केंद्रीय भूमि जल बोर्ड
जल संसाधन, नदी विकास और गंगा संरक्षण
विभाग, जल शक्ति मंत्रालय
भारत सरकार
Central Ground Water Board
Department of Water Resources, River
Development and Ganga Rejuvenation,
Ministry of Jal Shakti
Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

SINDGI TALUK,

BIJAPUR DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर
South Western Region, Bengaluru

AQUIFER MANAGEMENT PLAN OF SINDGI TALUK, BIJAPUR DISTRICT, KARNATAKA STATE

CONTENTS

AQUIFER MANAGEMENT PLAN OF SINDGI TALUK, BIJAPUR DISTRICT, KARNATAKA STATE

1. SALIENT INFORMATION

Name of the taluk: Sindgi
District: Bijapur
State: Karnataka
Area: 2,664 sq.km.
Population: 3,95,675 (as per 2011 census)
Annual Normal Rainfall: 621mm

1.1 Aquifer management study area

Aquifer mapping studies were carried out in Sindgi taluk, Bijapur district of Karnataka, covering an area of 2,664 sq.km under National Aquifer Mapping Project. Sindgi taluk of Bijapur district is located between north latitude 16^{o}34'47.5" and 17^{o}11'06.7" & east longitude 75^{o}57'15.3" and 76^{o}28'12.8",and is covered in parts of Survey of India Toposheet Nos. 56C/4, 56C/8, 56D/1, 56D/5, 56D/2 and 56D/6. Sindgi taluk is bounded by Afzalpur taluk on north, Muddebihal and Basavana Bagewadi taluk on south, Indi and Bijapur taluks on west and Jewargi and Shorapur on eastern side. Location map of Sindgi taluk of Bijapur district is presented in **Fig.1.1.**

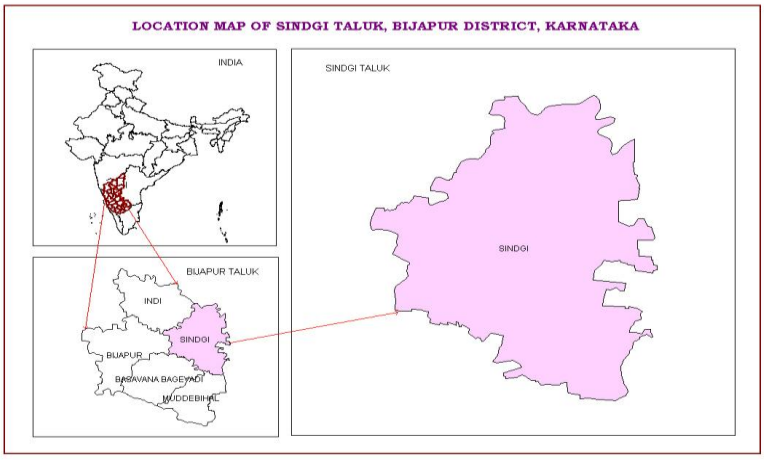

Fig.1.1: Location Map of Sindgi taluk, Bijapur district

Sindgi taluk is located in Bijapur District of Karnataka State. Taluk administration of Sindgi taluk is divided into 3 Hoblies and 40 Gram Panchayaths. There are 143 inhabited and 1 uninhabited villages in the taluk.

1.2 Population

According to 2011census, the population in Sindgi taluk is 3,95,675 of which rural population is 3,58,449 constituting about 91%, and the urban population is 37,226 constituting only about 9% of the total population. The taluk has an overall population density of 183 persons per sq.km.

1.3 Rainfall

Computations were carried out for the 30 year blocks of 1981- 2010 on Mean, Standard deviation and coefficient of variation of each month premonsoon, monsoon, post monsoon and annual and are shown in **Table 1.2**. Sindgi taluk enjoys semi-arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Northern Dry agro-climatic zone of Karnataka state and is categorized as drought prone.

The climate of the study area is quite agreeable and free from extremes. The year is usually divided into four seasons: summer from March to May; rainy season or south-west monsoon season from June to September, post-monsoon season covering the months of October and November and dry or winter Season from December to February.

There is one rain gauge station located in Sindgi taluk (**Table 1.1**). The data in respect of this station from the year 1981 to 2010 is analysed and presented in **Table 1.2**. The data pertaining to these gauges is of long term nature and are well maintained. It is presumed that they are representative of the taluks and the same is used for analysis. Normal annual rainfall in Sindgi taluk for the period 1981 to 2010 is 621 mm.

Table 1.1: Raingauge and its location in Sindgi taluk

Station	Latitude	Longitude	Altitude
Sindgi	16.92	75.97	651.2

Statistical analysis

The mean monthly rainfall at Sindgi taluk is ranging between 2 mm during February to 149mm during September. The CV percent for premonsoon, monsoon and post monsoon season is 79, 33 & 72 percent respectively. Annual CV at this station works out to be 27 percent.

Table 1.2: Statistical Analysis of Rainfall Data of Sindgi Taluk, Bijapur District for the Period 1981 to 2010

Station		Jan	Feb	Mar	Apr	May	Pre-Monsoon	Jun	Jul	Aug	Sep	South West Monsoon	Oct	Nov	Dec	North East Monsoon	Annual Rainfall
Sindgi	Normal Rainfall (mm)	4	2	7	11	34	58	105	89	108	149	451	88	18	6	112	621
	STDEV	11	6	15	18	37	43	85	69	74	77	150	74	31	15	80	167
	CV%	256	298	216	163	107	73	82	78	68	52	33	85	166	242	72	27

Assessment of Drought

Rainfall data of Sindgi taluk has been analysed for 93 years using IMD method to assess the drought condition in Sindgi taluk. The results of the classification are listed in the **Table 1.3**. It is observed that the Sindgi taluk has experienced alternating no drought to severe drought conditions over the years.

