	4110
	Stage of development as on March 2009 (%)	17% (Shimoga) to 59% (Sorab). 40% area of Sagar and Sorab taluk are under over exploited category & rest of the taluks under safe category
13	**Awareness and Training Activity organized by CGWB**	
A	Mass awareness programmes	
	Date Place No of participants	16/11/2005 Sagar town 200 persons from different section of society
B	Water Management training programmes	
	Date Place No of participants	14/11/2005 & 15/11/05 Shimoga town 50 persons from different fields.
C	Activity under IEC	
	National Seminar	"Sustainability of Ground Water Resources" at Shimoga, on 09.02.2011 in association with Dept. of Applied Geology, Kuvempu University, Shimoga
	Mass media campaign for sensitizing the public at Village/Panchayat level	Associated with M/s RN Event Source Management Pvt.Ltd for propagating awareness on water conservation in the Shimoga district during July 2011.
14	**Ground water control and regulation**	
	Number of OE Blocks Number of critical blocks Number of blocks notified	Nil Nil Nil
15	**Major ground water problems and issues:**	Water logging and salinity problem in Tunga-Bhadra command area covering parts of Shimoga and Bhadravati taluks.

SHIMOGA DISTRICT

1.0 Introduction

Shimoga district is bestowed with bounty of natural resources such as forests, mineral deposits and water resources with world famous jog falls located in Sagar taluk. Among many cultural torch bearers from the district, Kuvempu and Poorna chandra tejaswi are also known for their concern towards environment. Therefore, in order to protect the richness of these natural resources, particularly ground water, statistics of ground water resources and issues concerned with ground water in the district are compiled.

1.1 Location

Shimoga district covers an area of 8477.84 sq. km and lies in the western part of the Karnataka state between 13^0 27' to $14^0$14'39" north latitude and 74^0 38'to 75^0 45' east longitudes. The district is surrounded by Uttara-Kannada & Dharwad districts in the north, Udupi & Chikmagalur districts in the south and Davanagere district in the east.

1.2 Administrative Setup

The district is divided into two sub-divisions with taluks Sorab, Sagara, Hosanagara and Shikaripura coming under Sagara subdivision and taluks Shimoga, Bhadravati and Teerthahalli coming under Shimoga Sub division. A map showing administrative setup of the district is given as Figure1.

1.3 Population

The total population in the district is around 17,55, 512 (as per 2001 census), thus giving a ranking of 275^{th} in India. The district has a population density of 207 inhabitants per square kilometre Its population growth rate over the decade 2001-2011 was 6.88 %. Out of which rural population constitutes 11,32,286(64.5%) and urban population is 6,23,226(35.5%). Shimoga has a sex ratio of 995 females for every 1000 males and a literacy rate of 80.5 %.

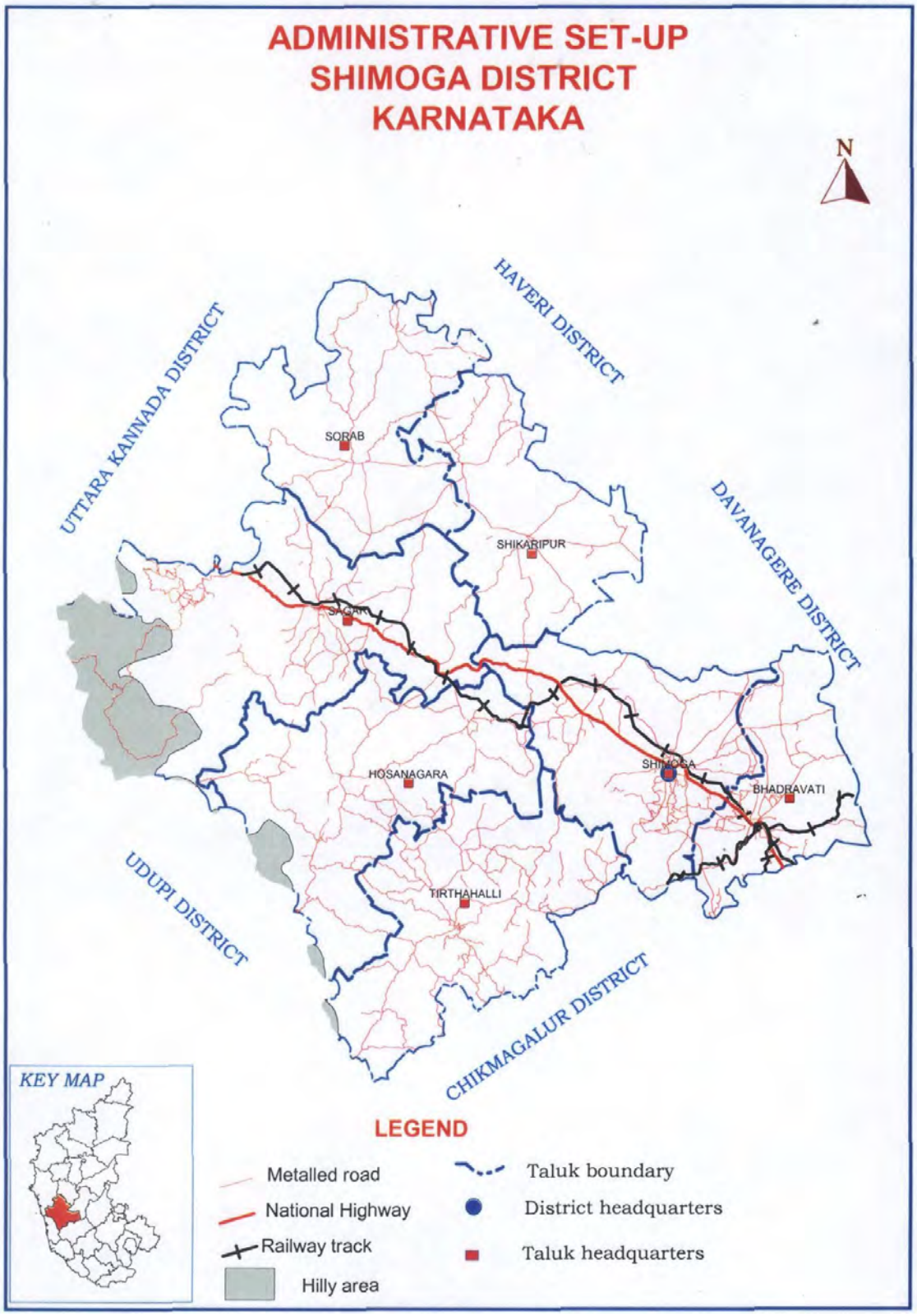
1.4 Land use pattern

The district has 276855 ha.m of forest, which constitutes 32.66 % of the total geographical area of the district. The fallow land in the district is around 38831 ha. Net area sown during the year 2006-07 was around 223695 ha, out of which, 36212 ha of land was sown more than once.

1.5 Crops

The main crops grown in the district are Paddy, Ragi, Jowar, Maize, Cotton, Groundnut, Pulses, Sugarcane and Areca nut.

Fig- 1


ADMINISTRATIVE SET-UP
SHIMOGA DISTRICT
KARNATAKA
N
UTTARA KANNADA DISTRICT
HAVERI DISTRICT
DAVANAGERE DISTRICT
UDUPI DISTRICT
CHIKMAGALUR DISTRICT
SORAB
SHIKARIPUR
SAGAR
HOSANAGARA
SHIMOGA
BHADRAVATI
TIRTHAHALLI
KEY MAP
LEGEND
Metalled road
National Highway
Railway track
Hilly area
Taluk boundary
District headquarters
Taluk headquarters

1.6 Irrigation

Out of 223695 ha of cultivated land during 2006-07, 133782 ha of land was under irrigation. Out of which, 45540 ha was irrigated under canals, 52639 ha was irrigated under tanks, 6416 ha was irrigated by dugwells, 18061 ha was irrigated by bore wells, 4690 ha was irrigated by lift irrigation schemes and 6436 ha by other sources..

In the last four years there were about seventy suicide cases of farmers reported in the district. Out of these, there were about 16 suicide cases, which were reported to be related to crop failures (Table 1). With about 89% of the cropped area in the district dependant on rains, failure of monsoon during the last four years has caused crop failure in a large scale. The small farmers usually take loan at each time of sowing and could not repay the loan for last three to four years, because of the crop failures. Year wise data brings out the fact that, of the sixteen suicide deaths due to crop failures, during 2003-04 itself there were eleven cases reported in the district and remaining five cases have been reported during 2004-05. The year wise data also suggests that there were no cases of farmer's suicides reported during 2005-06 because of crop failure. There is a sudden increase in farmer's suicide incidences during the year 2006-07. But, the number of incidences due to crop failure is not yet known. Similarly 175 farmer's deaths were reported during the year 2010 in Shimoga district.

As the ground water development is still a low-key affair in the district, with proper development and management of ground water along with surface water, the distress situation of the farmers can be lessened to some extent during the drought periods.

