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Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

MUDDEBIHALTALUK, BIJAPUR DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region, Bengaluru

AQUIFER MANAGEMENT PLAN OFMUDDEBIHALTALUK,BIJAPUR DISTRICT, KARNATAKA STATE

CONTENTS

AQUIFER MANAGEMENT PLANOF
MUDDEBIHALTALUKBIJAPUR DISTRICT, KARNATAKA STATE

1. 0 SALIENT INFORMATION

Nameofthetaluk:	**MUDDEBIHAL**
District:	Bijapur
State:	Karnataka
Area:	1501sq.km.
Population:	2,90,691 (as per 2011 census)
Annual NormalRainfall:	576mm

1.1 AquiferManagementstudyarea

Aquifer mapping studies were carried out in Muddebihaltaluk, Bijapurdistrict of Karnataka, covering an area of 1501 **sq.kms**under **National Aquifer MappingProject**. Muddebihaltaluk of Bijapurdistrict is located between north latitude 16°08'41" and 16°36'46" &east longitude 75°55'06" and 76°26'23",and is covered in parts of Survey of India Toposheet Nos. 56D/2, 56D/3, 56D/4, 56D/6, 56D/7 and 56D/8. Muddebihaltaluk is bounded by BasavanaBagewaditaluk on North West, Sindgi taluk on north, Shorapur on east, Bagalkot on West, Hungund on South West and Lingasugur on South East.Location map of Muddebihal taluk of Bijapurdistrict is presented in **Fig.1.1.**

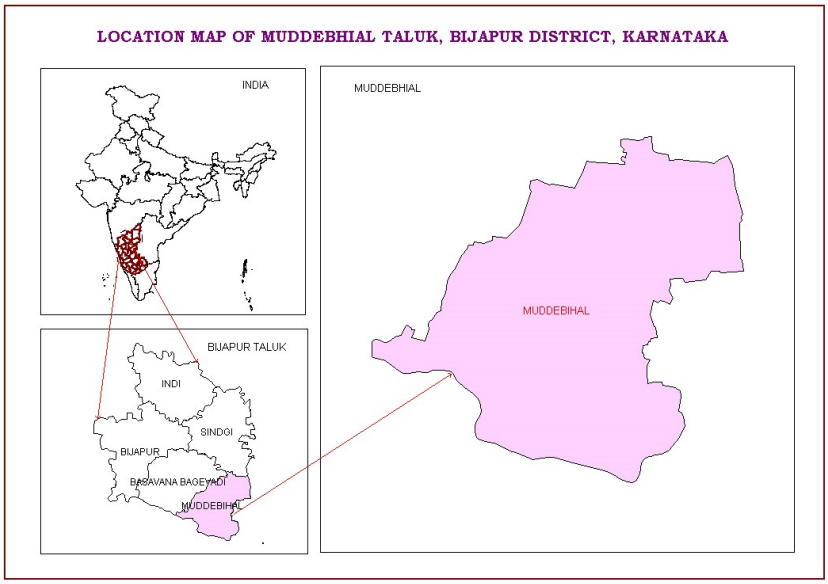

Fig.1.1: LocationMap of Muddebihaltaluk, Bijapurdistrict, Karnataka

Muddebihal taluk is located in Bijapur District of Karnataka State. Taluk administration of Muddebihal taluk is divided into 4Hoblies and 33 Gram Panchayaths. There are 149 inhabited and 4 uninhabited villages in the taluk.

1.2 Population

According to 2011census, the population in Muddebihaltaluk is 2,90,691, of which rural population is 2,24,781 constituting about 77.3%, and the urban population is 65,910 constituting only about 22.7% of the total population. The taluk has an overall population density of 195 persons per sq.km.

1.3 Rainfall

Muddebihal 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 Muddebihal taluk (Table 1.1). The data in respect of this station from the year 1981 to 2010 is analyzed 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 Muddebihal taluk for the period 1981 to 2010 is 576 mm.

Table 1.1: Raingauges and its location in Muddebihal taluk

Sl.No	Station	Latitude	Longitude	Altitude
1	Muddebihal	**16.35**	**76.13**	**582.1**

Statistical analysis

Computations were carried out for the 30 years 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.

The mean monthly rainfall at Muddebihal taluk is ranging between 1mm during February to 143 mm during September. The CV percent for pre-monsoon, monsoon and post monsoon season is 78, 38 & 58 percent respectively. Annual CV at this station works out to be 28 percent.

