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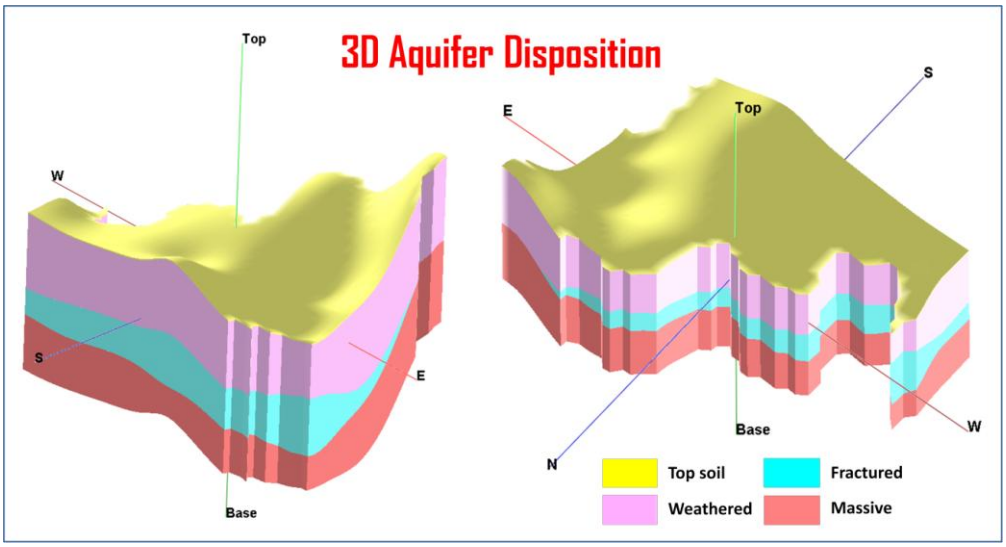
AQUIFER MANAGEMENT PLAN OF JAMAKHANDI TALUK, BAGALAKOTE DISTRICT, KARNATAKA STATE



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AQUIFER MANAGEMENT PLAN OF JAMAKHANDI TALUK, BAGALAKOTE DISTRICT, KARNATAKA STATE

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1.0 SALIENT INFORMATION

Name of the Taluk: Jamakhandi

District: Bagalakote

State: Karnataka

Area: 1,133 sq.km

Population (Census 2011): 4,70,176

Annual Normal Rainfall: 343 mm

1.1 Aquifer Management study area

Aquifer mapping studies was carried out in Jamakhandi taluk, Bagalakote district, Karnataka State under National Aquifer Mapping Project. The taluk is covering an area of 1,133 sq.kms. Taluk administration of Jamakhandi taluk is divided into 3 Hoblies and 38 Grama Panchyaths. Jamakhandi town is the taluk head quarter. There are 71 villages present in the taluk. Jamakhandi taluk of Bagalakote district is located between North Latitude 16° 24' 19.64" and 16° 46' 56.97" and East Longitude 74° 59' 13.58" and 75° 29' 42.71.71". The taluk is covered in parts of Survey of India Toposheet Nos. 47 P/2, P/3, P/5, P/6 and P/7. Jamakhandi taluk is bounded by Athani taluk towards north, Vijayapura taluks towards east, Mudhol taluk towards south and Raybag towards west. Location map of Jamakhandi taluk and also district as a whole is presented in **Fig. 1**.

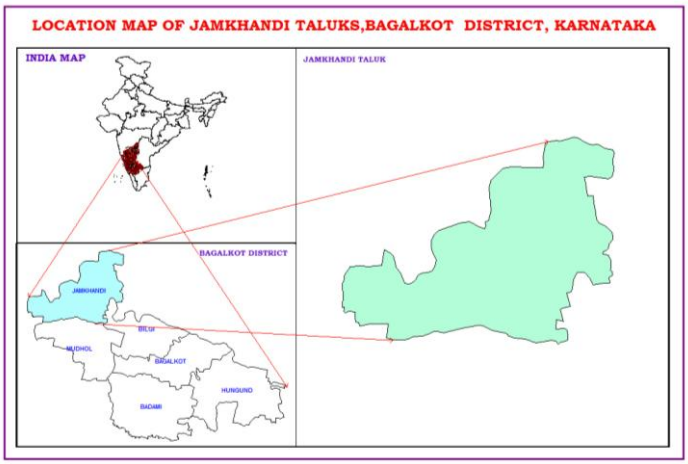

Fig. 1: Location Map of Jamakhandi taluk

1.2 Population

According to 2011 census, the population in the taluk is 4,70,176 in which 2,98,146 constitute the rural population and 1,72,030 urban population. The male population represents 2,37,086 and 2,33,090 represented by female population.

1.3 Hydrometeorology

Jamakhandi 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 Jamakhandi taluk **(Table 1)**. The data in respect of this station from the year 1981 to 2010 is analysed and presented in **Table 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 Jamakhandi taluk for the period 1981 to 2010 is 664 mm.

Table 1: Rain gauge and its location in Jamakhandi taluk

Station	Latitude	Longitude	Altitude
Jamakhandi	16.50	75.13	541.9

Statistical analysis

Computations were carried out for the 30 year blocks of 1981- 2010 on Mean, Standard deviation and coefficient of variation of each month pre-monsoon, monsoon, post monsoon and annual and are shown in **Table 2**. The mean monthly rainfall at Jamakhandi taluk is ranging between 0 mm during February to 124mm during September. The CV percent for pre-monsoon, monsoon and post monsoon season is 53, 43 & 65 percent respectively. Annual CV at this station works out to be 41 percent.

Table 2: Statistical Analysis of Rainfall Data of Jamakhandi Taluk, Bagalkot 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
JAMAKHANDI TALUK	Normal Rainfall (mm)	4	0	4	12	43	64	107	55	53	124	338	99	27	7	133	664
	STDEV	13	3	12	13	29	34	82	37	39	76	145	72	44	19	86	275
	CV%	309	548	264	110	67	53	76	67	73	61	43	73	163	262	65	41

Assessment of Drought

Rainfall data of Jamakhandi taluk has been analysed for 93 years using IMD method to assess the drought condition in Jamakhandi taluk. The results of the classification are listed in the **Table 3**. It is observed that the Jamakhandi taluk has experienced alternating no drought to severe drought conditions over the years.