Table 1. Taluk wise data on suicide of farmers

Sl; no	Taluks	2003-04			2004-05			2005-06			2007
		Total cases reported	Due to crop loss	Due to other reasons	Total cases reported	Due to Crop loss	Due to other reasons	Total cases reported	Due to Crop loss	Due to other reasons	Total cases reported
1	Thirthahalli	8	0	8	0	0	0	0	0	0	6
2	Sagar	3	2	1	1	0	1	1	0	1	4
3	Bhadravati	11	3	8	2	1	1	1	0	1	2
4	Shimoga	15	4	11	4	2	2	4	0	4	7
5	Shikaripura	5	0	5	0	0	0	1	0	1	4
6	Sorab	4	1	3	0	0	0	0	0	0	3
7	Hosanagar	4	1	3	5	2	3	1	0	1	4
	Total	**50**	**11**	**39**	**12**	**5**	**7**	**8**	**0**	**8**	**30**

*Source: Agricultural Commissioner, Govt. of Karnataka, Bangalore

1.7 Studies carried out by CGWB:

- Systematic Hydrogeological survey and Reappraisal Hydrogeological survey of all the taluks between 1987- 1999
- Industrial Pollution studies in Bhadravathi town
- Ground Water Exploration 1999-2004
- Report on Framer's distress district during 2006-07, detailed report with due recommendation was prepared with the coordination of district administration regarding the statistics on farmers suicide cases.

2.0 Rainfall and Climate

The area enjoys tropical climate throughout the year. Generally, the weather is hot and humid in the eastern part and very pleasant in the remaining parts of the area. The relative humidity ranges from 27 to 88%, the wind speed recorded is between 4 and 7km/hr. The evapo-transpiration is normally high in ghat section as compared to plain in the east. Summer prevails between March to early June, the wet months start from early June to September, October and November months experience scanty rain by N-E monsoon. The winter commences in mid-November and ends in the middle of February.

Taluk wise rainfall data for the last 10 years (2001-2010) suggest that average annual rain fall in the district varies between 874 mm at Bhadravati, which is located on eastern most part of district and 3341 mm at Hosanagar located on western part of the district. The taluk head quarters Sorab, which is the northern most taluk, has recorded an average annual rainfall of 1404.mm. The rainfall pattern suggests a steady decline in rainfall as we move from west to east. The mean annual rainfall for the period 2001-2010 in the Shimoga district is 1795 mm. The mean pre monsoon rainfall is 159 mm, mean South West monsoon rainfall is around 1460 mm and North East monsoon season is around 178 mm. Annual Normals rainfall of all the taluks are given in the Table 2.

Tabel-2: Seasonal & Annual Normal Rainfall for the period 2001-2010 Shimoga District

Sl No	Station	Pre-Monsoon	SW Monsoon	NE Monsoon	Annual
		Rainfall (mm)			
1	Bhadravathi	119	608	148	874
2	Hosanagar	264	2855	223	3341
3	Shimoga	159	722	186	1068
4	Shikaripur	148	647	168	963
5	Thirthalli	147	2619	195	2961
6	Sorab	115	1138	151	1404
7	Sagar	161	1632	159	1951
	Mean RF	159	1460	176	1795

Average Annual rainfall during 2011 is 2176mm in which 96 mm is received during premonsoon, 1878mm during South west monsoon and 201mm during North east monsoon (Table.3).

Table-3: Taluk wise annual rainfall received during 2011 in Shimoga district

Districts/ taluks	Jan	Feb	Mar	Apr	May	PRE	Jun	Jul	Aug	Sept	SWM	Oct	Nov	Dec	NEM	Annual
	Rainfall (mm)															
Shimoga	**0**	**0**	**3**	**50**	**32**	**84**	**409**	**518**	**389**	**328**	**1644**	**137**	**39**	**0**	**176**	**1904**
Bhadravathi	0	1	0	22	57	80	141	246	165	104	656	180	18	0	198	934
Hosanagara	0	0	13	44	60	117	834	1065	758	826	3483	106	45	0	151	3751
Sagara	0	0	2	99	7	108	426	586	425	303	1740	168	54	0	222	2070
Shikaripura	0	0	0	44	50	94	133	183	201	136	653	90	22	0	112	859
Shimoga	0	2	0	111	35	148	139	140	158	114	551	145	39	0	184	883
Soraba	0	0	4	0	2	6	285	456	289	246	1276	100	49	0	149	1431
Tirthahalli	0	0	0	27	10	37	902	948	730	566	3146	167	47	0	214	3397
Average RF						**96**					**1878**				**201**	**2176**

3.0 Geomorphology and Soil Types

3.1 Geomorphology

The district forms part of Western-ghat areas (Sahayadrihill ranges), which can be demarcated into two zones viz; the densely forested high hilly Malnad in the west and sparsely forested tablelands -semi-malnad in the east. The western region consists of valleys and hill ranges sloping west to east with a maximum altitude of 640 and 529m amsl. The Malnad region is characterized by mountains with heavy rainfall, covering Thirthahalli, Sagar, Sorab and Hosanagara taluks. The semi-malnad regions comprising Shimoga, Bhadravati and Shikaripur taluks lie in the eastern part having vast stretches of plain lands with low and rising hillocks with low vegetation. The famous ghats in the district are Agumbe ghat, Hullikal ghat and Kollur ghat, the peaks are Kodachadri-1343m, Agastya-parvata-848, Govardhanagiri-848m, Chandragutti-848m amsl in the central zone. The prominent hills in the eastern part of the area are Kovedurga-969m and Kabranagara-1031m amsl.

The district is covered under fifteen watersheds with the major rivers Tunga , Bhadra and Tunga-Bhadra draining the SSE part, ,Varada and Kumudavati with their tributaries drains the Northern part under major Krishna basin. The river Sharavathi originates near Kavaldurg in Thirthahalli taluk and forms cascades and fall into a deep gorge which is popularly called 'Jog falls / Gerusoppa falls' in the west flow river basin in four distinct flows of water which are termed as *Raja, Rani, Rover and Rocket*,. This is 11th highest waterfall in India with a total height of 253 mts. and ranks 313 in the list of highest waterfalls in the world

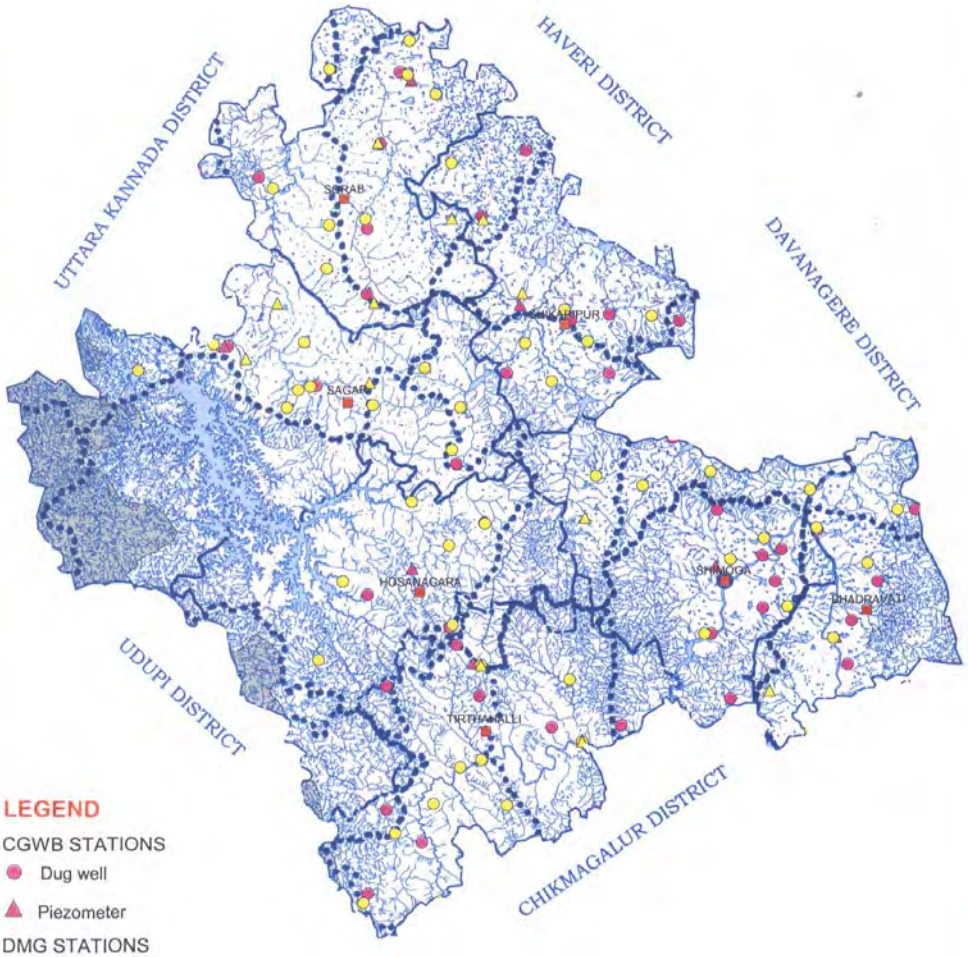
The above river systems form a dendritic to sub-dendritic pattern with a drainage density of 0.3 to 4 km/km$^{2.}$. The low drainage density and the ground slope indicate the flat terrain in Varada and Tunga sub-basins with a minimum surface runoff and moderate to good rate of water infiltration. In the rest of the area infiltration is low due to steep land, denser drainage pattern and maximum runoff. The drainage map of the district is presented as Figure 2.