Table 1.2: Statistical Analysis of Rainfall Data of Muddebihal Taluk, Bijapur District, Karnataka 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
MUDDEBIHAL TALUK	Normal Rainfall (mm)	2	1	7	20	42	72	81	58	82	143	364	107	26	8	140	576
	ST.DEV	6	2	17	30	47	56	50	40	54	84	137	82	39	17	82	159
	CV%	282	313	257	147	112	78	62	69	65	59	38	76	151	225	58	28

Assessment of Drought

Rainfall data of Muddebihal taluk has been analysed for 69 years using IMD method to assess the drought condition in Muddebihal taluk. The results of the classification are listed in the Table 1.3. It is observed that the Muddebihal 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					
Muddebihal	44	13	8	4	0	Once in 6 years

The details of the drought assessment are discussed as herein under. Out of 69 years of analysis in Muddebihal taluk, "No Drought" condition is experienced in 44years, "Mild Drought" condition is experienced in 13 years and "Moderate Drought" condition experienced in 8 years. Further it is observed that "Severe Drought" condition is experienced in 4 years i.e., during

1919, 1972, 1997 and 2003 in Muddebihal 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 6 years** at Muddebihal taluk.

1.4 Agriculture and Irrigation

Agriculture is the main occupation in Muddebihal taluk. Food grains are the major crop grown in the taluk accounting for almost 47 percent of the total crop area, followed by pulses (38%),Cereals (10%), Oil seeds (2.3%), Vegetables (0.3%), Sugarcane (1.9%) and Fruits and Cotton (0.5%) of the total crop area respectively **(Table 1.4)**.

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

Year	Cereals	Pulses	Food Grains	Oil seeds	Fruits	Vegetables	Sugarcane	Cotton
2016-17	26201	99292	125493	6342	131	848	5171	1066

It is observed that net sown area accounts for about 84% of total geographical area, while area sown more than once is 9% of total geographical area in the taluk**(Table 1.5).** As per the data available, the taluk uses 2815dug wells and 5065tubewells for irrigation purpose. Canals are the source for irrigation in the taluk **(Table 1.6).**Land use pattern of the taluk is represented as **Fig.1.2**.

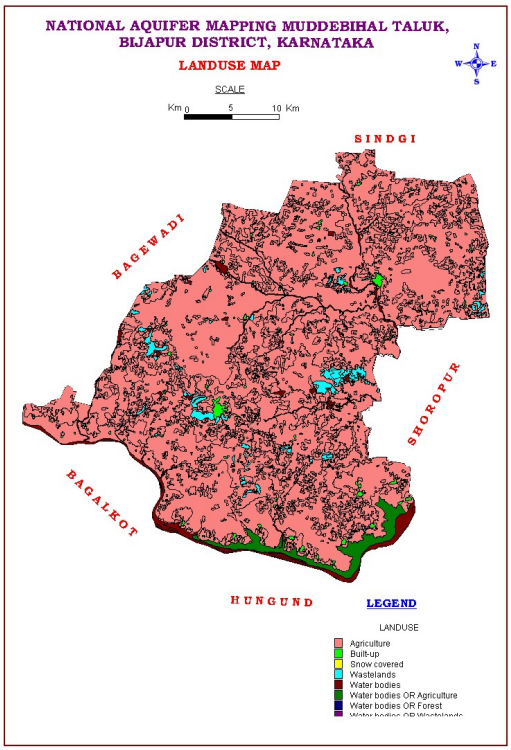

Fig.1.2: Landuse Map of Muddebihal Taluk, Bijapur District

Table 1.5: Details of landuse in Muddebihaltaluk 2016-2017(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
Muddebihal	1497.441	-	85.83	134.49	1256.21	135.59

Source: District at a Glance 2016-17, Govt. of Karnataka

Table 1.6: Irrigation details in Muddebihaltaluk(Ha)

Source of Irrigation	**Net area irrigated (Ha)**	**% of area**
Canals	7917	50
Tanks	0	0
Wells	2815	18
Tubewells	5065	32
Lift Irrigation	0	0
Other Sources	0	0
Total	**15797**	