Table 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	Jamakhandi	55	19	15	3	1	Once in 5 years

The details of the drought assessment are discussed as herein under. Out of 93 years of analysis in Jamakhandi taluk, “No Drought” condition is experienced in 55years, “Mild Drought” condition is experienced in 19 years and “Moderate Drought” condition experienced in 15 years. Further it is observed that “Severe Drought” condition is experienced in 3 years i.e., during 1942, 1976 and 2003. “Acute Drought” is observed during the year 2013 in Jamakhandi 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 5 years** at Jamakhandi taluk.

1.4 Agriculture & Irrigation

In the district, irrigation is carried out from surface water as well as from ground water. The land use pattern in the taluk is given in **Table 4**. Production and Productivity of major Crops in Jamakhandi taluk is given in **Table 5**. Dug wells, bore wells and canals are the important sources for irrigation in the taluk. About 109752 ha of area is under cropping area. The major crops grown are Jowar, maize, wheat, bajra, sugarcane, sunflower, pulses and groundnut.

Details of Irrigated and Rain fed Area (ha) in Jamakhandi taluk are given in **Table 6 & 7**.

Table 4: Land Use Pattern of Jamakhandi taluk

Total Geographical Area	Area under Agriculture				Area under Forest	Area not available for Cultivation	Other Uncultivated Land	Fallow land
	Gross Cropped Area(1)	Net Sown Area(2)	Area Sown More than once (1-2)	Cropping Intensity (%)				
116853	109752	93834	15918	117.0	11410	7107	1832	2670

Source: Bagalakote District at a glance 2014-15

Table 5: Production and Productivity of major Crops in Jamakhandi taluk

Name of the Block	Crop Sown						Rainfed			Irrigated			Total	
	Cereals	Coarse Cereals	Pulses	Oilseeds	Fibre Crops	Any other crops	Area (ha)	Production (tn/yr)	Productivity or Yield (kgs/ha)	Area (ha)	Production (tn/yr)	Productivity or Yield (kgs/ha)	Production (tn/yr)	Productivity or Yield (kgs/ha)
Kharif Season														
Jamkhandi	11655	2279	3746	2256	0	36344	7330	4206	573.8	48950	53922	1101.6	58129	1032.8
Rabi Season														
Jamkhandi	31769	0	6000	1170	0	8050	22597	7892	349.3	24392	62851	2576.7	70743	1505.5

Table 6: Irrigated and Rain fed Area (ha) in Jamakhandi taluk

Name of the Block	Total Sown Area	Irrigated Sown Area		Rainfed Sown Area	
		Area	%	Area	%
Jamkhandi	109752	79825	72.7	29927	27.3

Source: Bagalakote District at a glance 2014-15

Table 7: Irrigation Based Classification in Jamakhandi taluk (Source: Department of Agriculture, Govt. of Karnataka)

Block	Total Cultivable Area (ha)	Irrigated Area (In ha)		Rainfed Area (In ha)	
		Gross Irrigated Area	Net Irrigated Area (Major & Minor Irrigation)	Partially Irrigated/ Protective Irrigation (Ground water & Other Sources)	Un-Irrigated or Totally Rainfed
Jamkhandi	93834	47600	47600	32225	14009

1.5 Geomorphology, Physiography & Drainage

The taluk is drained by 1st to 4th order streams which flow towards south east. Krishna River enters the taluk at Terdal village and the portion of northern boundary of the taluk is coinciding with the Krishna River which flows across the taluk from north-west to south-east direction. The drainage system is well developed in the taluk. The general drainage pattern is dendritic to sub-dendritic in nature and joins Krishna River **(Fig. 2)**. The general topographic elevation ranges from 654 m amsl towards north and 514 m amsl towards the center of the taluk along the river course. The general slope is mostly towards NE to SW and SW to NE. The isolated hillock range is also located just adjacent to the taluk HQ which striking from E-W direction **(Fig. 3).**