Table 1.3: Classification of drought and its periodicity (IMD, 1971)

% Deviation (Di)		>0	0 to -25	-25 to -50	50 to 75	<-75	Probability of drought occurrences
Category		No drought	Mild (Normal)	Moderate	Severe	Acute	
		Years					
Taluk	Sindgi	52	16	23	2	0	Once in **4** years

The details of the drought assessment are discussed as herein under. Out of 93 years of analysis in Sindgi taluk, "No Drought" condition is experienced in 52years, "Mild Drought" condition is experienced in 16 years and "Moderate Drought" condition experienced in 23 years. Further it is observed that "Severe Drought" condition is experienced in 2 years i.e., during 1965 and 2003 in Sindgi taluk. Based on occurrence and frequency of past drought events, the probability of occurrence of various intensities of drought at each station has been studied. It has been observed that the frequency of occurrence of drought is once in 4 years at Sindgi taluk.

1.4 Agriculture and Irrigation

Agriculture is the main occupation in Sindgi taluk. Pulses are the major crop grown in the taluk accounting for almost 42 percent of the total crop area, followed by Jowar (13%), Sugar cane (11%), Oil seeds (10%), Bajra and wheat (7%), Maize (6%), Cotton (3%), Vegetables (1%) and Fruits 1% of the total crop area respectively **(Table 1.4)**.

Table 1.4: Cropping pattern in Sindgi taluk 2013-2014 (Ha)

Year	Paddy	Jowar	Bajra	Maize	Ragi	Wheat	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
	Area under cultivation (in ha)											
2013 - 2014	31	30332	16239	13780	0	17785	102008	1786	1991	23121	27408	7263

It is observed that net sown area accounts for about 94% of total geographical area, while area sown more than once is 18% of total geographical area in the taluk **(Table 1.5).** As per the data available, the taluk uses 26416 dug wells and 25686 borewells for irrigation purpose. Ground water and canals are the source for irrigation in the taluk **(Table 1.6).** Landuse pattern of the taluk is represented as **Fig.1.2**.

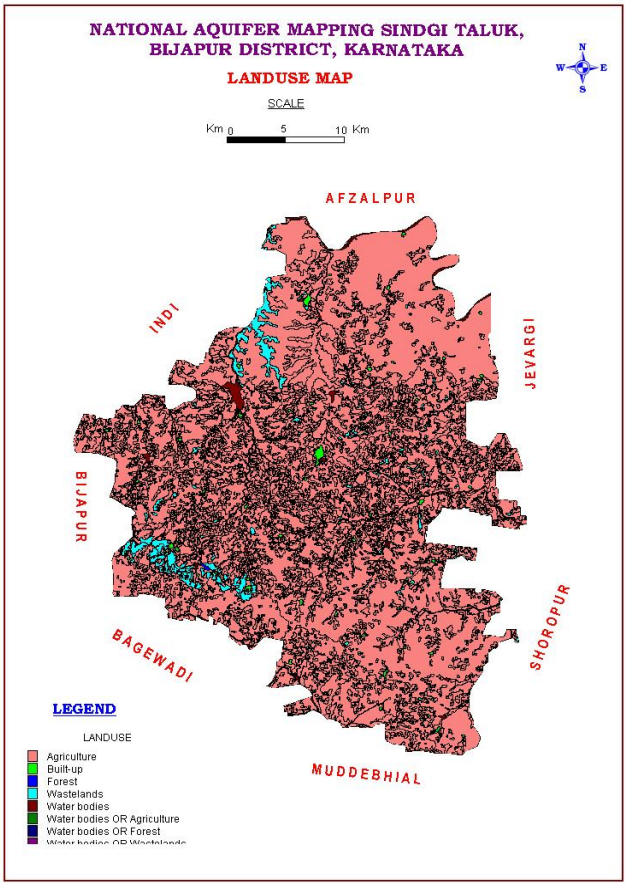

Fig.1.2: Landuse Map of Sindgi Taluk, Bijapur District

Table 1.5: Details of landuse in Sindgi taluk 2013-2014(Ha)

Taluk	Total Geographical Area (sq.km)	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Sindgi	2176.4	-	10051	1345	203915	39015

Source: District at a glance 2013-14, Govt. of Karnataka

Table 1.6: Irrigation details in Sindgi taluk (Ha)

Source of Irrigation	**Net area irrigated (Ha)**	**% of area**
Canals	49115	47.8
Tanks	236	0.3
Wells	26416	25.7
Bore wells	25686	25
Lift Irrigation	0	0
Other Sources	1208	1.2
Total	**102661**	

Source: District at a Glance 2013-14, Government of Karnataka

1.5 Geomorphology, Physiography and Drainage

The entire taluk is categorised as Deccan Pediplain **(Fig. 1.3).** Physiographically, it can be divided into four physiographic units' viz., residual hills, pediments, pediplains and valleys. The ground altitude varies from 470 to 650 m above MSL. The ground surface is flat, gently sloping forming broad valleys and flat-topped hills. Flat topped hills with step like sides exhibit the terraced landscape. The northern belt is a succession of low rolling uplands devoid of vegetation. The taluk is drained by Krishna river basin **(Fig. 1.4).**