Source: District at a Glance 2016-17,Govt.of Karnataka

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).**

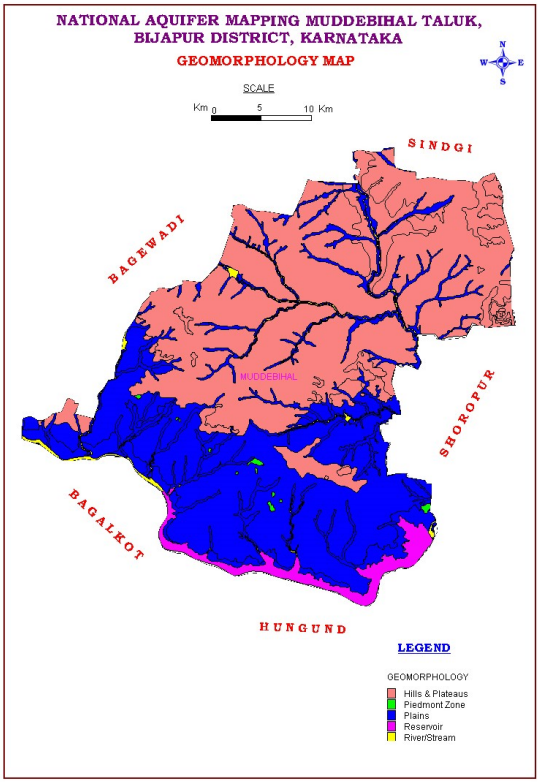

Fig.1.3:Geomorphology Map

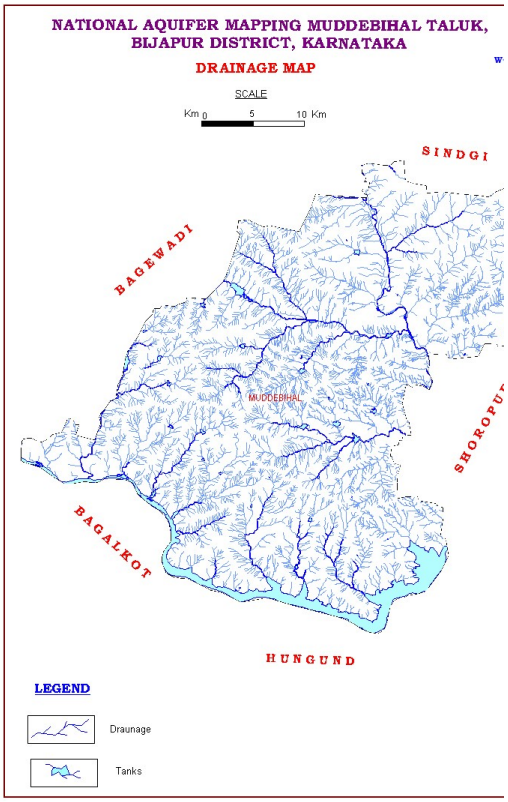

Fig.1.4:Drainage Map

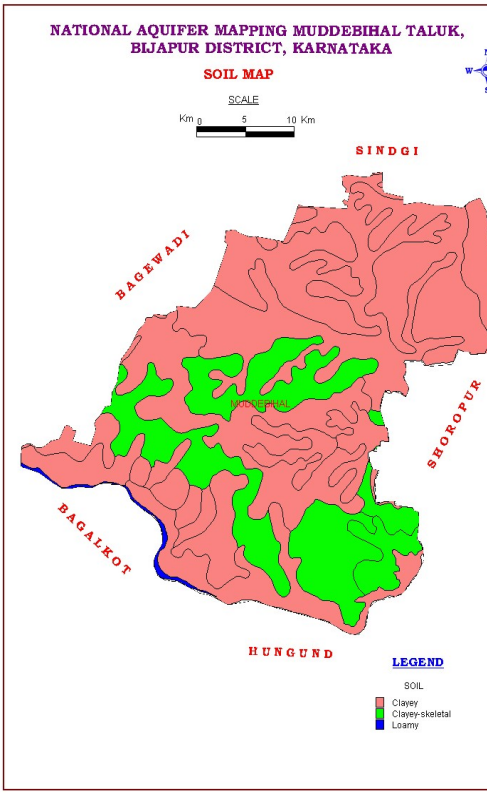

Fig.1.5: Soil Map

1.7Ground water resource availability and extraction

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

Table1.7: Total GW Resources (2017)(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
Muddebihal	3955	5875	3924	13754

1.8Existing and future water demands (as per GEC-2017)

Net ground water availability for future irrigation development: 1031 ham

Domestic and Industrial sector demand for next 25 years: 570 ham

1.9Water level behaviour

(a) Depth to water level

Aquifer-I

Pre-monsoon: 1.65 – 9.68 mbgl**(Fig.1.6)**

Post-monsoon: 2.70 – 8.95 mbgl**(Fig.1.7)**

Aquifer-II

Pre-monsoon: 7.3–16.85 mbgl**(Fig.1.8)**

Post-monsoon: 1.5–10.1 mbgl**(Fig. 1.9)**

(b) Water level fluctuation

Aquifer-I

Seasonal Fluctuation: Rise in the range of 0.05 m to 6.09 m and fall of 0.88 m to 1.05 m**(Fig. 1.10).**