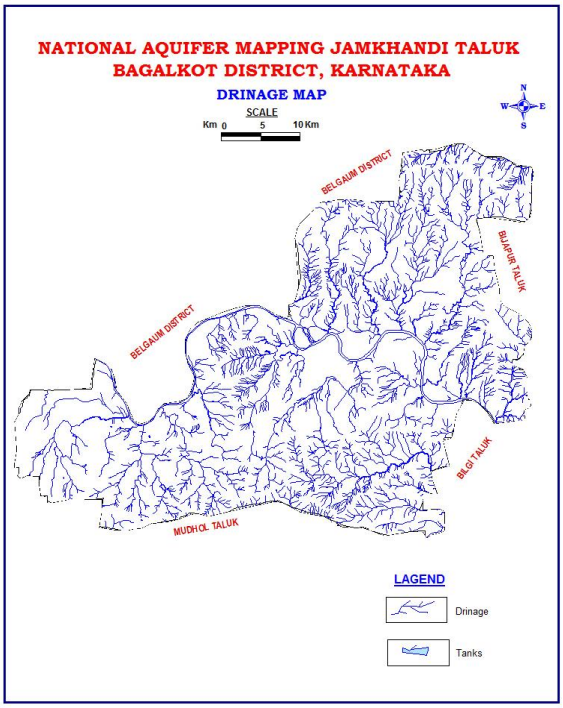

Fig. 2: Drainage map

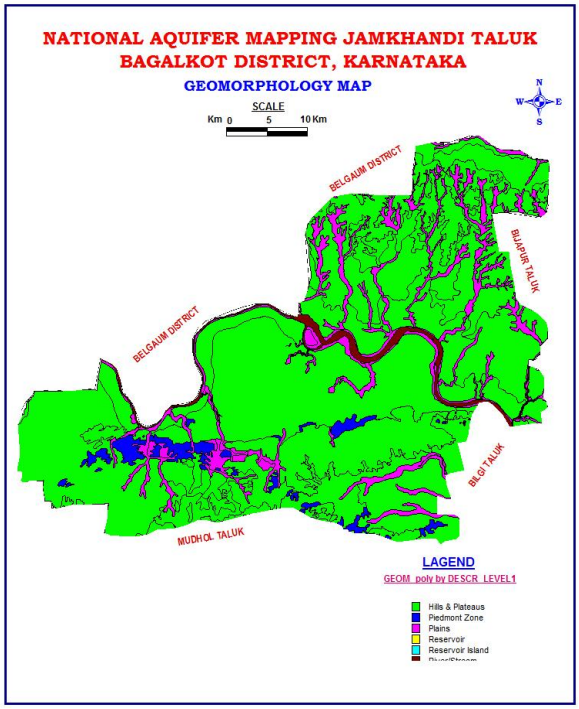

Fig.3: Geomorphology map

1.6 Geology and Soils

The taluk is underlain mainly by the basaltic formation which is distributed throughout the taluk. The small patch of limestone formation is also noticed towards southern part of the taluk which extends from west to east direction **(Fig. 4).**

There are two types of soils viz., clayey and loamy were noticed in the taluk distributed in both basaltic and limestone formations **(Fig. 5).**

(i) Soils in Basaltic area: Soils of this type are again classified as shallow, moderate and deep black cotton soils. They are usually light black to black in colour and vary in thickness from 25 cms to 8 mtrs and have high water holding capacity. These soils are fertile but when occupy the low-lying area cause water logging conditions in canal command areas.

(ii) Soils in Limestone: These are dark grey in colour, clayey and calcarious. These have high water holding capacity and low permeability. High hydraulic conductivity when compared to black cotton soil and are low in nutrients.

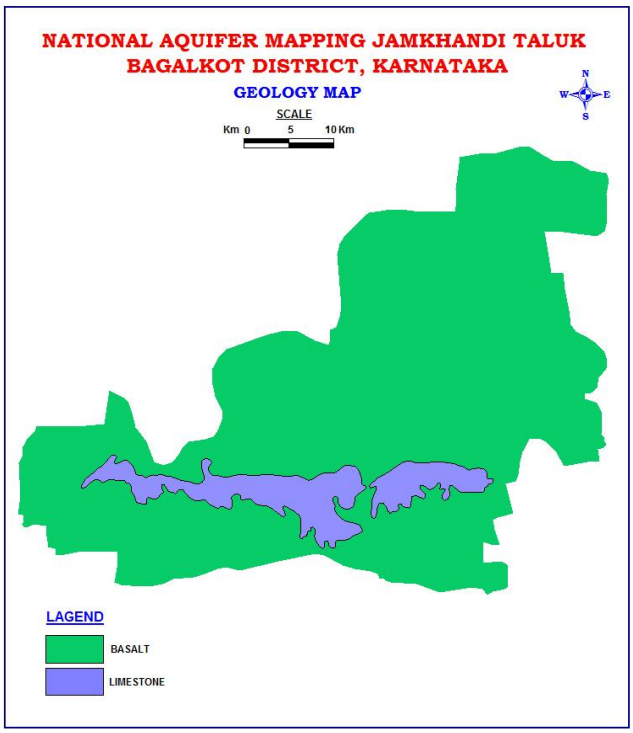

Fig. 4: Geology map, Jamakhandi taluk

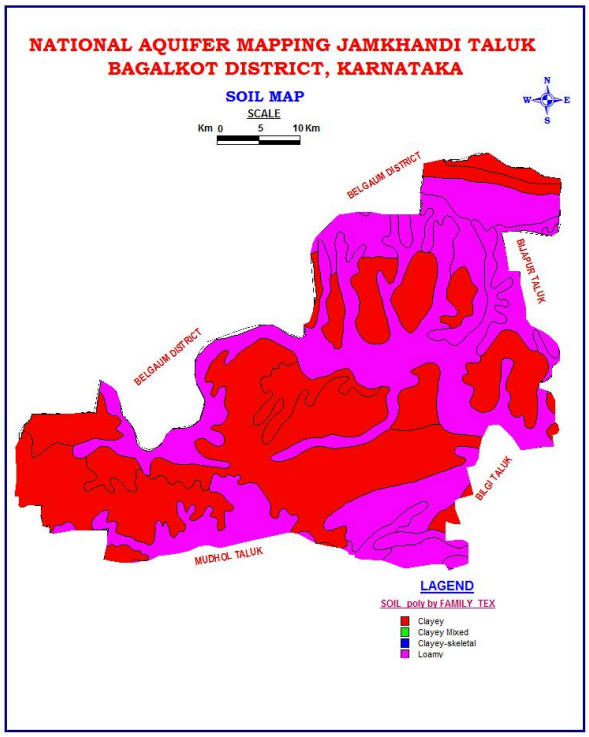

Fig. 5: Soil map, Jamakhandi taluk

1.7 Ground water resource availability and extraction

Aquifer-wise total ground water resources up to 200 m depth is given in **Table 8** below.

Table 8: Total Ground Water Resources (2017) (Ham)

Taluk	Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (Down to 200m)	Dynamic + phreatic in-storage + fractured
Jamakhandi	15961	6145	3876	25982

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

- Net ground water availability for future irrigation development: 4686 HAM
- Domestic (Industrial sector) demand for next 25 years : 1224 HAM

1.9 Water level behavior

(a) Depth to water level

Aquifer - I

- Pre-monsoon: 4.26 – 22.02 mbgl (**Fig. 6**)
- Post-monsoon: 2.14 – 17.10 mbgl (**Fig. 7**)

Aquifer - II

- Pre-monsoon: 30.48 mbgl (**Fig. 8)**
- Post-monsoon: 26.07 mbgl (**Fig. 9**)

(b) Water level fluctuation

Aquifer-I (**Fig. 10 & 11**)

- Seasonal Fluctuation: Rise ranges 2.12 – 17.30 m;