1.6 Soil

The taluk is occupied by two types of soils viz. Clayey and loamy soils. Formation of various types of soils is a complex function of chemical weathering of bedrocks, vegetative decay and circulation of precipitated water. Soils are mostly insitu in nature **(Fig.1.5).**

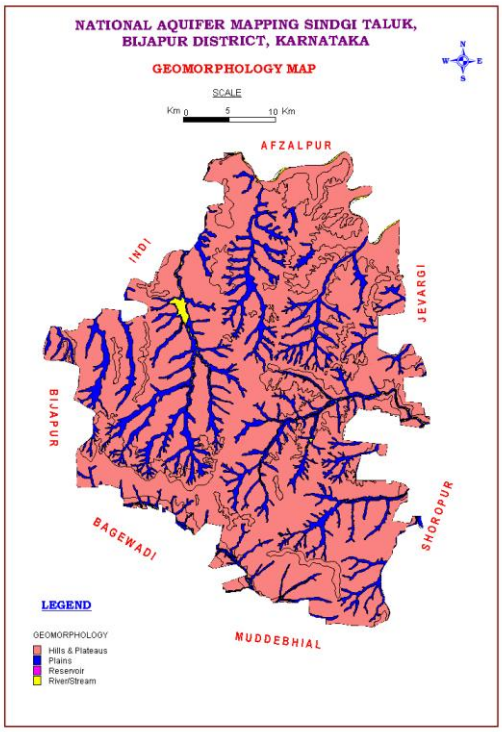

Fig.1.3: Geomorphology Map

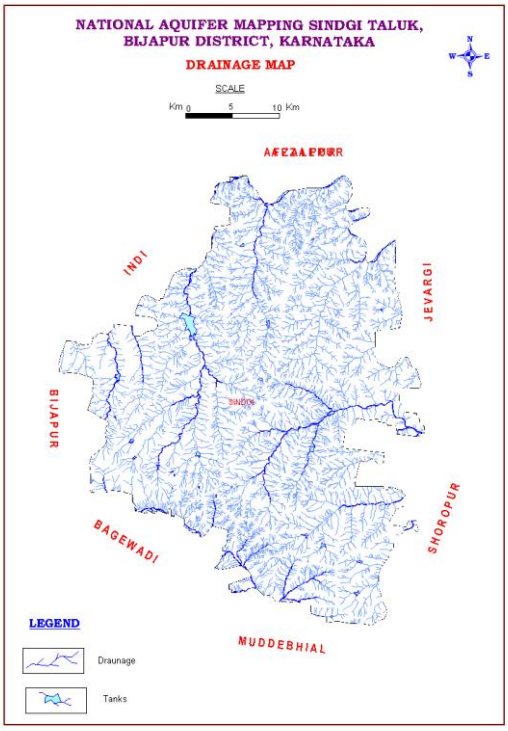

Fig.1.4: Drainage Map

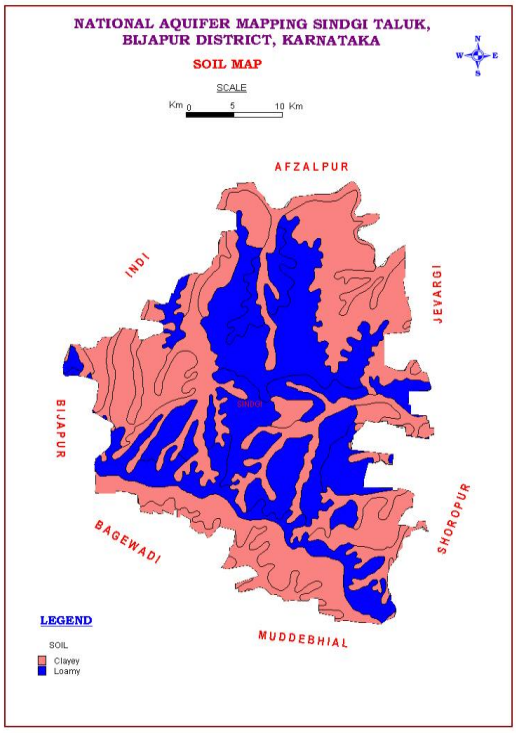

Fig.1.5: Soil Map

1.7 Ground water resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth are given in **Table 1.7** below.

Table 1.7: Total GW Resources (2013) (Ham)

Taluk	Annual Replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (down to 200 m)	Dynamic + Phreatic in-storage + fractured
Sindgi	12333	13690	5498	31521

1.8 Existing and future water demands (as per GEC-2013)

Net ground water availability for future irrigation development: 4666 ham

Domestic and Industrial sector demand for next 25 years: 1957 ham

1.9 Water level behaviour

(a) Depth to water level

Aquifer-I

Pre-monsoon: 2.34 – 12.48 mbgl **(Fig.1.6)**

Post-monsoon: 1.72 – 6.08 mbgl **(Fig.1.7)**

Aquifer-II

Pre-monsoon: 7.1–25.5 mbgl **(Fig.1.8)**

Post-monsoon: 2.8–23.00 mbgl **(Fig. 1.9)**

(b) Water level fluctuation

Aquifer-I

Seasonal Fluctuation: Rise in the range of 0.25 m to 7.80 m and fall of 2.28 m for one well. **(Fig. 1.10)**