Aquifer-II

Seasonal Fluctuation:Rise in the range of2.65–9.55m**(Fig. 1.11)**

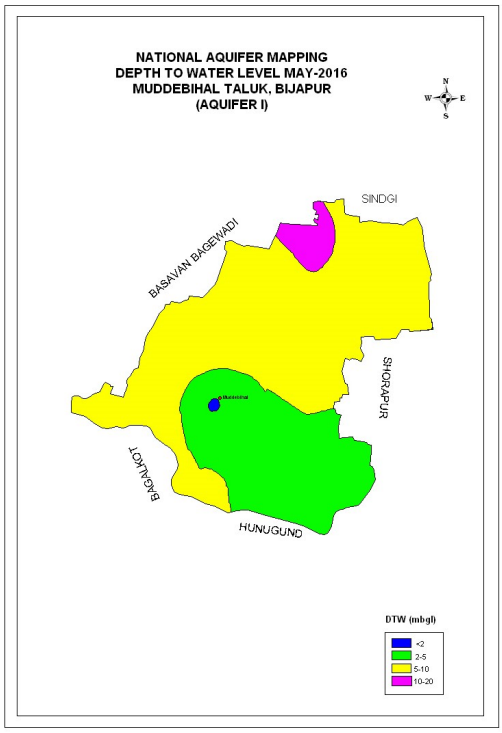

Fig.1.6: Depth to Water Level, Pre-Monsoon (DW)

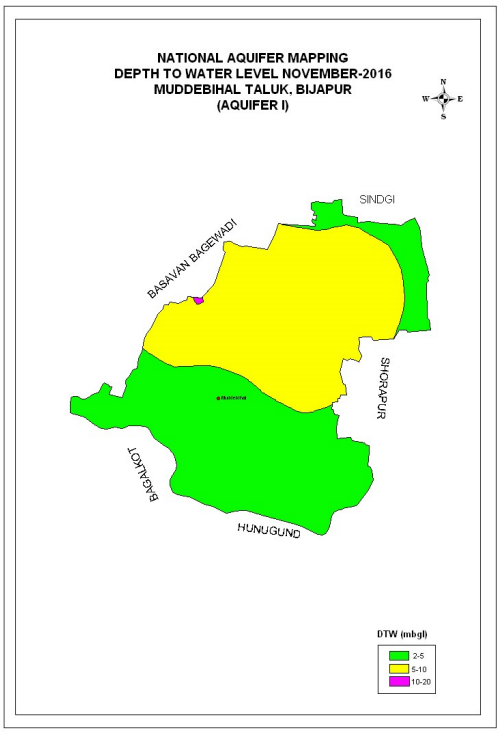

Fig.1.7: Depth to Water Level, Post-Monsoon (DW)

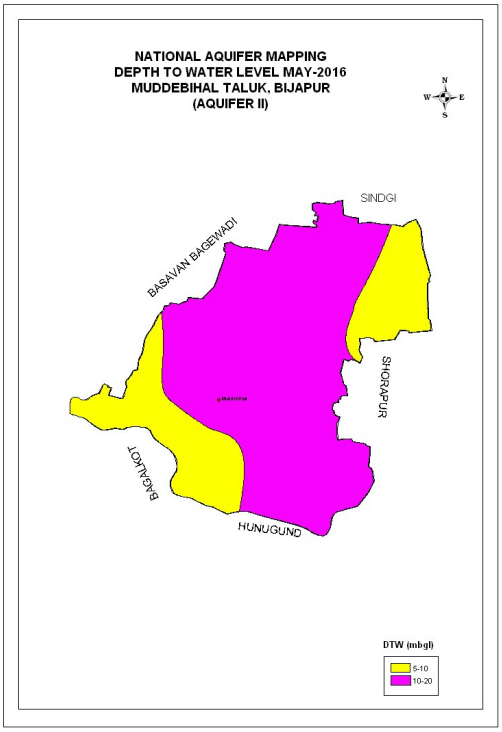

Fig.1.8: Depth to Water Level, Pre-Monsoon (PZ)