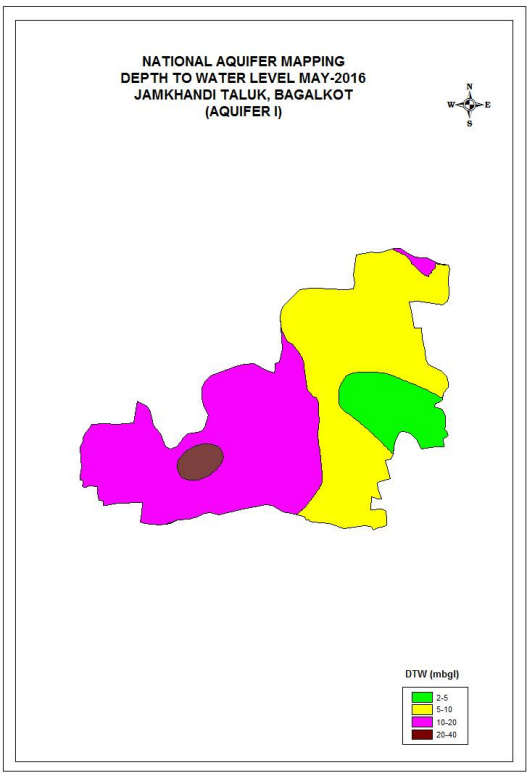

Fig-6: Pre-monsoon Depth to Water Level (Aq-I)

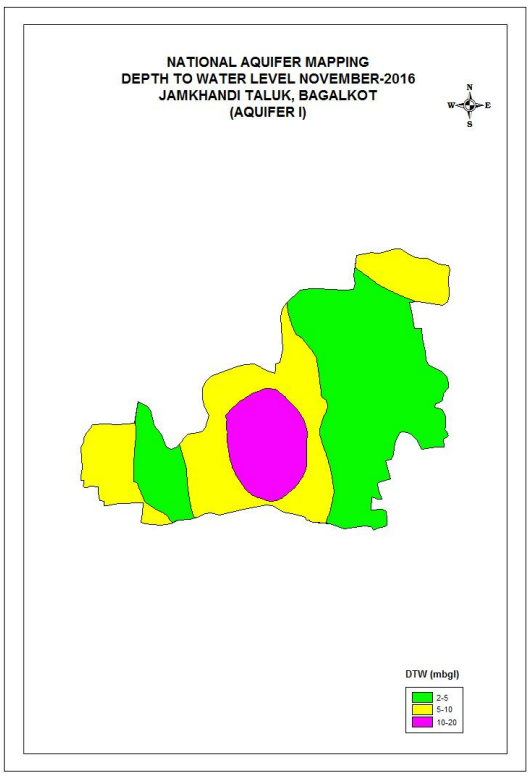

Fig-7: Post-monsoon Depth to Water Level (Aq-I)

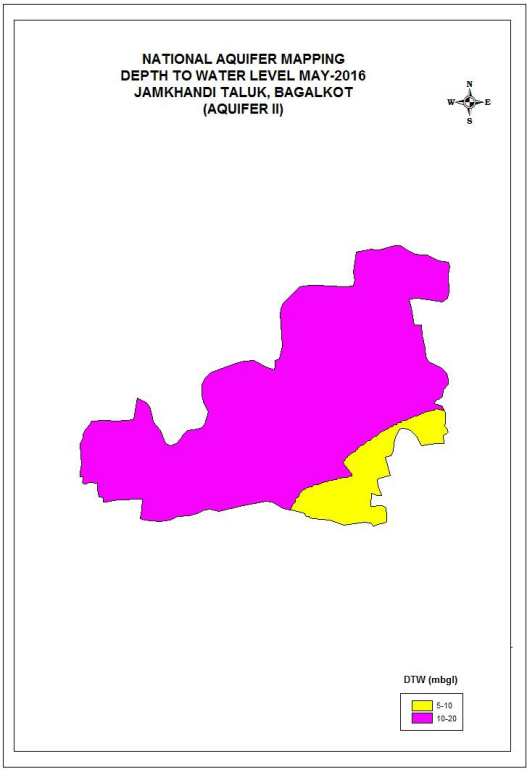

Fig-8: Pre-monsoon Depth to Water Level (Aq-II)

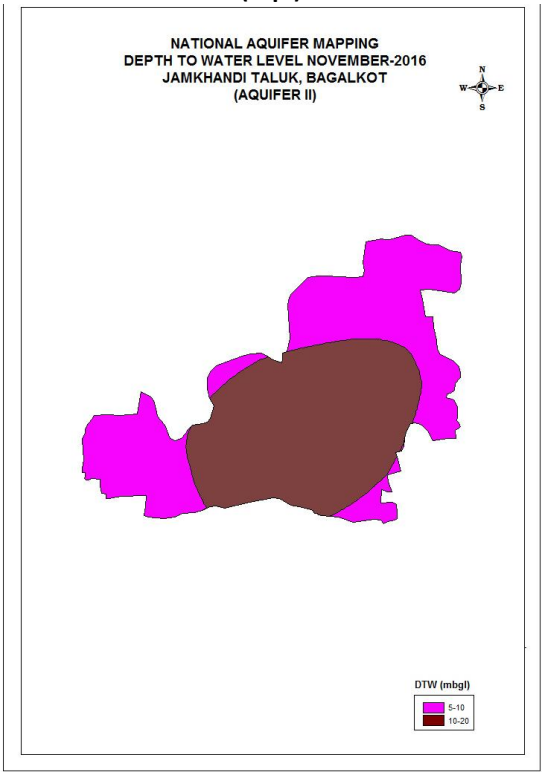

Fig-9: Post-monsoon Depth to Water Level (Aq-II)