Aquifer-II

Seasonal Fluctuation: Fall in the range of 2.3–9.6 m **(Fig. 1.11)**

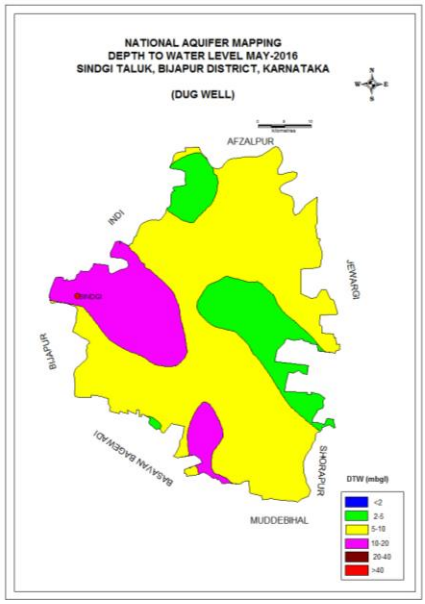

Fig.1.6: Depth to Water Level, Pre-Monsoon (DW)

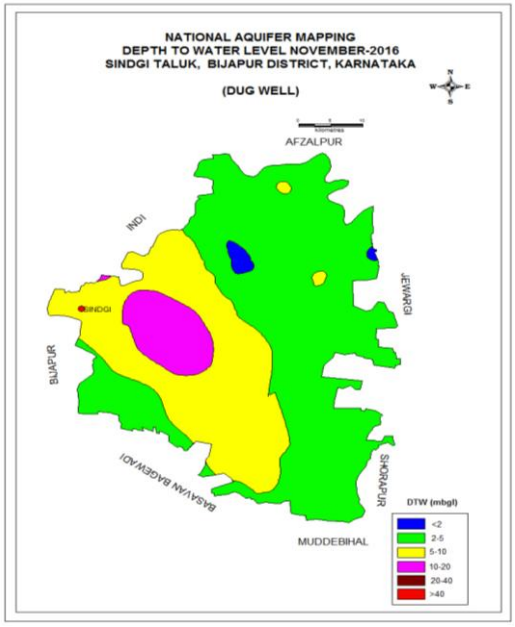

Fig.1.7: Depth to Water Level, Post-Monsoon (DW)

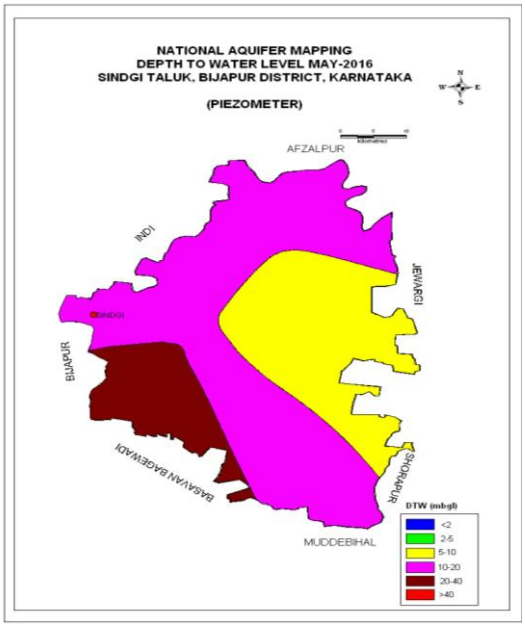

Fig.1.8: Depth to Water Level, Pre-Monsoon (PZ)

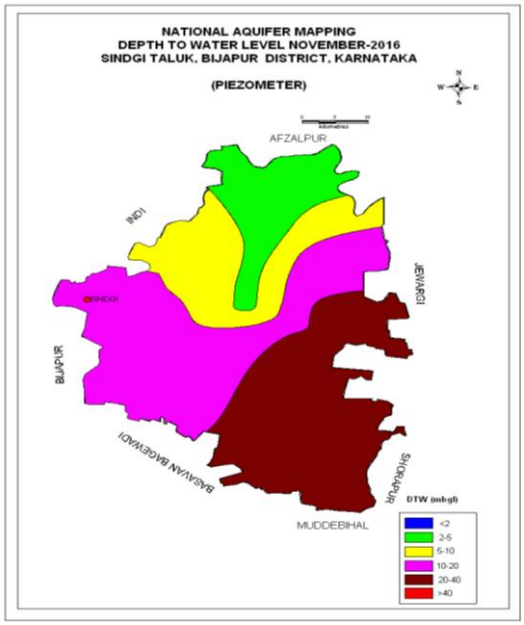

Fig.1.9: Depth to Water Level, Post-Monsoon (PZ)

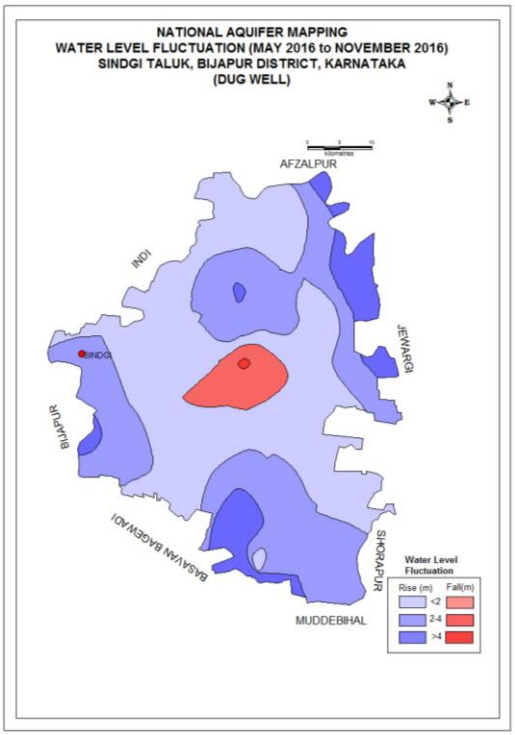

Fig.1. 10: Water Level Fluctuation, Pre-Post 2016 (DW)