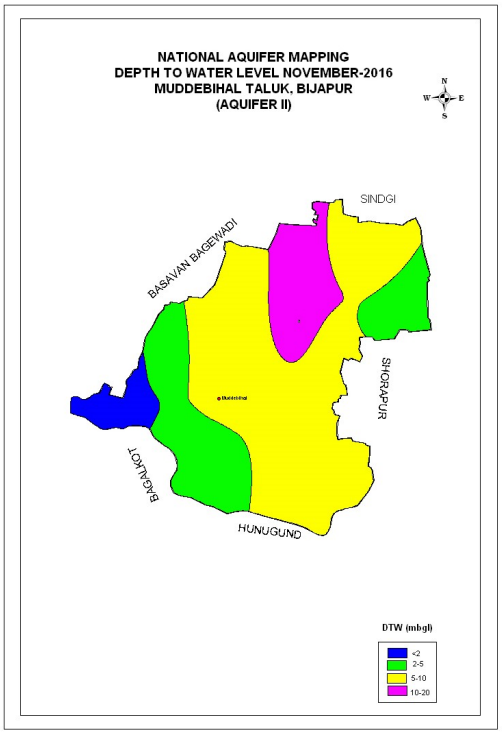

Fig.1.9: Depth to Water Level, Post-Monsoon (PZ)

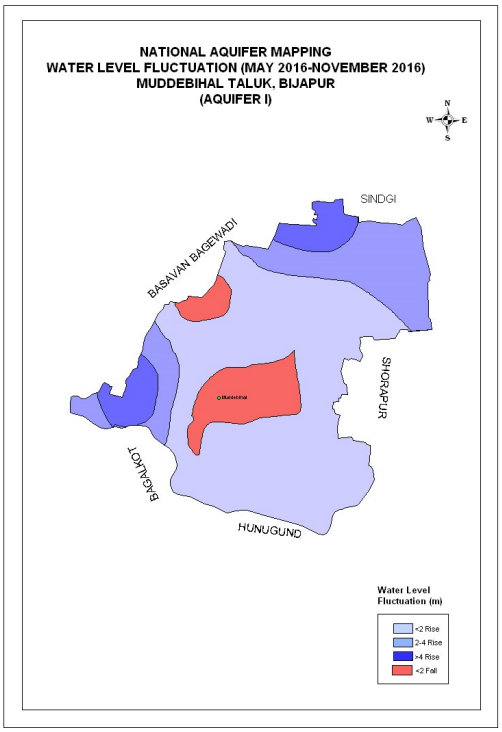

Fig.1. 10: Water Level Fluctuation, Pre-Post 2016 (DW)

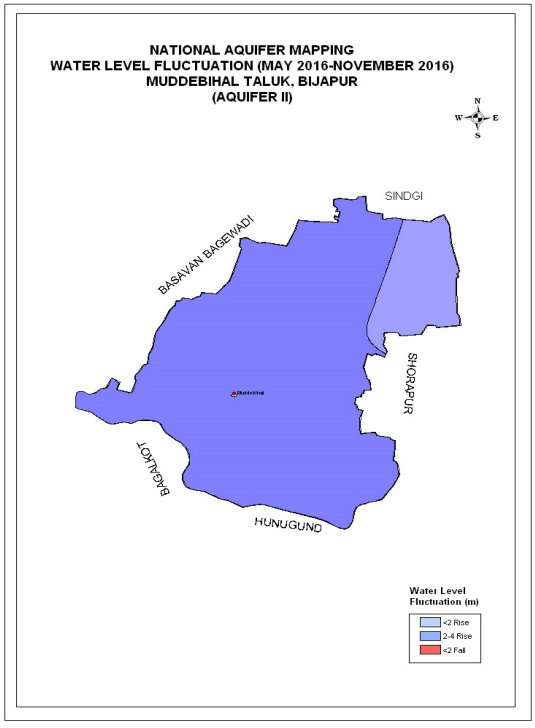

Fig.1. 11: Water Level Fluctuation, Pre-Post 2016 (PZ)

2. AQUIFER DISPOSITION

2.1 Number of aquifers: In Muddebihal taluk,therearemainlytwotypesofaquifersystems;

i. Aquifer-I (Phreaticaquifer)comprisingWeatheredBasalt and BGC

ii. Aquifer-II(Fractured aquifer) comprising Fractured Basalt, Granite, Limestone and Sandstone

In Muddebihal taluk, fractured basalt, Granite, Limestone and Sandstone are the major water bearing formations **(Fig.2.1)**. Groundwater occurs within the jointed and fractured basalt and Granite under semi-confined to confined conditions. In Muddebihal taluk borewells were drilled from a minimum depth of 47.3 mbgl to a maximum of 200.1mbgl **(Table 2.1)**. Depth of weathered zone (Aquifer-I) ranges from 6 mbgl to 40.6mbgl. However, isolated patches in topographical lows are seen yielding seasonally, that too for very short durations. Ground water exploration reveals thataquifer-II fractured formation was encountered between the depthof 9.7 to 156 m bgl. Yield ranges from 0.43to 2.85lps.