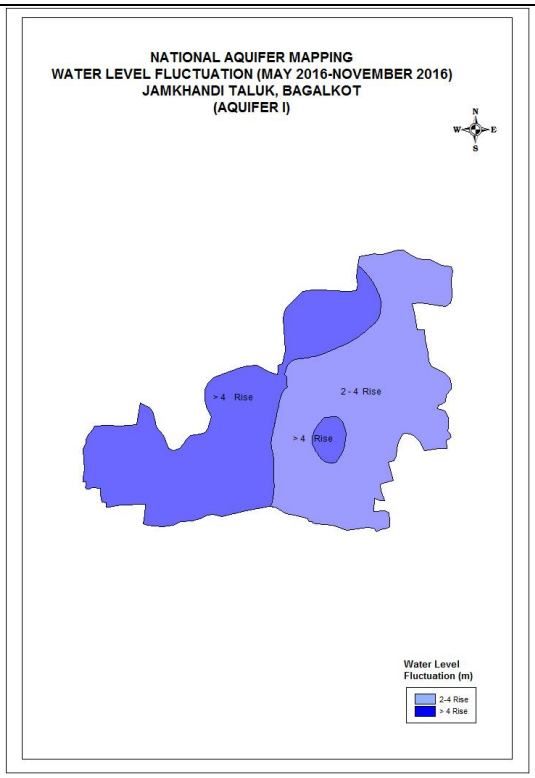

Fig-10: Water Level Fluctuation (Aq-I)

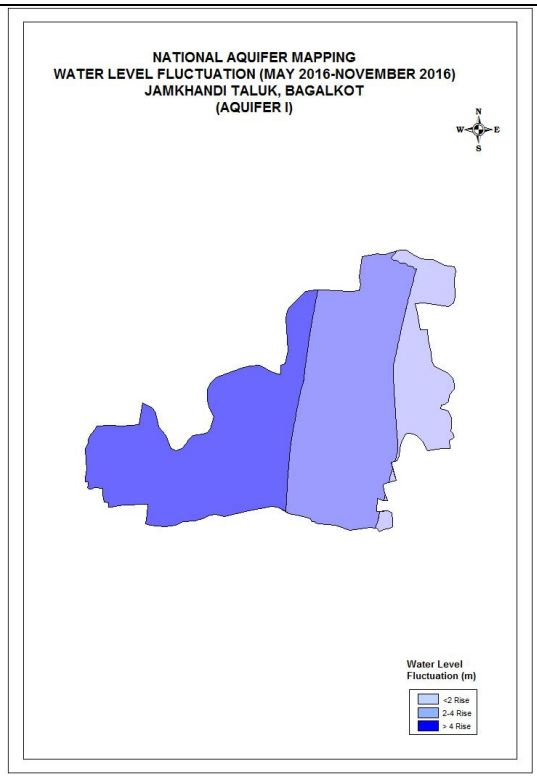

Fig-11: Water Level Fluctuation (Aq-II)

2.0 AQUIFER DISPOSITION

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

i. Aquifer-I (Phreatic aquifer) comprising weathered basalts and limestones.

ii. Aquifer-II (Fractured aquifer) comprising basalts and limestones.

In Jamakhandi taluk, Basalts and limestones are the major water bearing formations. Ground water occurs within the weathered and fractured formations semi-confined condition.

The bore wells were drilled to a maximum of 200 mbgl. Depth of weathered zone (Aquifer-I) ranges from 5 to 42 mbgl. Ground water exploration reveals that aquifer-II fractured formation was encountered upto the depth 155 bgl. Yield ranges from <1 to 6.71 lps (**Table 9**). The 3D aquifer disposition models, 2D aquifer sections and 3D aquifer fence diagrams have been prepared and presented in **Fig. 12, 13 & 14**.