3.2 Soil types

The soils that occur in the study area are reddish to brownish clayey loam to lateritic. These cover major parts of the area. Thin strips of yellowish loamy soil are seen along the banks of major river and nallah courses. In general these soils are acidic in nature**.** The thickness varies from few cms to 3.50m.The rate of water infiltration through these soils is recorded as 4.3 to 40.11cm/hr. The sandy soil is also identified in the areas where the Archaean gneissic complex occurs. It is coarse grained highly porous and permeable in nature. The thickness of this soil varies from few cms to 5.00 m. The rate of water infiltration in this soil is remarkably higher than the clayey loam. Red soil as noticed at the contacts of granites and schistose rocks, is medium grained, highly permeable and having neutral pH value. The thickness of the soil varies from less than one metre (<1m) to 9.00 m and is having an average rate of water infiltration capacity about 2.4 cm/hr. The mixed soil occurs in the areas where the schistose rock is predominant. It is of medium to fine-grained and permeable with higher moisture content. The thickness of this type of soil ranges from 0.5 m to 29 m and is having the water infiltration capacity of about 0.60 cm/hour.

Fig-2

DRAINAGE & HYDROGRAPH MONITORING STATIONS SHIMOGA DISTRICT, KARNATAKA



4.0 Ground Water Scenario

4.1 Hydrogeology

The study area comprises of rock formations belonging to Archaean to lower Proterozoic and Recent age. Numerous quartz and pegmatite veins occur as intrusives in the older schistose rocks (Amphibolites) and granitic-gneiss rocks. The Laterites occur over the schists and granitic-gneises with an approximate thickness of few centimeters to 40.00 m, which cover the major part in Sorab taluk and isolated patches in Thirthahalli and Hosanagara Taluks. The alluvium occurs along the riverbanks. Main aquifers in the study area are the weaker weathered and fractured zones of gneissic- granites and schists. It covers an estimated area of 672343.50 ha of the district. The gneissic-granitic complex does not posses the primary porosity. Secondary structures like joints, fissures and faults present in these formations act as a porous media. The ground water occurs under atmospheric influence in the phreatic zone, which generally occurs within the depth range of 13.00 to 30.00mbgl. The sustained yield of dugwells ranges from negligible to 30 m^3/day. The fracture zones that occur at various depth zones within the depth of 185.00 mbgl are expected to be saturated with ground water. It is found that the water bearing characteristics of schists are more or less similar to that of gneisses and granites. But the weathered zones of schists may not yield as granites, because of their compact and fine-grained nature.

Laterite overlying the schists and gneissic-granites in moderate thickness acts as an aquifer locally. Alluvium occurring along the riverbanks with a thickness of few cm to 3.00 meters, holds the bank storage. Ground water in these aquifer materials generally occurs under unconfined to semi-confined conditions. The ground water is being exploited from within the depth range of 13.00 to 30.00mbgl through dugwells and 30.00 to 200.00mbgl through dug-cum-bore wells and bore wells. The Hydrogeology map of the district is presented as Figure 3.

4.2 Depth to water levels

Out of 38 National Hydrograph Network Stations (NHNS) located in Shimoga district, the general depth to water levels in the national hydrograph stations (dug wells) recorded during May-2011 were in the range of 1.05 to17.37 mbgl. The pre-monsoon depth to water level map of the district for the year 2011 is presented as Figure 4. The general depth to water levels in the national hydrograph stations (dug wells) recorded during November–2011 were in the range of 0.45 to 13.56 mbgl. The post-monsoon depth to water level map of the district for the year 2011 is presented as Figure 5. The water levels in 4 piezometers national hydrograph stations range from 0.0.69 to 11.20 mbgl during May 2011 and 0.60 to 6.10 mbgl during November 2011.

4.3 Seasonal water level fluctuation

The seasonal water level fluctuation for the year 2011 available for dug well national hydrograph network stations was in the range of 0.08 – 7.78 mbgl. The seasonal water level fluctuation for the year 2011 available for four piezometer hydrograph network stations was in the range was between 0.09 to 5.10mbgl.