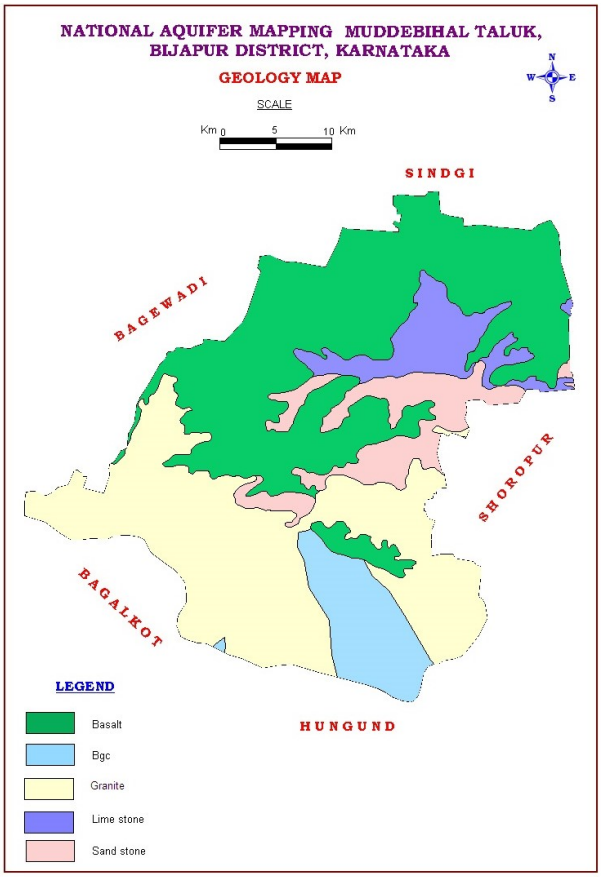

Fig.2.1: Geology Map

Table 2.1:Detailsof 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.	Bommanahalli	16°31'50"	76°18'15"	120	6	58.4, 65	1.55	0.43	26.398
2.	Gudnal	16°24'50"	76°13'00"	120	20.6	-	1.6	-	-
3.	Muddebihal	16°20'00"	76°07'20"	120	16	14.9,33,49.3,112	13.07	2.85	23.77
4.	Vanahalli	16°28'15"	76°12'30"	95.12	9.58	9.7,48.4,58,94	3.55	1.8	21.75
5.	Bijjur	16°13'00"	76°17'30"	55.4	6	25.67	0.924	0.43	5.17
6.	Jammaldinni	16°23'00"	76°14'15"	47.3	36.5	-	8.77	0.5	-
7.	Tangadgi	16°13'04.4"	76°05'41.3"	200	15.79	52-54, 126-129, 147-150	4.41	0.75	-
8.	Rakkasagi	16°11'12.1"	76°13' 30"	200.1	20.3	31.9-34.8	10.45	0.75	-
9.	Veersh Nagar	16°15'35.3"	76°19'32.9"	200.1	8.7	101.5-104.4	Dry	-	-
10.	Nalatvad	16°15'05.3"	76°17'24.4"	200.1	14.5	26.1-29, 87-89	-	2.44	-
11.	Hulabagal	16°11'12.1"	76°13'30"	200.1	14.5	-	Dry	-	-
12.	Dhavalgi	16°25'41.1"	76°07'10.6"	200.1	40.6	142.1-145	-	0.08	-
13.	Muddebihal	16°20'30.9"	76°07'38.4"	200	6	27-30, 153-156	-	0.75	-
14.	Basarkod	16°23'50.5"	76°05'07.3"	200	8.7	58-60.9, 130.5-133.4	-	0.75	-

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATIONAND OTHER ISSUES

3.1 Aquifer wise resource availability and extraction

(a) Present Dynamic Ground Water Resource (2017)

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	%	
Muddebihal	Command	756.46	313.02	114.07	427.09	250.13	257.97	56	Safe
Muddebihal	Non Command	3198.40	2202.26	294.36	2496.62	319.51	773.42	78	Semicritical
Muddebihal		3954.86	2515.28	408.43	2923.71	569.64	1031.39	74	SEMICRITICAL

(b)Present total Ground Water Resource (Ham)

Taluk	Annual Replenishable GWResources	Fresh In-storage GW Resources		Total availability of GW Resource
		Phreatic	Fractured	Dynamic+phreatic in-storage+ fractured in-storage
Muddebihal	3955	5875	3924	13754

(c) Comparison of Ground Water Availability and Draft Scenario in Muddebihal 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	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development
	2009			2011			2013			2017		
Muddebihal	7444	5090	50	3790	2969	78	6429	3921	61	3955	2924	74