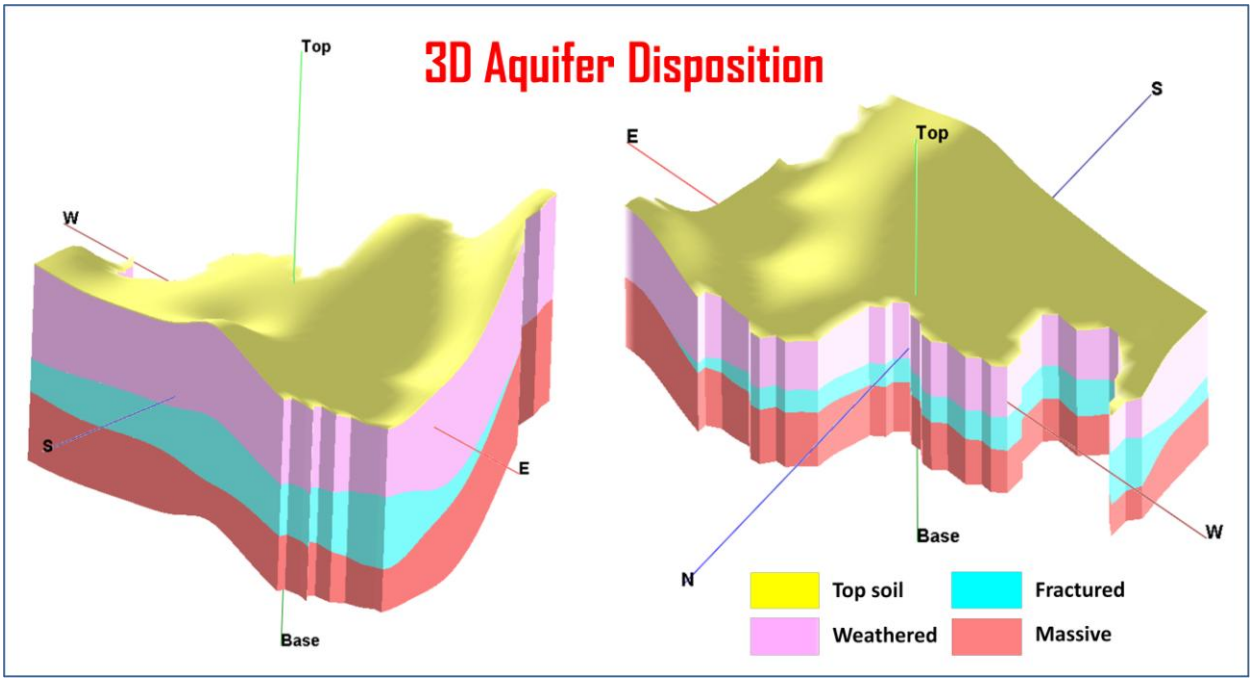

Fig. 12: 3D Aquifer models for Jamakhandi taluk

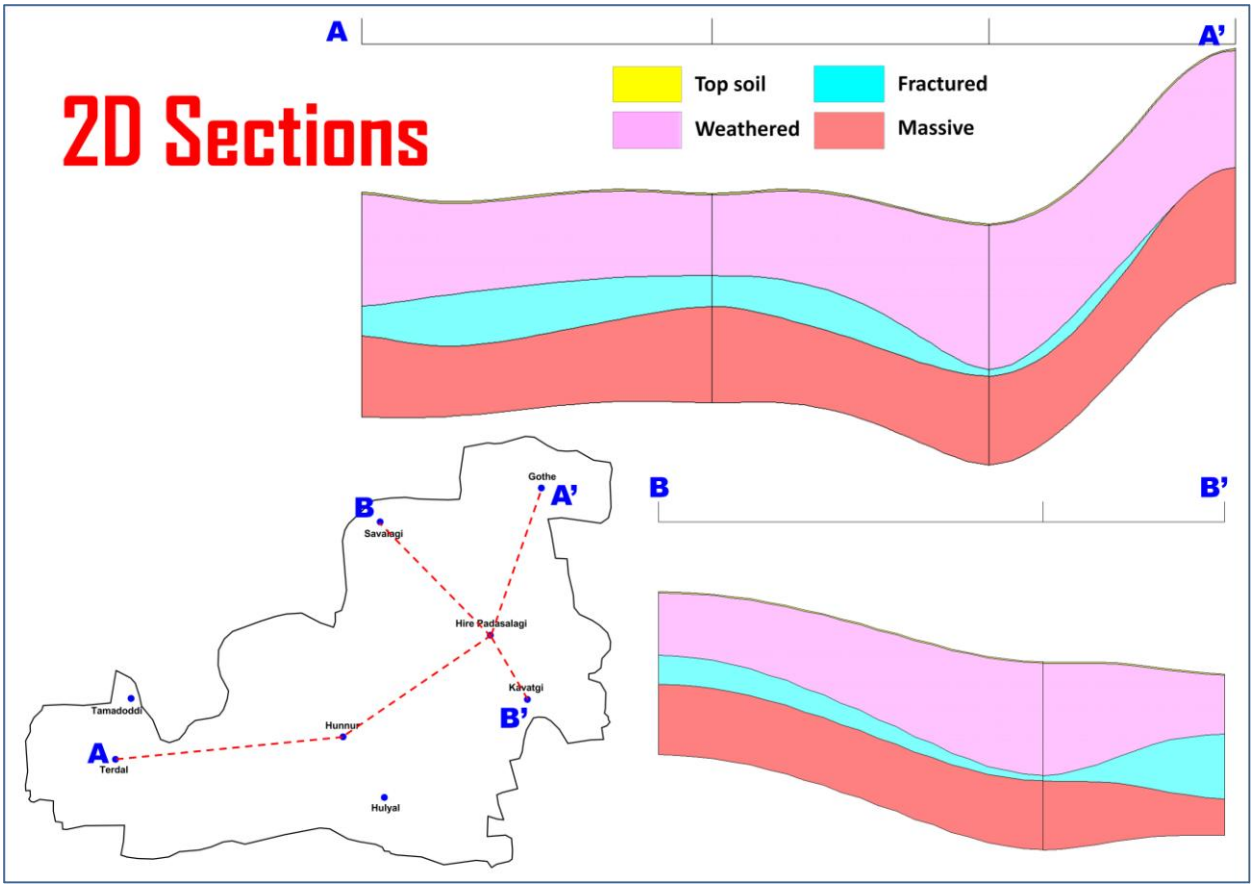

Fig. 13: 2D Aquifer sections for Jamakhandi taluk

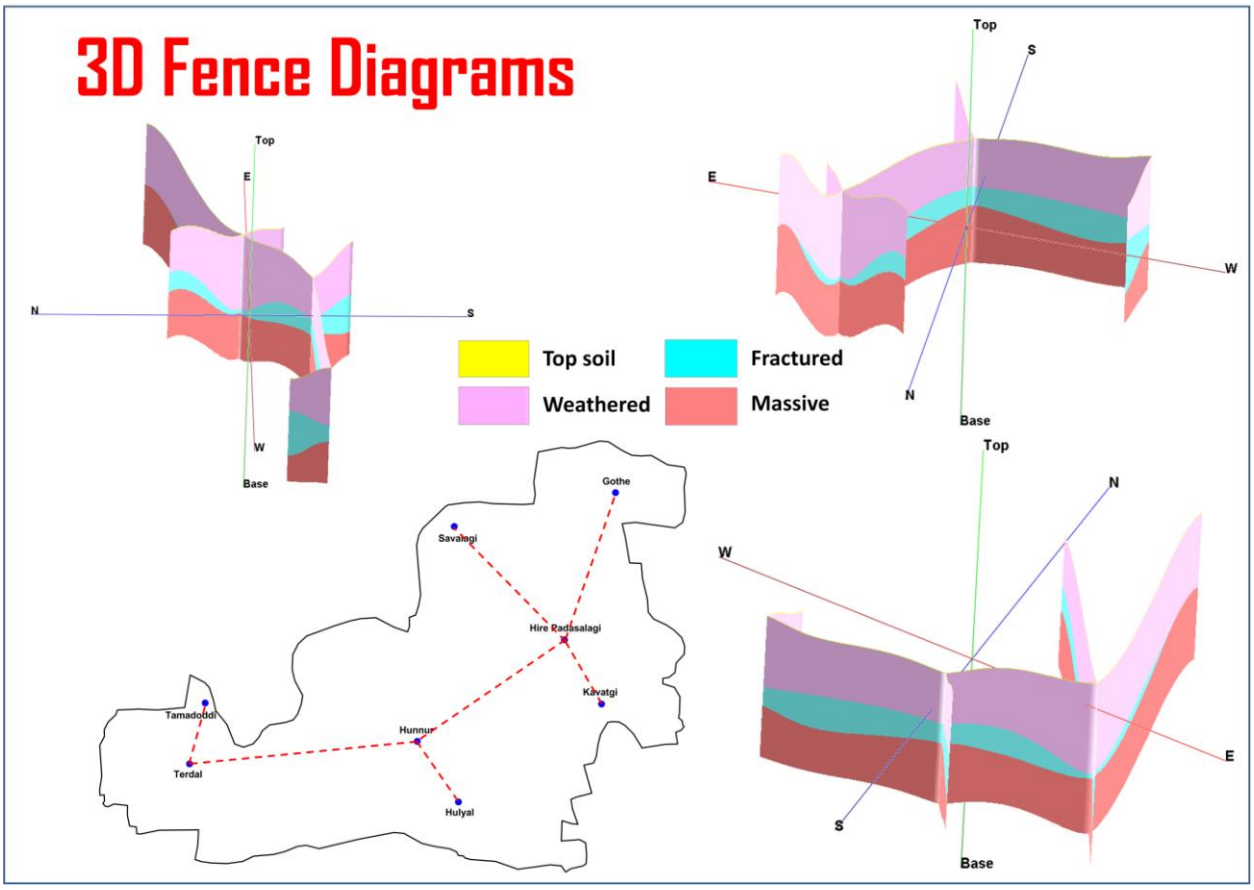

Fig. 14: 3D Aquifer fence diagrams for Jamakhandi taluk

Table 9: Details of exploratory wells drilled in Jamakhandi taluk

Village	Latitude	Longitude	Depth Drilled (m bgl)	Casing mbgl	Fractures (m bgl)/ Discharge(cms)	Q (lps)	SWL(m)	T (m^2/day)
Hunnur	N 16° 30' 40"	E 75° 15' 51"	200	23.95	105.50 to 106 - 1 cm	0.01	21.93	
Hulyal	N 16° 27' 34"	E 75° 17' 58"	200	42.30	Dry	-	-	
Hipparagi	N 16° 33' 33"	E 75° 10' 10"	79	11.66	27.36 to 28 - 11 cm 42.56 to 43 m- 12 cm	6.71	3.15	
Hire padasalagi	N 16° 35' 52"	E 75° 23' 24"	200	29.88	116 to 116.50 - 1 cm 151 to 151.50 m-2 cm	0.08	6.60	
Tamadoddi	N 16° 32' 38"	E 75° 04' 0059"	200	21.88	34 to 35- 6 cm 47 to 48 - 15cm 73to 74 - 7 cm	1.74	2.45	
Terdal	N 16° 29' 31"	E 75° 04' 11"	200	5.57	103.36 to 104 - 2 cm	0.08	11.48	
Savalagi	N 16° 41' 40"	E 75° 17' 45"	200	5.58	122 to 122.50 - 2 cm 134 to 135 - 7 cm	1.74	8.15	
Kavatgi	N 16° 32' 35"	E 75° 25' 18"	200	24.40	44 to 45 - 9 cm	3.27	2.27	
Gothe	N 16° 43' 24"	E 75° 26' 01"	200	8.83	Dry	-	-	
Algur	16.56666667	75.34583333	40.2	14.35	9.0, 13.75	1.75	5.198	9.15
Hippargi	16.59861111	75.17777778	85.1	5.05	13.0, 54.0, 85.1	2.5	25.57	12
Mareguddi	16.46666667	75.35	51.3	6.75	9.5, 18.8, 45.2, 51.3	2.85	6.146	195
Rabkavi	16.46666667	75.09722222	92	12.3	13.6, 19.8, 40.15, 79.8	3.76	9.621	71
Rabkavi	16.46666667	75.09722222	43.25	5.1	15.0, 28.0, 43.25	0.96	10.015	-

3.0 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

3.1 Aquifer wise resource availability and extraction

Table 10: Present Dynamic Ground Water Resource (2017) of Jamakhandi taluk