Fig-3

HYDROGEOLOGY
SHIMOGA DISTRICT
KARNATAKA

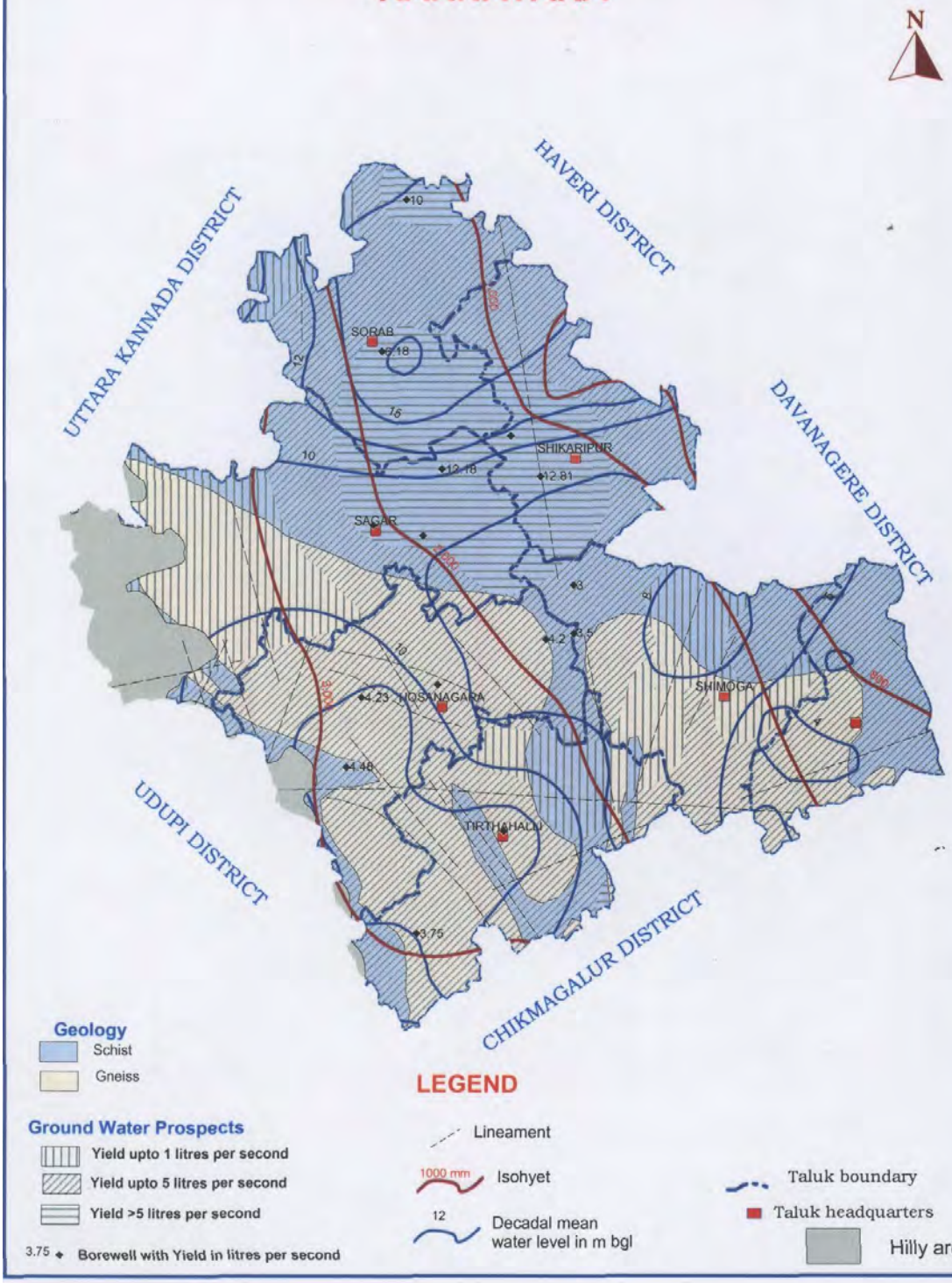


Fig 4

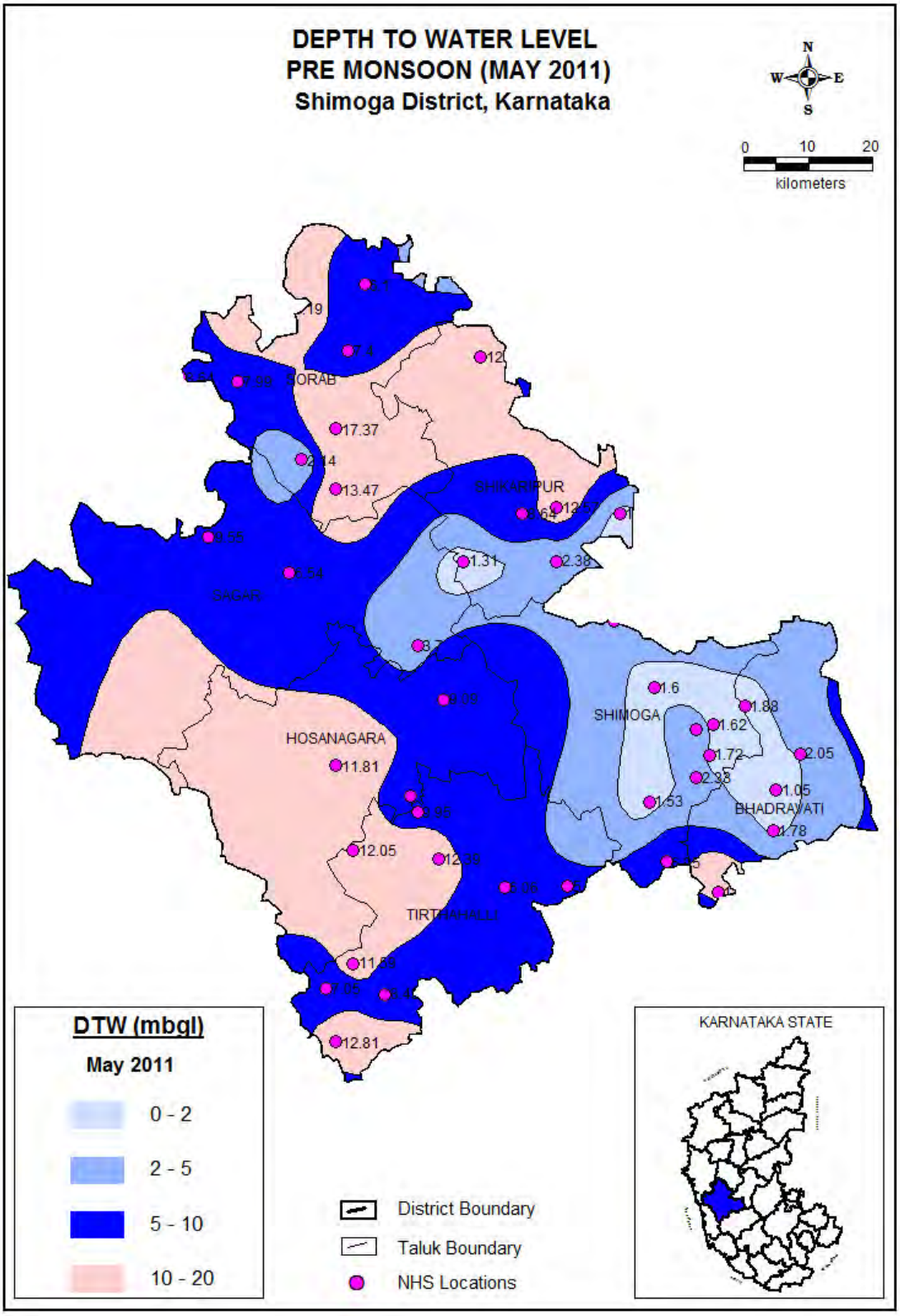

DEPTH TO WATER LEVEL
PRE MONSOON (MAY 2011)
Shimoga District, Karnataka
N
W
E
S
0 10 20
kilometers
SORAB
SHIKARIPUR
SAGAR
SHIMOGA
HOSANAGARA
BHADRAVATI
TIRTHAHALLI
17.37
13.47
11.81
12.05
12.81
1.31
2.36
1.6
1.88
1.62
1.72
2.05
2.33
1.05
1.53
1.78
DTW (mbgl)
May 2011
0 - 2
2 - 5
5 - 10
10 - 20
District Boundary
Taluk Boundary
NHS Locations
KARNATAKA STATE

Fig 5

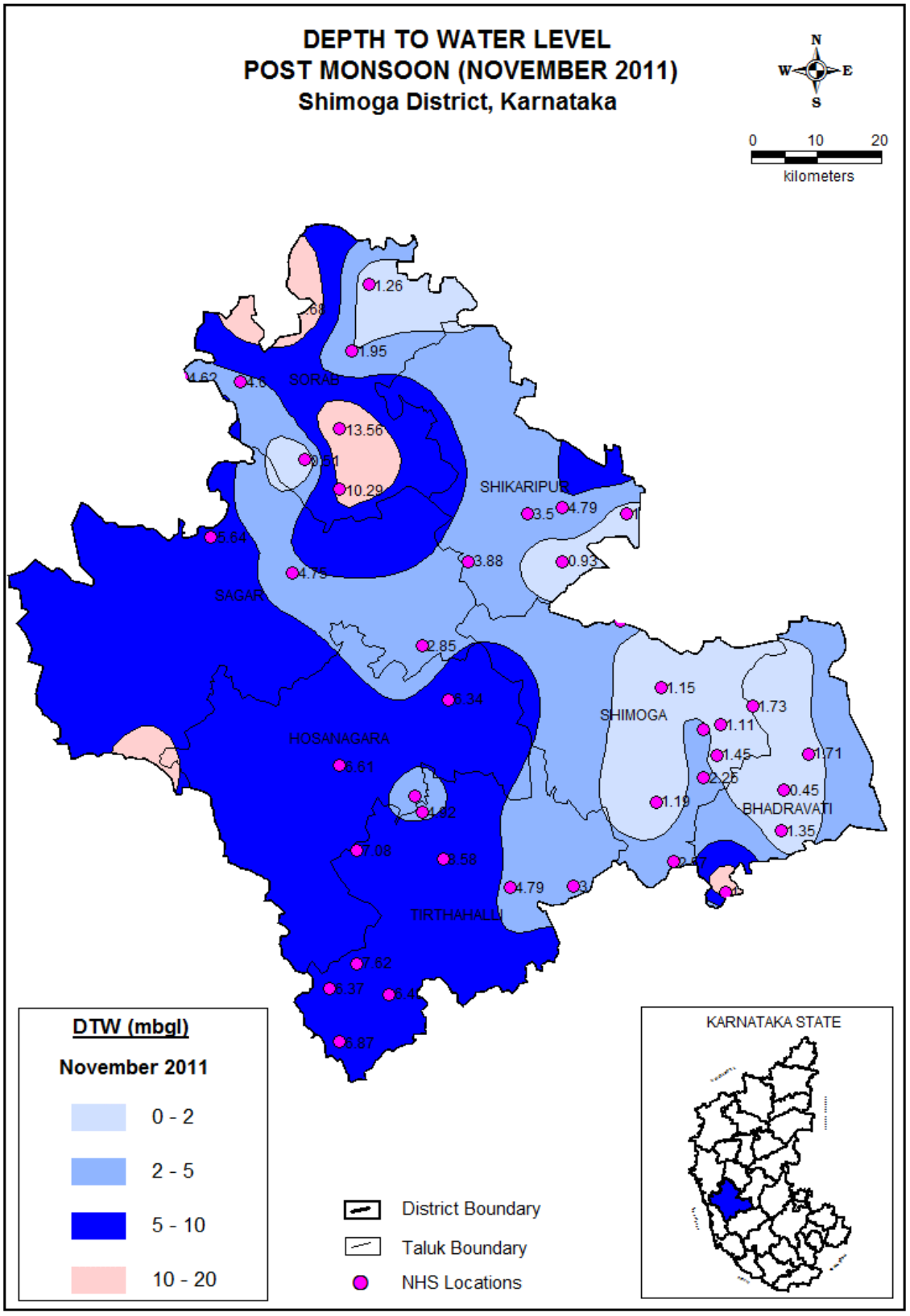
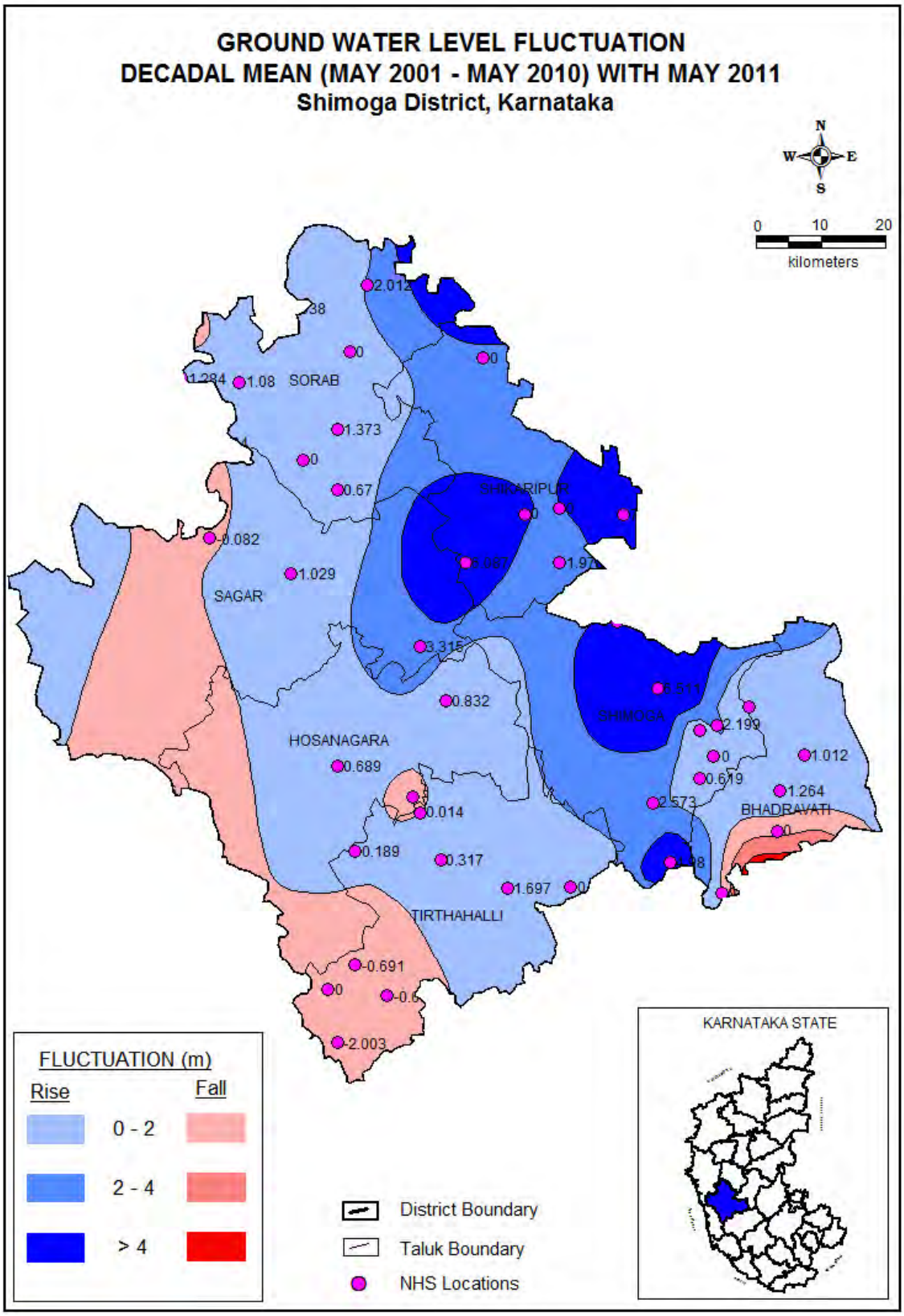