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 (772-2390 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 drinkingpurpose**(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 0.6 mg/l to 2.6 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 taluk indicated that the values are in the range of 7 mg/l to 217 mg/l. Nitrate in drinking water should not exceed 45 mg/l as per BIS (ISO: 10500: 2012) standard**(Fig.3.3).**

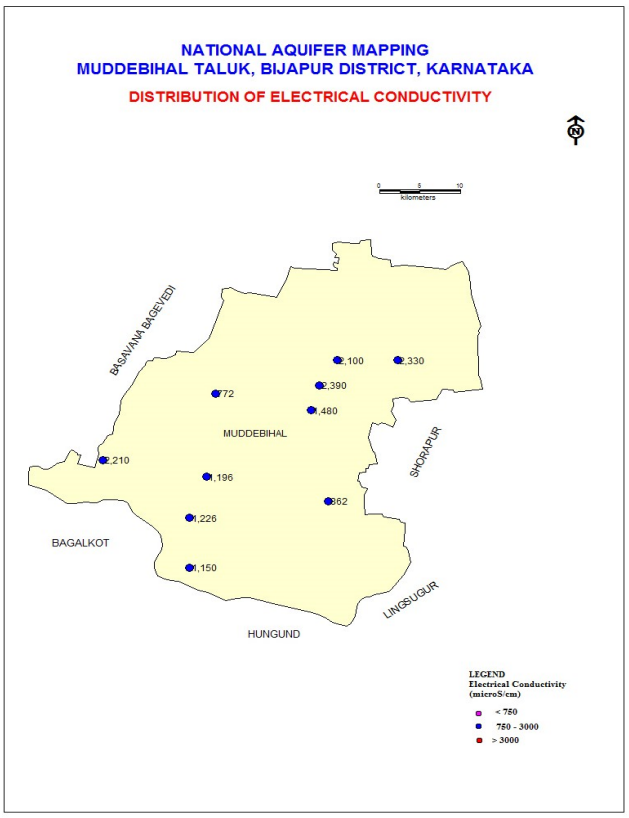

Fig.3.1: Distribution of EC

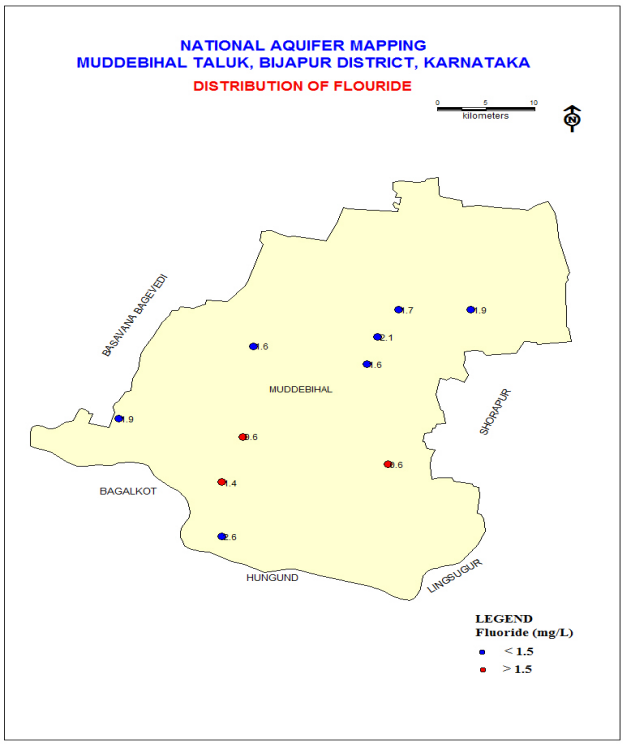

Fig.3.2: Distribution of Fluoride

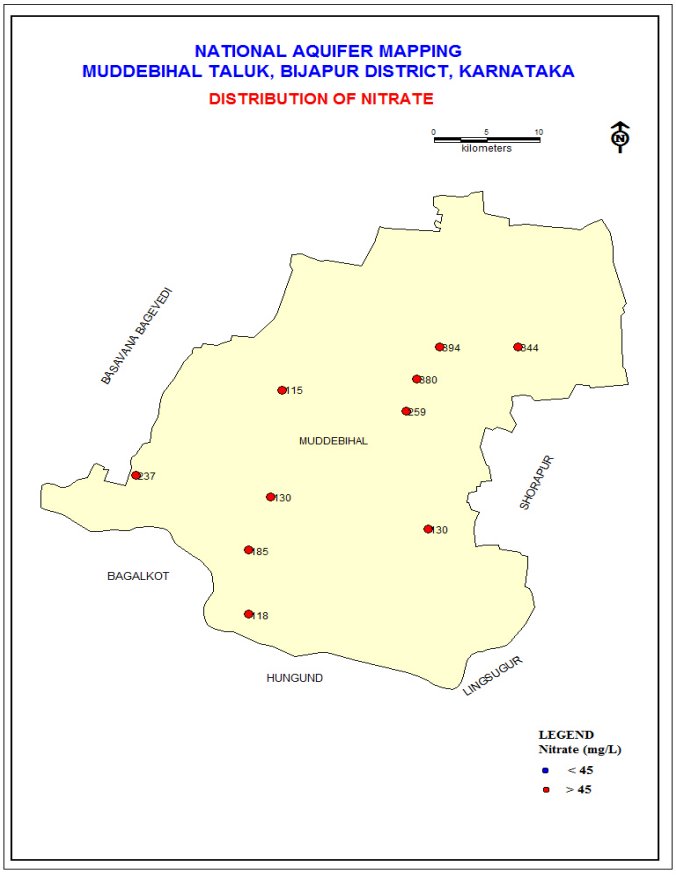

Fig 3.3: Distribution of Nitrate

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

4. GROUND WATER RESOURCE ENHANCEMENT

4.1Aquifer wise space available for recharge and proposed interventions

Recharge phreatic aquifer (Aq-I) in the taluk, through construction of artificial recharge structures, viz. Check dams, percolation tanks &point recharge structures **(Table 4.1).** The choice of recharge structures should be site specific and such structures need 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 (As per Master Plan o Artificial Recharge in Karnataka and Goa,2020)

Artificial Recharge Structures Proposed	Muddebihal Taluk
Non committed monsoon runoff available (Ham)	76.101
Number of Check Dams	0
Number of Percolation Tanks	68
Number of Subsurface dykes	02
Tentative total cost of the project (Rs.in lakhs)	1409.132
Excepted recharge (MCM)	57.076
Cost Benefit Ratio (Rupees /cu.m. of water harvested)	2.47

4.2 Improvement in GW availability due to Recharge, Muddebihal taluk

Table 4.2: Improvement in GW availability due to Recharge, Muddebihal 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	%	HAM	HAM	HAM	%	%
Muddebihal	3955	2924	74	5707.6	-	9662.6	30.26	43.74

After implementation of Artificial Recharge structures for GW recharge, the annual ground water availability will increase from 3955 to 9662.6 ham and the expected improvement in stage of development is 43.74% from 74% to 30.26%.

5. DEMAND SIDE INTERVENTIONS

5.1Advanced 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 existing18350 ha of gross irrigated area. Presently, draft through irrigation is 2515 ham. Implementation of efficient irrigation techniques will contribute in saving groundwater by 754.5 ham and thus, will improve stage of development by 2.19% from 30.26% to 28.07% **(Table 5.1).**