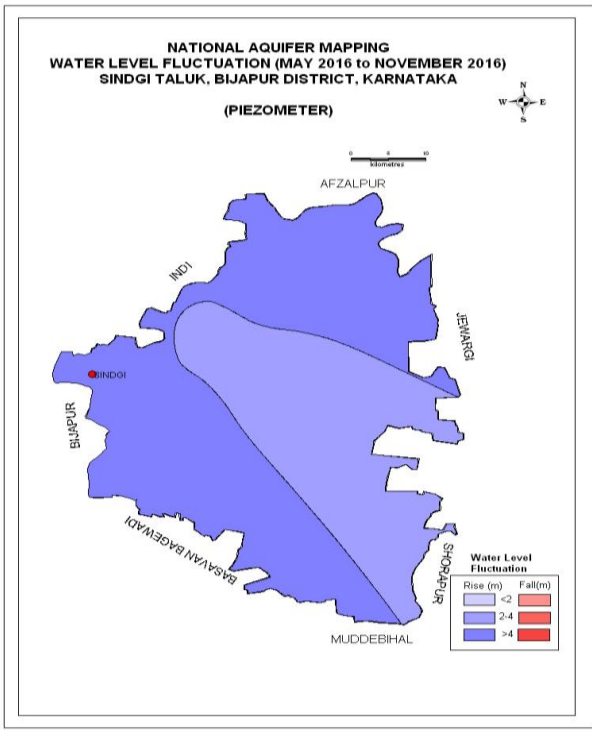

Fig.1. 11: Water Level Fluctuation, Pre-Post 2016 (PZ)

2. AQUIFER DISPOSITION

2.1 Number of aquifers: In Sindgi taluk, there are mainly two types of aquifer systems;

i. **Aquifer-I (Phreatic aquifer)** comprising Weathered Basalt
ii **Aquifer-II (Fractured aquifer)** comprising Fractured Basalt

In Sindgi taluk, fractured basalt is the major water bearing formation. A small portion is covered with limestone **(Fig.2.1)**. Groundwater occurs within the jointed and fractured basalt under semi-confined to confined conditions. In Sindgi taluk borewells were drilled from a minimum depth of 70.65 mbgl to a maximum of 95.05mbgl **(Table 2.1)**. Depth of weathered zone (Aquifer-I) ranges from 2.1 to 7 mbgl. However, isolated patches in topographical lows are seen yielding seasonally, that too for very short durations. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depth of 70 to 100m bgl. Yield ranges from 0.15to 5.4 lps.

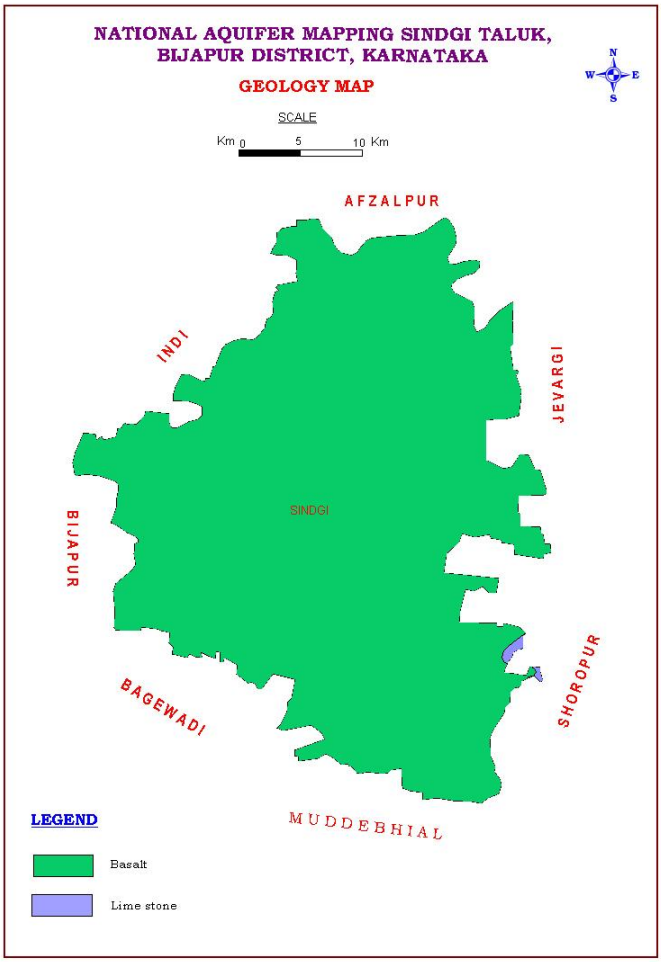

Fig. 2.1: Geology Map

Table 2.1: Details of Ground water Exploration

Sl. No.	Location	Latitude	Longitude	Depth Drilled (m bgl)	Casing Depth (m bgl)	Fracture Zones (mbgl)	SWL (mbgl)	Q (lps)	DD (m)
1.	Almel	17°05'30"	76°13'11"	70.65		11.65,22.85, 36.05,57.35	4.85	5.4	3.05
2.	Kannoli	16°51'15"	76°08'50"	92.05	7.0	9.5,44.25,77.35,92.05	5.421	0.95	
3.	Mulsavalgi	16°53'15"	76°01'30"	80.0		15.5,24.0,49.0, 56.0	6.425	0.68	13.45
4.	Rampur	16°57'35"	76°13'30"	95.05	2.1	41.56,95.05	16.036	0.95	4.11
5.	Vandal	16°44'40"	76°21'45"	82.0		16,17,48,72	7.35	0.52	12.96
6.	Yankanchi	16°52'05"	76°21'30"	92.0		12,45,73,92	27.12	1.75	6.926
7.	Yargolkhur	16°57'30"	76°19'00"	80.0		16,42,43,58, 60	9.293	0.15	20.596

2.2. 3 D Aquifer Disposition and Cross-sections.