DEPTH TO WATER LEVEL
POST MONSOON (NOVEMBER 2011)
Shimoga District, Karnataka
N
W
E
S
0
10
20
kilometers
SORAB
SHIKARIPUR
SAGAR
HOSANAGARA
SHIMOGA
BHADRAVATI
TIRTHAHALLI
1.26
1.95
13.56
10.29
4.79
3.5
5.64
3.88
0.93
4.75
2.85
6.34
1.15
1.73
1.11
1.45
1.71
2.25
0.45
1.19
1.35
3.61
7.08
3.58
4.79
7.62
6.37
6.87
DTW (mbgl)
November 2011
0 - 2
2 - 5
5 - 10
10 - 20
District Boundary
Taluk Boundary
NHS Locations
KARNATAKA STATE

Fig-6


GROUND WATER LEVEL FLUCTUATION
DECADAL MEAN (MAY 2001 - MAY 2010) WITH MAY 2011
Shimoga District, Karnataka
N
W
E
S
0
10
20
kilometers
SORAB
SHIKARIPUR
SAGAR
SHIMOGA
HOSANAGARA
BHADRAVATI
TIRTHAHALLI
2.012
1.08
1.373
0.67
-0.082
1.029
3.315
0.832
6.511
2.199
1.012
0.619
1.264
2.573
0.689
0.014
0.189
0.317
1.697
-0.691
-2.003
FLUCTUATION (m)
Rise
Fall
0 - 2
2 - 4
> 4
District Boundary
Taluk Boundary
NHS Locations
KARNATAKA STATE

4.4 Long-term water level trends

The trend in water levels for pre monsoon as well as post monsoon period are quite significant. The rising trend in pre monsoon generally indicates the reduction of draft, due to increased dependence on surface water supply. While, a falling trend in pre monsoon indicates the reverse. The rising trend in post monsoon indicates effective watershed treatment or high incidence of rainfall, while the falling trend in post monsoon throw light on high level of urbanization by reducing the natural infiltration rates by way of concrete pavements, lined water channels, reduced areas of natural tanks and other water impounding structures etc.

Out of pre monsoon water level trend data available for 34 national hydrograph network stations for the period from 2001 to 2011, 29 NHS are having rising trends in the range between 0.004 and 1.332 m/year. 5 national hydrograph stations in parts of Hosanagara, Shimoga & Tirthahalli taluks for the period from 2001 to 2011 the water levels are having falling trends in the range between 0.003 and 0.0.216 m/year.(Figure-6).

Long term pre monsoon water level trend data available for 4 piezometers for the period from 2001 to 2011indicate rising trend in the range of 0.062-0.33m/year.

Out of post monsoon water level trend data available for the period from 2001 to 2011 for 38 national hydrograph network stations, 32 are having rising trends in the range between 0.009 and 0.965 m/year. In 6 national hydrograph stations in parts of Shikaripur, Sagar & Tirthahalli taluks the water levels are having falling trends in the range between 0.003 and 0.045 m/year(Figure-7). Long term trend of piezometers indicated falling trend in water level maximum in soraba followed by Sagara and Shimoga stations.

4.5 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 borewells at sites which were selected scientifically. Totally 49 wells were drilled in the district under this programme in the depth range of 71 to 200m.Casing depth ranges from 6-53mand d staic water level rnaged from 4.9-18.73m. D discharge of these wells ranged from negligible to 18.9 lps.. The aquifer zones are weathered/ fractured and jointed gneissic granites, schist, metabasalts and greywacke material and occurs at various depths between 15 to 185 mbgl. Location of these exploratory wells are shown in Figure-8.

Fig-7

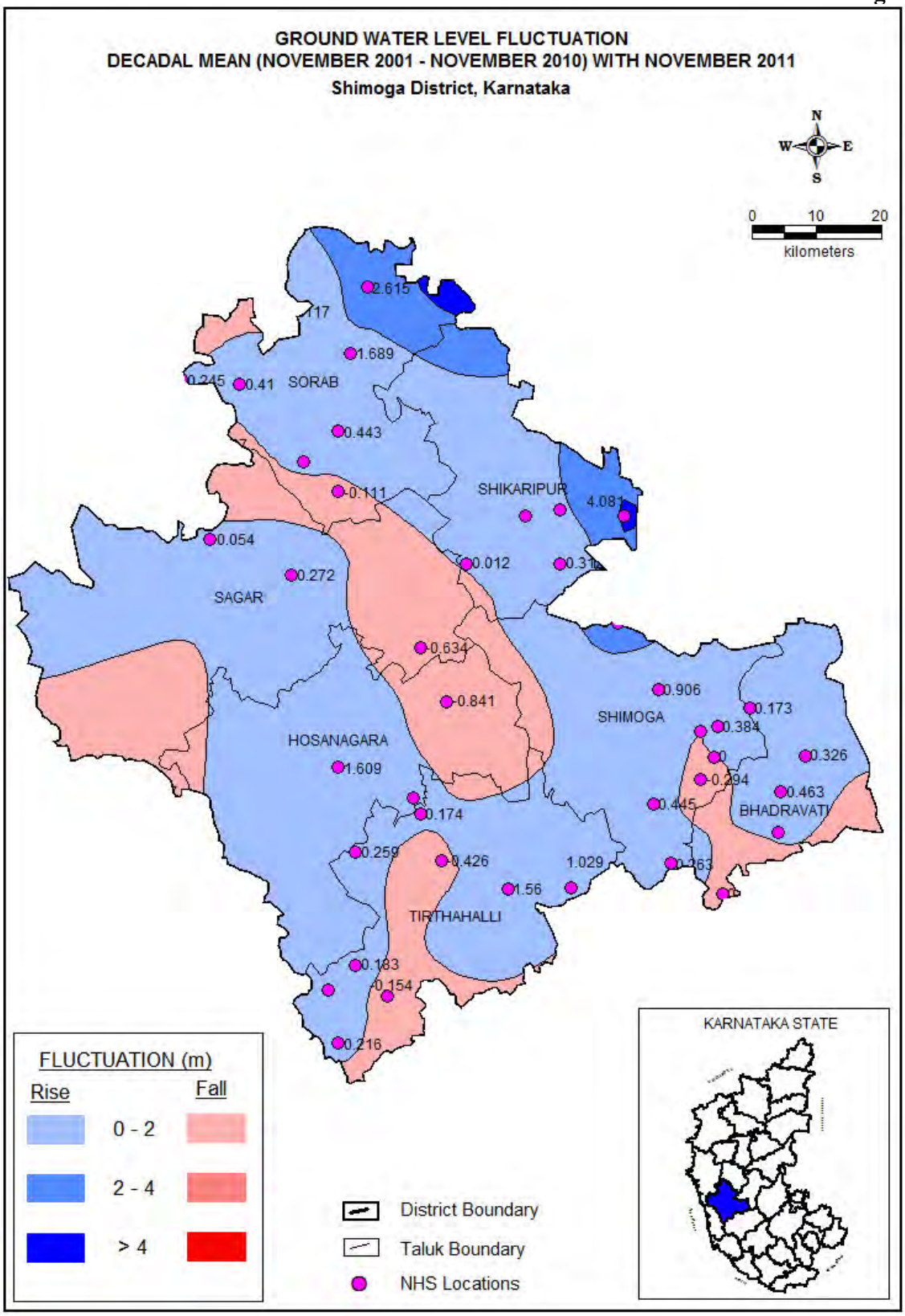
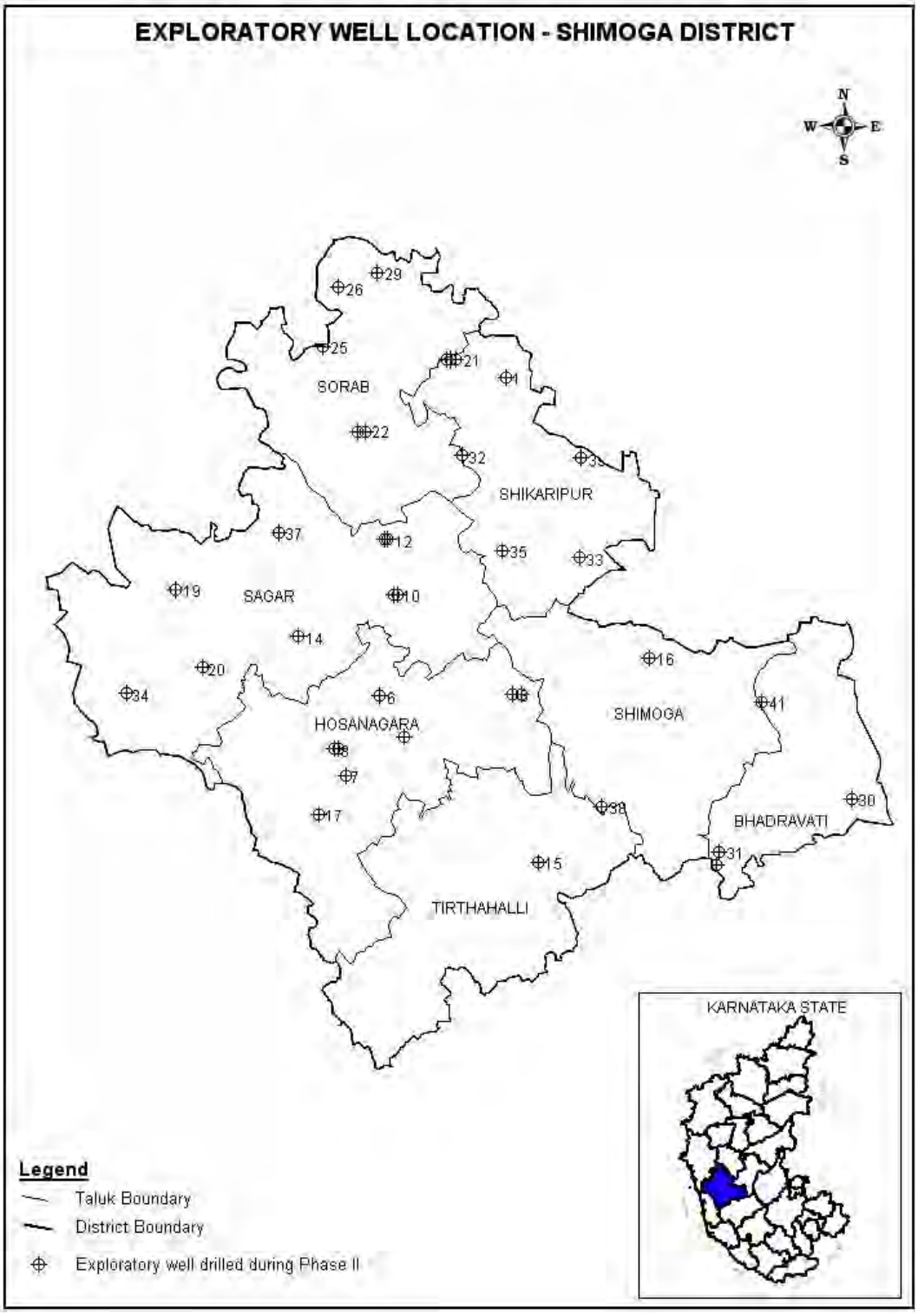