5.2 Change in cropping pattern

In Muddebihal taluk the water intensive crops grown are paddy and sugarcane. Paddy is grown in small area of 4 hectares which is basically for self-consumption, and hence, it may not be possible to change it. Sugarcane is grown in 5171 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 after implementing artificial recharge structures	Existinggrossgroundwaterdraftforallus es	Stageofgroundwaterdevelopmentaft er implementingARstructures&Surfac e water schemes	SavingduetoadoptingWUEmeasures	Cumulative annual ground water availability	Expectedimprovementinstageofground waterdevelopment aftertheimplementation oftheproject	Expectedimprovementinoverallstage of groundwaterdevelopment
	Ham	Ham	%	Ham	Ham	%	%
Muddebihal	9662.6	2924	30.26	754.5	10417.1	28.07	2.19

5.3Additional 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 28.07% 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 Muddebihal taluk, the command area is coming under Safe category as the stage of development is 56% and for non-command area the stage of development is 78% which is falling under Semicritical category. The overall stage of development in the taluk is 74% and the taluk is falls under Semi-Critical category. Karnataka Ground Water Authority has to take necessary action for controlling the over exploitation of ground water in the taluk as well as for improving the quality of ground water.

Groundwater 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 incorporated in the Recharge Plan.

5.6 Summary

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

Table 5.2: Summary of Management plan of Muddebihal taluk

Muddebihal taluk is 'Semi-Critical' and present stage of GW Development (2017)	74%
Net Annual Ground Water Availability (MCM)	39.55
Existing Gross Ground Water Draft for all uses (MCM)	29.24
Total GW Resources (Dynamic & Static up to the depth of 200 m bgl) (MCM)	137.54
Expected additional recharge from monsoon surplus runoff (MCM)	57.076
Change in Stage of GW development, %	74 to 30.26
Expected Saving due to adopting WUE measures (MCM)	7.55
Change in Stage of GW development, %	30.26 to 28.07