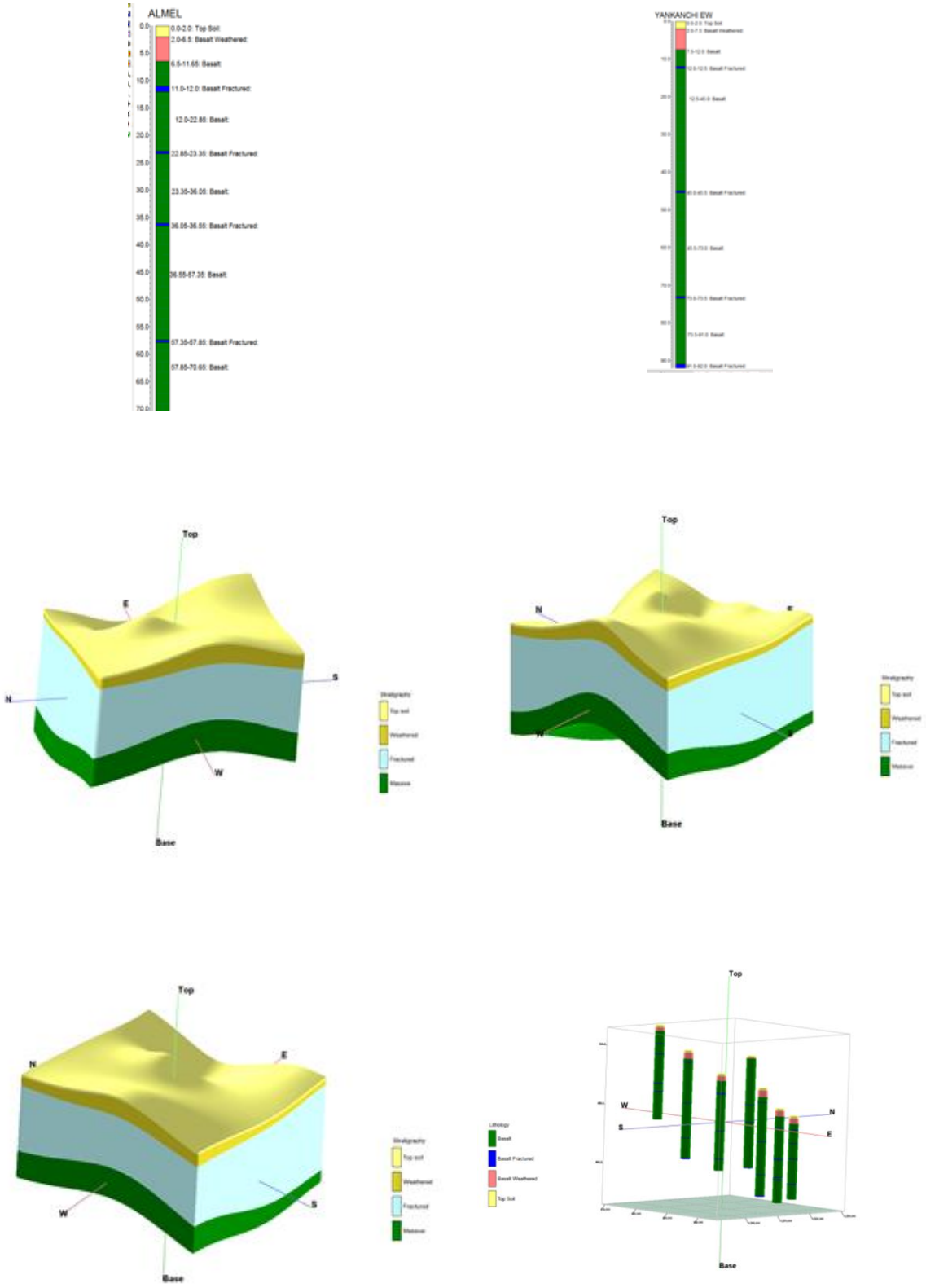

Fig 2.2: Aquifer Disposition and Cross-sections

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

3.1 Aquifer wise resource availability and extraction

(a) Present Dynamic Ground Water Resource (2013)

Taluk	Command/Non Command	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	Category
		HAM	HAM	HAM	HAM	HAM	HAM	%	
Sindgi	Command	3975	850	196	1046	462	2663	26	Safe
	Non Command	7338	5385	442	5827	1494	2003	79	Semicritical
		11313	6235	638	6873	1957	4666	61	Safe

(b)Present total Ground Water Resource (in ham)

Taluk	Annual Replenishable GW Resources	Fresh In-storage GW Resources		Total availability of GW Resource
		Phreatic	Fractured	Dynamic+phreatic in-storage+ fractured in-storage
Sindgi	12333	13690	5498	31521

(c) Comparison of Ground Water Availability and Draft Scenario in Sindgi taluk

Taluk	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development
	2009			**2011**			**2013**		
Sindgi	12772	10750	45	11841	7239	80	11314	6873	61

3.2 Chemical Quality of Ground Water and Contamination

Ground Water Quality (May 2014)

The water samples collected from shallow aquifers of GWMS were collected during pre-monsoon and analysed in the Regional Chemical Laboratory for pH, Electrical Conductivity (EC), Chloride, Nitrate and Fluoride by employing Standard methods. Based on the hydro chemical data, the portability of these samples has been assessed as per the Standards prescribed by the Bureau of Indian Standards (IS 10500: 2012) and categorized into 'Desirable', 'Permissible' and 'Unsuitable' classes.