GROUND WATER LEVEL FLUCTUATION
DECADAL MEAN (NOVEMBER 2001 - NOVEMBER 2010) WITH NOVEMBER 2011
Shimoga District, Karnataka
N
W
E
S
0
10
20
kilometers
2.615
1.689
0.245
0.41
SORAB
0.443
0.111
SHIKARIPUR
4.087
0.054
0.272
SAGAR
0.012
0.634
0.841
0.906
0.173
SHIMOGA
0.384
0.326
0.294
0.463
BHADRAVATI
0.445
HOSANAGARA
1.609
0.174
0.259
0.426
1.029
1.56
TIRTHAHALLI
0.183
0.154
0.216
FLUCTUATION (m)
Rise
Fall
0 - 2
2 - 4
> 4
District Boundary
Taluk Boundary
NHS Locations
KARNATAKA STATE

Fig-8


EXPLORATORY WELL LOCATION - SHIMOGA DISTRICT
N
W
E
S
SORAB
SHIKARIPUR
SAGAR
HOSANAGARA
SHIMOGA
BHADRAVATI
TIRTHAHALLI
KARNATAKA STATE
Legend
Taluk Boundary
District Boundary
Exploratory well drilled during Phase II

The exploratory bore wells drilled in Sorab taluk are having depths ranging from 77.25 to 190.10 mbgl. The discharge ranges between 1 to 12 lps. The yield cum recuperation tests conducted on the wells show that the general specific capacity ranges from 10.92 to 96.31 lpm/m/d.d. The transmissivity of aquifer in general range from 16.8 to 58.00m^2/day.

The exploratory bore wells drilled in Sagar taluk are having depths ranging from 70 to 191 mbgl. The discharge ranges between negligible to 18 lps. The yield cum recuperation tests conducted on the wells show that the general specific capacity ranges from 1.29 to 46.01 lpm/m/d.d. The transmissivity of aquifer in general range from 0.56 to 34.18 m^2/day.

The exploratory bore wells drilled in Hosanagar taluk are having depths ranging from 126.90 to 200.10 mbgl. The discharge ranges between negligible to 4.36 lps. The yield cum recuperation tests conducted on the wells show that the general specific capacity ranges from 11.31 to 28.1 lpm/m/d.d. The transmissivity of aquifer in general range from 2.56 to 56.00m^2/day.

The exploratory bore wells drilled in Tirthahalli taluk are having depths ranging from 84.20 to 200.10 mbgl. The discharge ranges between negligible to 4.20 lps. The yield cum recuperation tests conducted on the wells show that the general specific capacity ranges from 3.40 to 12.57 lpm/m/d.d. The transmissivity of aquifer in general range from 1.34 to 8.31m^2/day.

The exploratory bore wells drilled in Shikaripur taluk are having depths ranging from 68.00 to 187.05 mbgl. The discharge ranges between 2.80 to 24 lps. The yield cum recuperation tests conducted on the wells show that the general specific capacity ranges from 7.44 to 298.47 lpm/m/d.d. The transmissivity of aquifer in general range from 5.28 to 207.20 m^2/day.

The exploratory bore wells drilled in Shimoga taluk are having depths ranging from 98.30 to 200.43 mbgl. The discharge ranges between negligible to 9.96 lps. The yield cum recuperation tests conducted on the wells show that the general specific capacity ranges from 29.12 to 59.62 lpm/m/d.d. The transmissivity of aquifer in general range from 21 to 29.44 m^2/day.

The exploratory bore wells drilled in Bhadravati taluk are having depths ranging from 148.25 to 170.65 mbgl. The discharge ranges between negligible to 3.18 lps. The yield cum recuperation tests conducted on the wells show that the general specific capacity ranges from 10.27 to 21.50 lpm/m/d.d. The transmissivity of aquifer in general range from 5.80 to 19.00m^2/day.

4.6 Ground water resources

The salient features of the taluk-wise dynamic ground water resources as on March 2009 is discussed below.

The net annual utilizable groundwater resources for the whole district, was computed as 92617 ham. The annual draft for domestic and industrial uses was 2904 ham and for irrigation purposes the draft computed was 25632 ham. Thus the total ground water

draft for the district is 28536 ham. Keeping allocation of 4110 ham of ground water for futuristic domestic and industrial purposes, balance ground water potential available for irrigation is 62944 ha.m.

Major part of the district is under safe category as per the stage of ground water development i.e.; The stage of ground water development ranges from 17% in Shimoga taluk to 59% in Sorab taluk. In sorab taluk, Long term trend of water levels in some areas of Sorab taluk have shown declining trend, which corroborates with the stage of development. Taluk wise Dynamic Ground water Resources as on March 2009 in Shimoga District is shown in Table-4. The map showing categorization based on ground water development in Shimoga district is presented as Figure 9.

Table-4: Taluk wise dynamic ground water resources as on March 2009

Taluk	Net annual ground water availability	Existing gross ground water draft for Irrigation	Existing gross ground water draft for Industrial & Domestic water supply	Existing gross ground water draft for all uses	Allocation for domestic and industrial use for next 25 years in	Net ground water availability for future irrigation development	Stage of ground water development	Taluk wise Categorisation of areas as on March 2009			
								Safe area	Semicritical area	Critical area	O.E. area
	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	%	(%)	(%)	(%)	(%)
Bhadravati	20484	3596	504	4100	1092	15810	20	100	-	-	-
Hosanagara	8437	1957	317	2274	390	6089	27	100	-	-	-
Sagar	8053	3077	315	3392	364	4642	42	60	-	-	40
Shikaripur	12189	4819	427	5246	535	6835	43	100	-	-	-
Shimoga	17921	2779	327	3106	510	14632	17	100	-	-	-
Sorab	12973	7123	562	7685	670	5206	59	60	-	-	40
Tirthahalli	12560	2281	452	2733	549	9730	22	100	-	-	-
Total	**92617**	**25632**	**2904**	**28536**	**4110**	**62944**					