Taluk	Net Annual Ground Water Availability	Existing Gross Ground Water Draft For Irrigation	Existing Gross Ground Water Draft For Domestic And Industrial Water Supply	Existing Gross Ground Water Draft For All Uses	Allocation For Domestic And Industrial Use For Next 25 Years	Net Ground Water Availability For Future Irrigation Development	Existing Stage Of Ground Water Development	Category
Jamakhandi	Ham	Ham	Ham	Ham	Ham	Ham	%	SEMI-CRITICAL
	15961	10491	1063	11554	1224	4686	72	

3.2 Chemical quality of ground water and contamination

The water samples were collected from the representative dugwells during May 2018 and the data is given in **Table 11**. The results of quality parameters shows that the EC from 330 to 8100 µ/mhos/cm at 25^{o}C causing severe quality issues around Rabakivi, Kumbarhal, Savalgi and Algur villages. The fluoride is noticed upto 1.16 mg/l. The nitrate varies upto 183 mg/l. The higher amount of nitrates were observed in Kumbarhal, Banhatti and Algur villages.

Table 11: Water quality parameters of dug wells

Sl. No.	Village Name	Well type	Latitude	Longitude	PH	EC	Chloride	Nitrate	Fluoride
1	Rabakivi	Dugwell	16.4750000	75.1083333	8.28	1520	142	31	0.78
2	Banhatti	Dugwell	16.4792000	75.1319444	8.14	1470	142	94	1.16
3	Jamakhandi	Dugwell	16.5000000	75.1333333	8.92	330	36	0	0.09
4	Kumbarhal	Dugwell	16.5397000	75.3297222	8.23	2300	213	52	0.92
5	Algur	Dugwell	16.5722000	75.3486111	9.41	8100	618	183	0.65
6	Savalgi	Dugwell	16.6817000	75.3536111	8.15	2900	320	1	0.71

4.0 GROUND WATER RESOURCE ENHANCEMENT

4.1 Aquifer wise space available for recharge and proposed interventions

The details pertaining to proposed recharge structures, cost estimates and likely Recharge benefits for Jamakhandi taluk, Bagalakote district have been carried and given in below **Tables 12 & 13.**