The electrical conductivity in water samples is an indication of total dissolved ions. Thus the higher the EC, the higher the levels of dissolved ions in the sample. The perusal of the data indicates that the distribution of electrical conductivity in the taluk shows wide variations (590-3170 μS/cm at 25˚ C). The BIS has recommended a drinking water standard for total dissolved solids a limit of 500mg/l (corresponding to about EC of 750 μS/cm at 25^0C) can be extended to a TDS of 2000mg/l (corresponding to about 3000 μS/cm at 25^0C) in case of an alternate source. Water samples having TDS more than 2000mg/l are not suitable for drinking purpose **(Fig.3.1).**

One of the essential elements for maintaining normal development of healthy teeth and bones is Fluoride. Lower concentrations of fluoride usually below 0.6mg/l may contribute to dental caries. However, continuing consumption of higher concentrations, above 1.2mg/l however cause dental fluorosis and in extreme cases even skeletal fluorosis. Most of the fluoride found in groundwater is of geogenic origin. Distribution of fluoride in the taluk ranges from 0.5 mg/l to 3.05 mg/l. Thus majority of samples in the taluk shows fluoride concentration beyond 1.5 mg/l rendering them unsuitable for drinking purpose **(Fig.3.2).**

Nitrate is a problem as a contaminant in drinking water (primarily from groundwater and wells) due to its harmful biological effects. High concentrations can cause methemoglobinemia, and have been cited as a risk factor in developing gastric, an intestinal cancer. The distribution of nitrate in the State indicated that the values are in the range of 6.8 mg/l to 210 mg/l. Nitrate in drinking water should not exceed 45 mg/l as per BIS (ISO: 10500: 2012) standard **(Fig.3.3).**

Thus majority of the samples collected from the taluk indicates that the ground water is not suitable for drinking purpose.