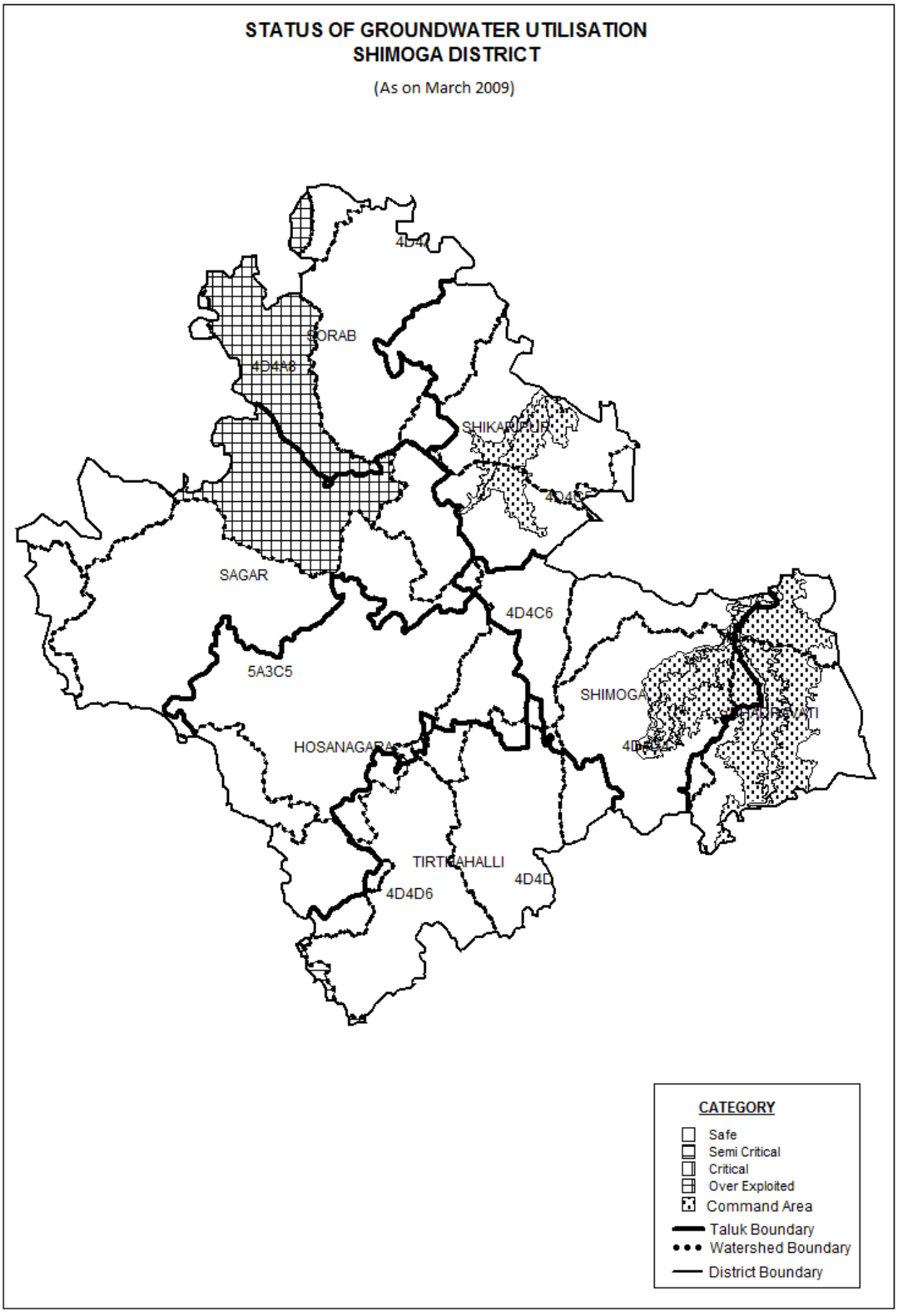
4.7 Ground water quality

The Electrical conductivity values in general ranges from 190-1740 micromhos/cm. Higher EC values are observed in Bhadravathi, Gajanur and Holehonnur area of Bhadravathi taluk and Nidige, and Bilingri parts of Shimoga taluk.district. pH value ranges from 7.4 to 9.6 and total hardness ranges from 60-430. Nitrate in ground water is generally in the range of 12-36 mgl. Flouride content is in the range of 0.02 to 0.2mgl i.e.,within the permissible limit .Chloride problem in the district (Chloride content more than 250 ppm) is observed in eastern parts of Sorab and Shikaripur taluk as well as some parts of Tungabhadra command area in Shimoga and Bhadravati taluks.

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
SHIMOGA DISTRICT
(As on March 2009)
4D4A
SORAB
4D4A6
SHIKARIPUR
4D4C
SAGAR
4D4C6
5A3C5
SHIMOGA
HOSANAGARA
TIRTHAHALLI
4D4D
4D4D6
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 .Shimoga district, Nitrate content in ground water exceeds the permissible limit of 45mgl going upto 60mgl in areas of Gajanur of Bhadravathi , Bilnigri of Shimoga district and also parts of Sagar and Sorab taluk . Areas of Shikaripur, Bhadravthi and Shimoga are prone for ground water contamination due to usage of pesticide and industrial wastes. (Figure-10)

4.8 Status of Ground Water Development

Owing to the hilly and undulating terrain condition, the uneven distribution of aquifers, the financial constraints of the marginal farmers and the non-availability of cultivable land, the ground water development is in low pace in the district.

The farmers with small acreage of land depend mainly on the rainwater and water available in the shallow wells. The abstraction structures, dug-wells and bore wells constructed/existing are mainly tapping the aquifers within depth range from 8.00 to 12.00mbgl and 150 to 200mbgl respectively. The taluk wise existing ground water abstraction structures and well density in the district is given in Table 5.

The major ground water developmental activities are concentrated in the valley regions, along the banks of rivers/streams and a moderate development found in the undulating land/plateau.

Fig-10

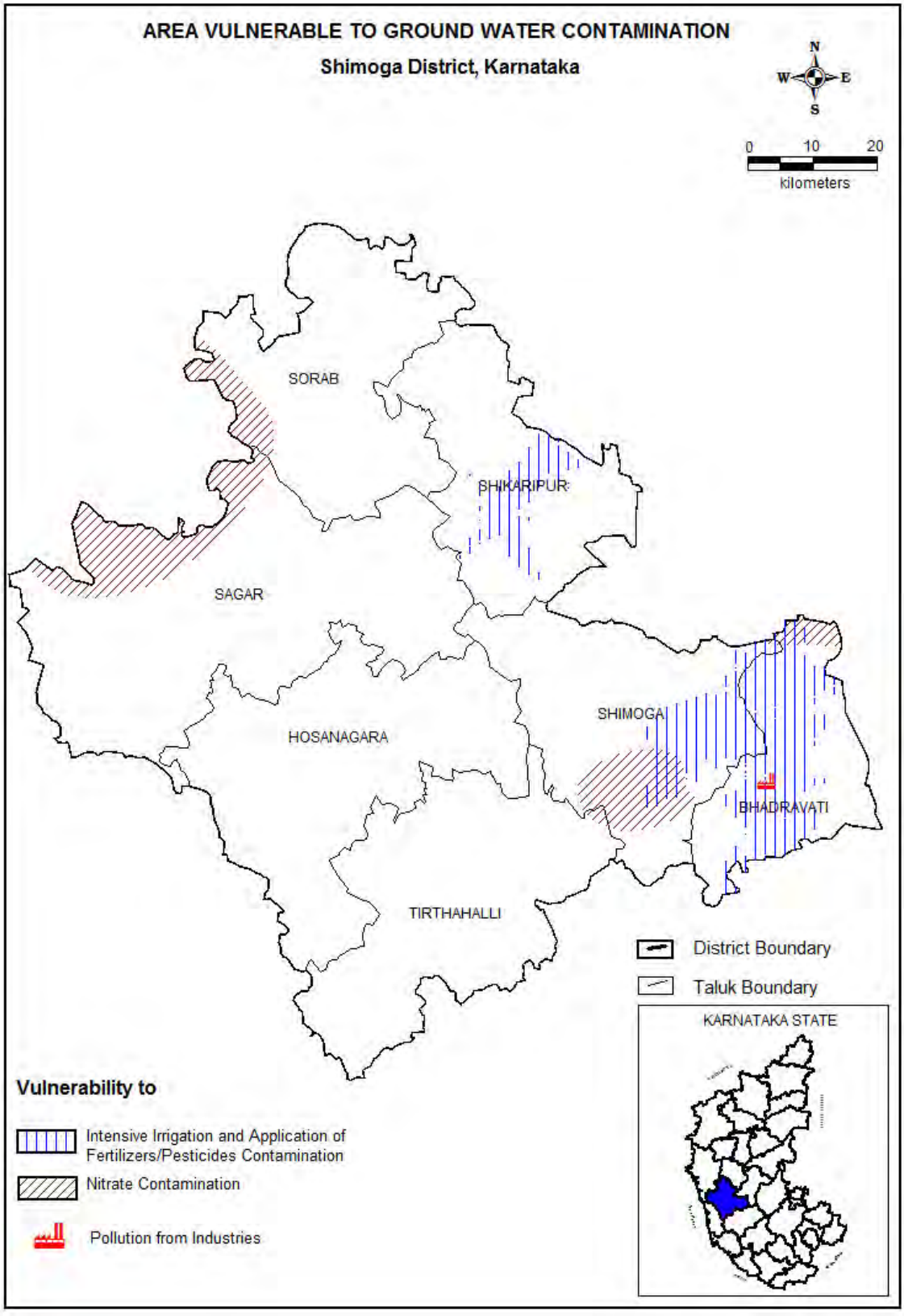

AREA VULNERABLE TO GROUND WATER CONTAMINATION
Shimoga District, Karnataka
N
W
E
S
0
10
20
kilometers
SORAB
SHIKARIPUR
SAGAR
SHIMOGA
HOSANAGARA
BHADRAVATI
TIRTHAHALLI
District Boundary
Taluk Boundary
KARNATAKA STATE
Vulnerability to
Intensive Irrigation and Application of Fertilizers/Pesticides Contamination
Nitrate Contamination
Pollution from Industries

Table- 5. The taluk wise existing ground water abstraction structures and Well density

Taluk	Category	Area in km^2	No of Dug wells	No of Bore wells	Well Density (No of bore wells per km^2)
Bhadravathi	C	248	263	806	3.25
	NC	442.1	186	1883	4.26
Hosanagara	NC	1422.79	1455	539	0.38
Sagar	NC	1939.55	1850	1094	0.56
Shikaripur	C	87.86	8	875	9.96
	NC	821.98	50	6516	7.93
Shimoga	C	125.14	32	211	1.69
	NC	988.44	231	3508	3.55
Sorab	NC	1147.67	406	3931	3.43
Thirthalli	NC	1253.77	1746	818	0.65
Total		**8477.3**	**6227**	**20181**	2.38

Source: Minor irrigation Census 2006-07, Govt.Of Karnataka)

As per the record for 2005-06 the domestic water requirement supplied through 825 numbers of Mini-water, 591 numbers of piped water supply schemes through borewells along with 6599 number of bore wells installed with hand pumps. The ground water is a major source for drinking purpose. Irrigation from ground water is through dug wells, dug-cum-bore wells and bore wells with 18.2% of the total irrigation in the district. The depth of dug wells ranges between 5 to 15 mbgl and depth of borewells range between 60 to 100 m. The sustained yield of the dug wells recorded from negligible to $30m^3$/day and yield of bore wells range between negligible to 19 lps.