Table 12: Quantity of non-committed surface runoff & expected recharge through AR structures (As per Master Plan on Artificial Recharge in Karnataka, 2020)

Artificial Recharge Structures Proposed	Jamakhandi taluk
Non committed monsoon runoff available (MCM)	48.730
Number of Check Dams	57
Number of Percolation Tanks	44
Number of Subsurface dykes	1
Tentative total cost of the project (Rs. in lakhs)	1472.08
Expected recharge (MCM)	36.55
Additional irrigation potential (in lakh hectares)	0.044

Table 13: Quantity of non-committed surface runoff & expected recharge through AR structures (As per Master Plan on Artificial Recharge in Karnataka, 2020)

District	Taluk	NET ANNUAL GROUND WATER AVAILABILITY	EXISTING GROSS GROUND WATER DRAFT FOR IRRIGATION	EXISTING GROSS GROUND WATER DRAFT FOR DOMESTIC AND INDUSTRIAL WATER SUPPLY	EXISTING GROSS GROUND WATER DRAFT FOR ALL USES	ALLOCATION FOR DOMESTIC AND INDUSTRIAL USE FOR NEXT 25 YEARS	NET GROUND WATER AVAILABILITY FOR FUTURE IRRIGATION DEVELOPMENT	EXISTING STAGE OF GROUND WATER DEVELOPMENT	CATEGORY
		HAM	HAM	HAM	HAM	HAM	HAM	%	
Bagalkote	Jamkhandi	15961	10491	1063	11554	1224	4686	72	SEMICRITICAL

District	Taluk	Number of Recharge Structures Completed by various agency			Number of Proposed Recharge Structures				Cost of Recharge Structures (Rs. In Lakhs)			
		CD/MACD/VD	PT	PRS	Sub surface dyke	Pecolation tank	Check dam	Filter Beds	Sub surface dyke (@Rs 20 lakhs)	Pecolation tank (@Rs 20 lakhs)	Check dam(@Rs 10 lakhs)	Filter Beds(@Rs 1.5 lakhs)
BAGALKOTE	JAMKHANDI	203	0	295	1	44	57	0	25.99	877.14	568.94	0.00

District	Taluk	Availability of Surface non commited monsoon runoff (MCM	Recharge Capacity of each structure (MCM)				Total Recharge capacity (MCM)	Total Cost in Lakhs	Expected benefit of artificial recharge & RWH	
			Sub surface dyke	Pecolation tank	Check dam	Filter Beds			Vol. of water likely to be recharged (MCM)	Additional Irrigation Potential (Lakh Hectares)
BAGALKOTE	JAMKHANDI	48.730	7.310	24.365	12.183	4.873	48.730	1472.075	36.548	0.044

4.2 Improvement in GW availability due to Recharge in Jamakhandi 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	Cumulative annual ground water availability	Expected improvement in stage of ground water development after the implementation of the project
	HAM	HAM	%	HAM	HAM	%
Jamakhandi	15961	11554	72	3654.76	19615.76	49.65

4.3 Alternate water sources

Proposed GW Recharge and Assured Supply of Drinking Water Schemes (Inter basin Transfer):

Inter-basin transfer from Aghanashini & Bedti rivers under Project-4 service canal is proposed in the "Integrated Irrigation Development Schemes" by Shri.G.S.Paramashivaiah, Retd. CE, Irrigation Department and submitted to the Govt. of Karnataka. Under this project, it is proposed to fill 1486 Minor Irrigation tanks with 182 TMC of water to 35 taluks of Bagalkote, Bidar, Bijapur, Gulbarga, Yadgiri, Koppal and Raichur districts. About 50% recharge is considered from the surface water proposed to fill the tanks for irrigation, which includes recharge from tanks, canal seepage and return flow from irrigation. After implementation of Artificial Recharge structures and proposal of GW recharge scheme (inter-basin transfer), the annual ground water availability will increase.

4.4 Benefit of Artificial recharge scheme

- Artificial recharge structures namely check dams and Nala bunds can be taken up on large scale in the over-exploited areas as a management plan to tackle falling ground water levels.
- These structures have proved in building-up of ground water levels and sustainability of ground water abstraction structures, mainly in bore wells.
- An increase in the area irrigated by ground water source is also observed in the area of influence

- Such activities help in providing sustainable drinking water to the rural population. The qualitative result from farmer's perception indicate that, there is rising trend in ground water levels in the area of influence, productivity of crops enhanced and improvement in yield is observed in bore wells
- The cropping pattern has shown that farm households have resumed growing crops such as grapes which were not previously grown in the area

5.0 DEMAND SIDE INTERVENTIONS

a. Advanced irrigation practices

It is observed that bore wells are only the source for irrigation in the taluk. Thus, by adopting the below mentioned techniques will contribute in ground water resource enhancement in the long run.

- Efficient irrigation practices like Drip irrigation & sprinkler needs to be adopted by the farmers in the existing gross irrigated area.
- Present Irrigation draft is 10491 ham in Jamakhandi taluk
- Efficient irrigation techniques will contribute in saving ground water and thus will improve stage of development

b. Change in cropping pattern

The major crops grown are Jowar, maize, wheat, bajra, sugarcane, sunflower, pulses and groundnut. Water intensive crop of sugarcane and paddy is significant from the of total cropped area by surface water, canal and ground water. Hence, change in cropping pattern has been suggested for paddy and sugarcane growing areas.

c. Regulation and Control

- Jamakhandi taluk has been categorized as **Semi Critical**, since the Stage of ground water development has reached 71 (GEC 2017). Care should be taken up through State Ground Water Authority to control further ground water exploitation in the taluk
- Ground water recharge component needs to be made mandatory in the non-command area of the taluk for further development of ground water

d. Other interventions proposed

- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan
- Excess nitrate concentration is found in ground water samples which require remedial measures viz. dilution of nitrate rich ground water through artificial recharge & water conservation
- Roof top rain water harvesting
- Micro irrigation