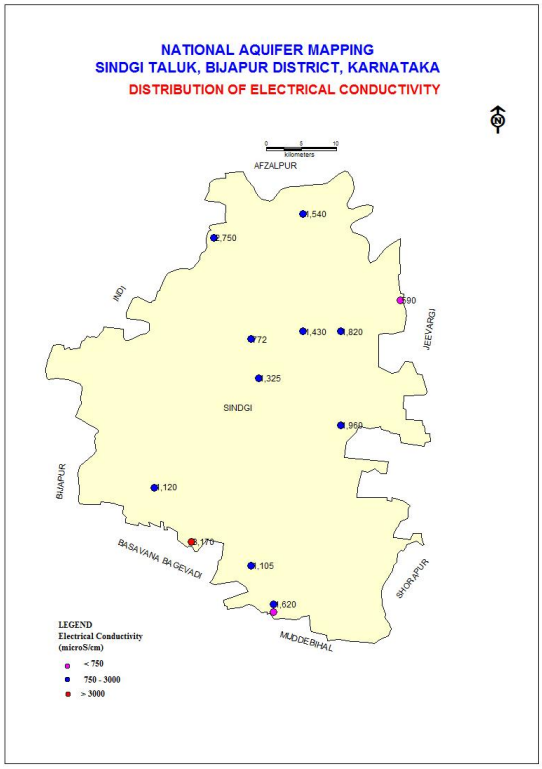

Fig.3.1: Distribution of EC

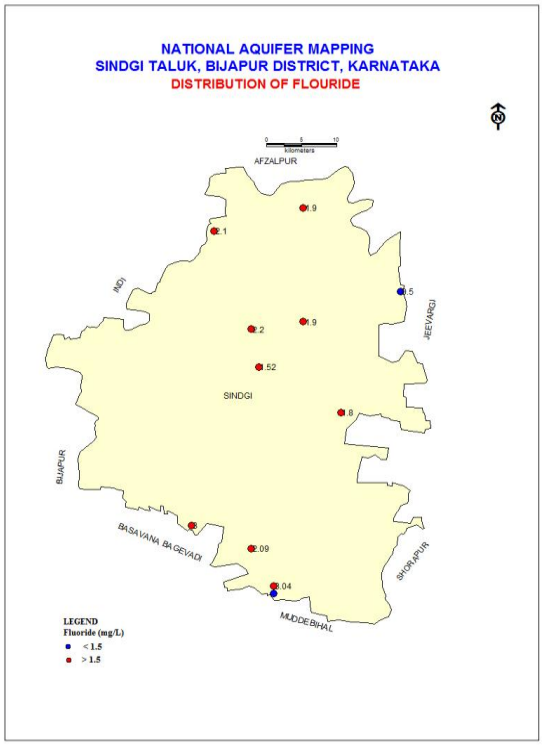

Fig.3.2: Distribution of Fluoride

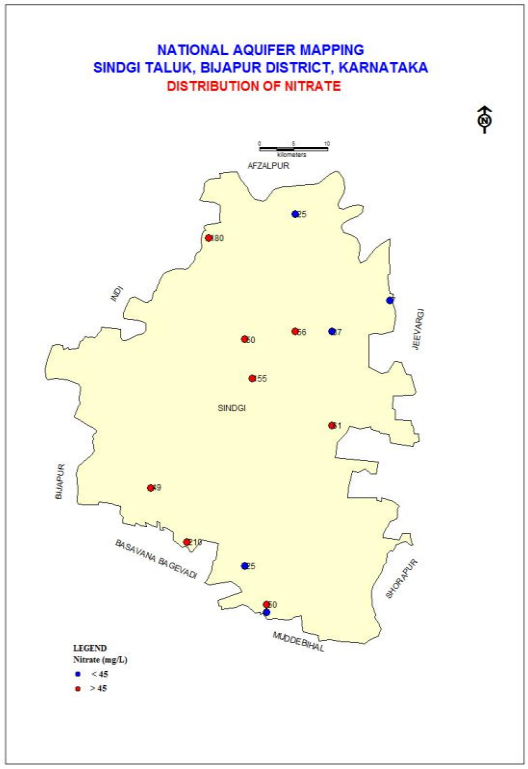

Fig.3.3: Distribution of Nitrate

4. GROUND WATER RESOURCE ENHANCEMENT

4.1 Aquifer wise space available for recharge and proposed interventions

Recharge phreatic aquifer (Aq-I) in the taluk, through construction of artificial recharge structures, viz. checkdams, percolation tanks & point recharge structures **(Table 4.1).** The choice of recharge structures should be site specific and such structures needs to be constructed in areas already identified as feasible for artificial recharge.

Table 4.1: Quantity of non-committed surface runoff and expected recharge through AR structures

Artificial Recharge Structures Proposed	Sindgi Taluk
Non committed monsoon runoff available (Ham)	4214
Number of Check Dams	260
Number of Percolation Tanks	18
Number of Point Recharge structures	28
Tentative total cost of the project (Rs. in lakhs)	968.00
Excepted recharge (MCM)	24
Expected rise in water level (m)	0.872
Cost Benefit Ratio (Rupees /cu.m. of water harvested)	4.26

4.2 Improvement in GW availability due to Recharge, Sindgi taluk

Table 4.2: Improvement in GW availability due to Recharge, Sindgi taluk

Taluk	Net annual ground water availability	Existing gross ground water draft for all uses	Existing stage of ground water development	Expected recharge from proposed artificial recharge structures	Additional potential from proposed irrigation development schemes through inter-basin transfer	Cumulative annual ground water availability	Expected improvement in stage of ground water development after the implementation of the project	Expected improvement in overall stage of ground water development
	HAM		%	HAM			%	
Sindgi	11314	6873	61	2400	-	13714	11	50

After implementation of Artificial Recharge structures for GW recharge, the annual ground water availability will increase from 11314 to 13714 ham and the expected improvement in stage of development is 11% from 61% to 50%.

5. DEMAND SIDE INTERVENTIONS

5.1 Advanced irrigation practices

It is observed that presently, in the command areas canals are the source of irrigation and in non-command areas ground water through dug wells and borewells is used for irrigation purpose in the taluk. Water use efficiency measures have to be adopted for saving the ground water resources.

Efficient irrigation practices like Drip irrigation and sprinkler has to be adopted by the farmers in the existing 54074 ha of gross irrigated area. Presently, draft through irrigation is 6235 ham. Implementation of efficient irrigation techniques will contribute in saving ground water by 1616 ham and thus, will improve stage of development by 5% from 50% to 45% **(Table 5.1).**

5.2 Change in cropping pattern

In Sindgi taluk the water intensive crops grown are paddy and sugarcane. Paddy is grown in small area of 31 hectare which is basically for self-consumption, and hence, it may not be possible to change it. Sugarcane is grown in 27408 hectares which can be reduced by using less water require crops.

Table 5.1: Improvement in GW availability due to saving by adopting water use efficiency

Taluk	Cumulative annual ground water availability	Existing gross ground water draft for all uses	Stage of ground water development after implementing AR structures & Surface	Saving due to adopting WUE measures	Cumulative annual ground water availability	Expected improvement in stage of ground water development after the	Expected improvement in overall stage of ground water
	Ham	Ham	%	Ham	Ham	%	%
Sindgi	13714	6873	50	1616	15330	45	16

5.3 Additional area of irrigation

After adopting various water use efficiency techniques and recharge measures and its resultant savings, the stage of development is expected to be 45% in the taluk, the non-command area which is in semicritical category can bring to safe category. In command area irrigation has to depend on canals only and can retain it on safe category. Hence bringing additional area under irrigation may not be practical with a long-term resource management point of view.

5.4 Regulation and Control

In the Sindgi taluk, the command area is coming under Safe category as the stage of development is 26% and for non-command area the stage of development is 79% which is falling under Semicritical category. The overall stage of development in the taluk is 61% and the taluk is falls under Safe category. Even if the taluk is falling under Safe category, Karnataka Ground Water Authority has to take necessary action for controlling the over exploitation of ground water in the taluk.

Ground water recharge component needs to be made mandatory in the taluk to save the situation from deteriorating further.

5.5 Other interventions proposed:

Periodical maintenance of artificial recharge structures should also be in corporated in the Recharge Plan.

5.6 Summary

The summary of Management plan of Sindgi taluk is given in **Table 5.2.**

Table 5.2: Summary of Management plan of Sindgi taluk

Sindgi taluk is 'Safe' and present stage of GW Development (2013)	61%
Net Annual Ground Water Availability (MCM)	113.14
Existing Gross Ground Water Draft for all uses (MCM)	68.73
Total GW Resources (Dynamic & Static up to the depth of 200 m bgl (MCM)	315.21
Expected additional recharge from monsoon surplus runoff (MCM)	24
Change in Stage of GW development, %	61 to 50
Expected Saving due to adopting WUE measures (MCM)	16.16
Change in Stage of GW development, %	50 to 45