5.0 Ground water management strategy

5.1 Ground water development

Further ground water development should be encouraged only in the areas, which are categorized as safe. In those areas, which are categorized as 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 irrigation 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

In view of the need to conserve and augment ground water resources, excepting the hilly areas in the western fringes of Sagar, Hosanagara and Tirthahalli taluks, major part of the district is suitable for adopting water harvesting structures like percolation tanks ,point recharge structures , check dams, Subsurface dykes .Recharging through existing dug/bore wells may be also practiced. In semi-urban areas in the district (Shimoga, Bhadravati, Shikaripur, Thirthahalli, Hosangar, Sagar, Sorab and Anavatti) rooftop rainwater harvesting practices may be encouraged. This will help in reducing the load on urban water supply systems.

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 Shimoga.district the unit area annual recharge is in the range of 0.025-0.10m in Sagar taluk, 0.10-0.15m in Sorab, Tirthahalli and Hosanagara taluks and 0.25-0.50m in Shimoga, Bhadravathi and Shikaripur taluk.. (Figure-11)

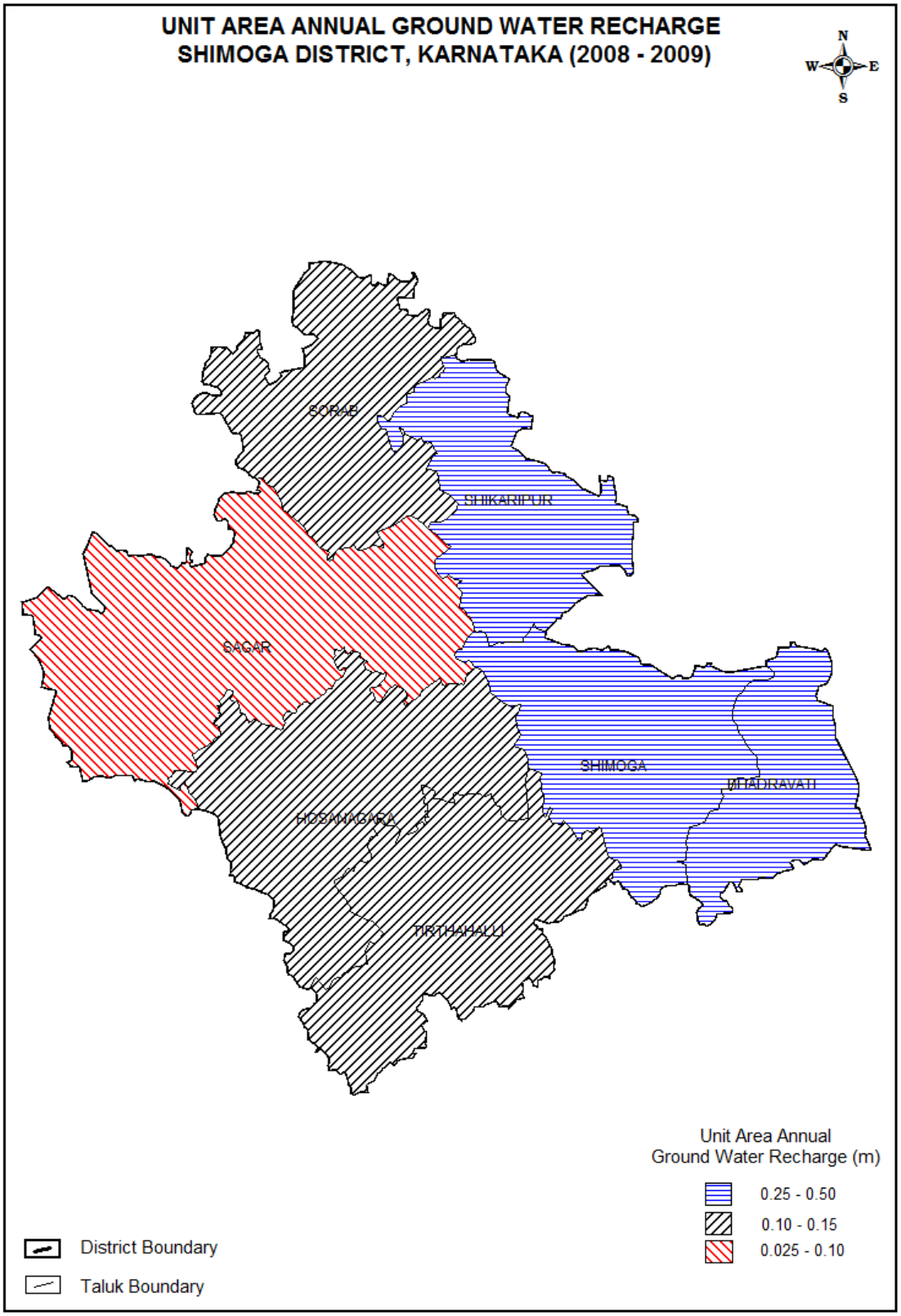
6.0 Awareness and Training Activity

Programmes on water conservation conducted by Central Ground Water Board, SWR in Shimoga district are given below.

1. On 14th and 15th of November 2005, a Training programme on rainwater harvesting and artificial recharge at Shimoga town and it was attended by fifty representatives from various state government agencies, N.G.O's, progressive farmers.

2. On 16th November 2005 a mass awareness programme was conducted at Sagar town on ground water conservation. 200 people belonging to different section of society had participated in the programme and benefited by film shows and lectures on the artificial recharge and rainwater harvesting subject. An inter-action session was arranged where the participants and the officers of the Board exchanged their ideas on the subject.

Fig-11


UNIT AREA ANNUAL GROUND WATER RECHARGE
SHIMOGA DISTRICT, KARNATAKA (2008 - 2009)
N
W
E
S
SORAB
SHIKARIPUR
SAGAR
SHIMOGA
BHADRAVATI
HOSANAGARA
THIRTHAHALLI
Unit Area Annual
Ground Water Recharge (m)
0.25 - 0.50
0.10 - 0.15
0.025 - 0.10
District Boundary
Taluk Boundary

3. One day National Seminar on "Sustainability of Ground Water Resources" was organized at Shakaraghatta, Shimoga, on 09.02.2011 in association with Department of Applied Geology, Kuvempu University, Shankaraghatta, Shimoga. 24 technical papers were presented by scientists of CGWB, DMG, Research institutes, Universities on various issues of groundwater, irrigation, crop management etc and deliberations were recorded as recommendations.
4. As a part of Mass media campaign for sensitizing the public at Village/Panchayat level CGWB associated with M/s RN Event Source Management Pvt.Ltd for propagating awareness on water conservation in the Shimoga district during July 2011.

7.0 Recommendations

Even though there is rising trend of ground water level and increase in net available annual ground water resources, the scenario of increased ground water draft and increase in area irrigated through borewells is a fore warning signal for sustainable management of ground water resources. Thus, considering the prevailing scenario of groundwater resources and development, the following recommendations are made for optimum drawl with sustainable development of resources in the area.

1. The dugwells, which penetrate partially the weathered, fractured zones of the aquifers, may be deepened further for better productivity.

2. Sinking of the filter points and collector wells with the maximum depth of 2-4 m in the alluvial stretches of riverbanks would be ideal ground water abstraction structures.

3. In the hard rock terrain, in the areas not covered under canal-command in Shimoga & Bhadravathi taluks sinking of suitable dug well and dug-cum-borewell / borewell with a maximum depth of 8 and 30 m is recommended respectively for the structures.

4. Considering the fresh water scarcity in some pockets of Sagar, Shikaripur and waterlogged areas of Shimoga & Bhadravathi taluks, a comprehensive programme should 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 lead to arrest the sub surface flows and augment the groundwater resources.

5. The ground water worthy areas such as topographic lows, valley portions, low fluctuation zones should be developed with adequate soil conservation measures to prevent the soil erosions during rainy seasons.

6. Constant monitoring of ground water quality should be carried out in the Tunga and Bhadra canal command areas to prevent the pollution and related problems. The determination of trace elements and organic compound may be done to help in categorizing the quality of water.

7. The 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.

8. The farming community in the valley and low lying regions should be encouraged with financial assistance and necessary technical guidance to sink appropriate abstraction structures, to install pump sets, to practice modern irrigation methods thereby to strengthen their economy.

9. 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 ensure availability of canal water to the tail end areas.