केन्द्रीय भूमिजल बोर्ड

जल शक्ति मंत्रालय, जल संसाधन, नदी विकास और गंगा संरक्षण विभाग

भारत सरकार

Central Ground Water Board

Ministry of Jal Shakti,
Department of Water Resources, River Development
and Ganga Rejuvenation
Government of India

Report on

AQUIFER MAPPING AND MANAGEMENT PLAN

Bantwal Taluk, Dakshina Kannada District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

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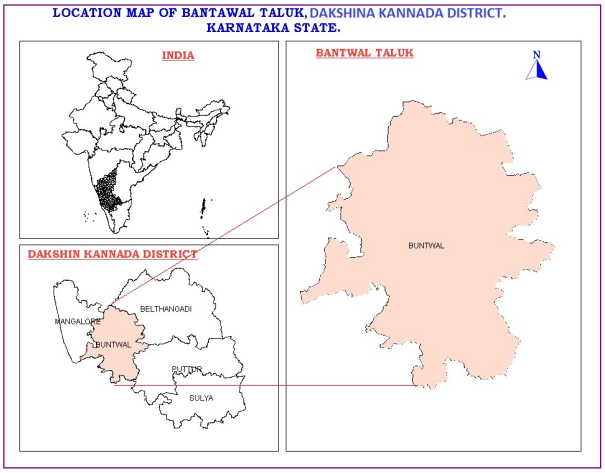
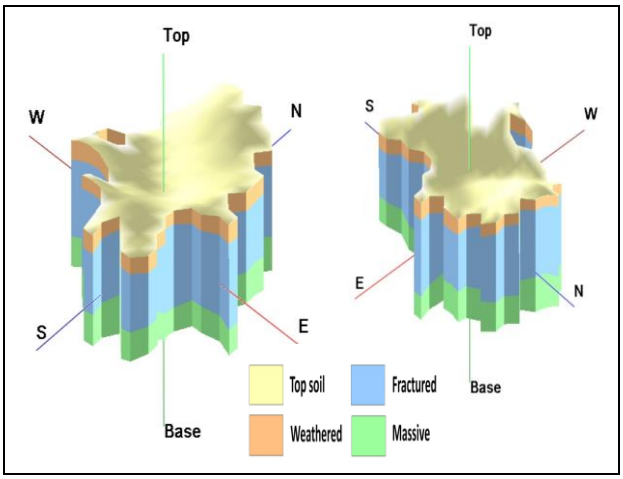
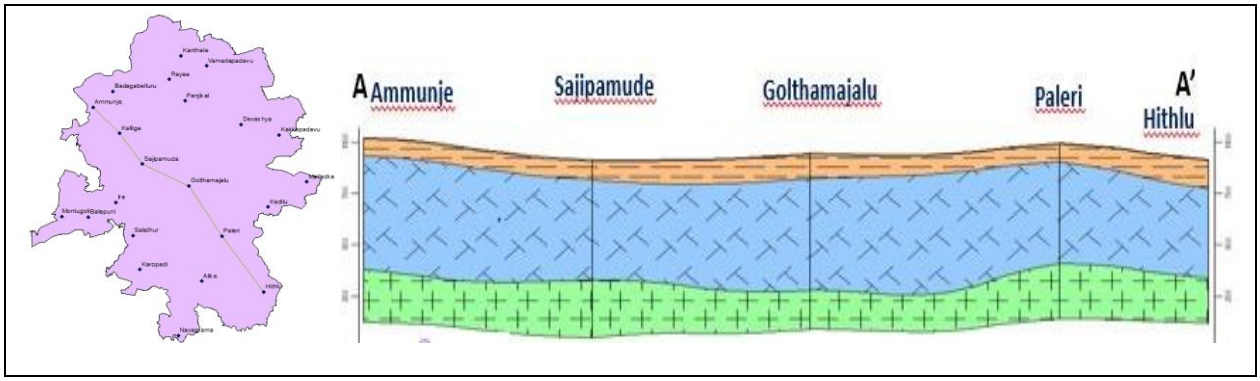
AQUIFER MAPS AND MANAGEMENT PLAN, BANTWAL TALUK, DAKSHINA KANNADA DISTRICT, KARNATAKA STATE

(AAP – 2022-2023)







By

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MAY 2023

AQUIFER MAPS AND MANAGEMENT PLAN, BANTWAL TALUK, DAKSHINA KANNADA DISTRICT, KARNATAKA STATE

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AQUIFER MAPS AND MANAGEMENT PLAN, BANTWAL TALUK, DAKSHINA KANNADA DISTRICT, KARNATAKA STATE

1 SALIENT INFORMATION

Name of the taluk: **Bantwal**

District: **Dakshin Kannada**; State: Karnataka

Area: 748 sq.km.

Population: 3,95,380

Annual Normal Rainfall: 3721 mm

1.1 Aquifer management study area

Aquifer mapping studies was carried out in Bantwal Taluk, Dakshin Kannada district of Karnataka, covering an area of 748 sq.kms under National Aquifer Mapping. Bantwal Taluk of Dakshin Kannada district is located between north latitude **12°39'29.83"** and **13°00'28.57"** & east longitude **75°02'39.02"** and **75°04'11.06"** and is covered in parts of Survey of India Toposheet Nos. 48P/1 & 2. It is bounded by Mangalore Taluk, Dakshin Kannada District in West, Puttur Taluk, Dakshin Kannada District in East, Belthangady Taluk of Dakshin Kannada district in north, Kerela State on the southern side. Location map of Bantwal Taluk of Dakshin Kannada district is presented in **Fig. 1.**

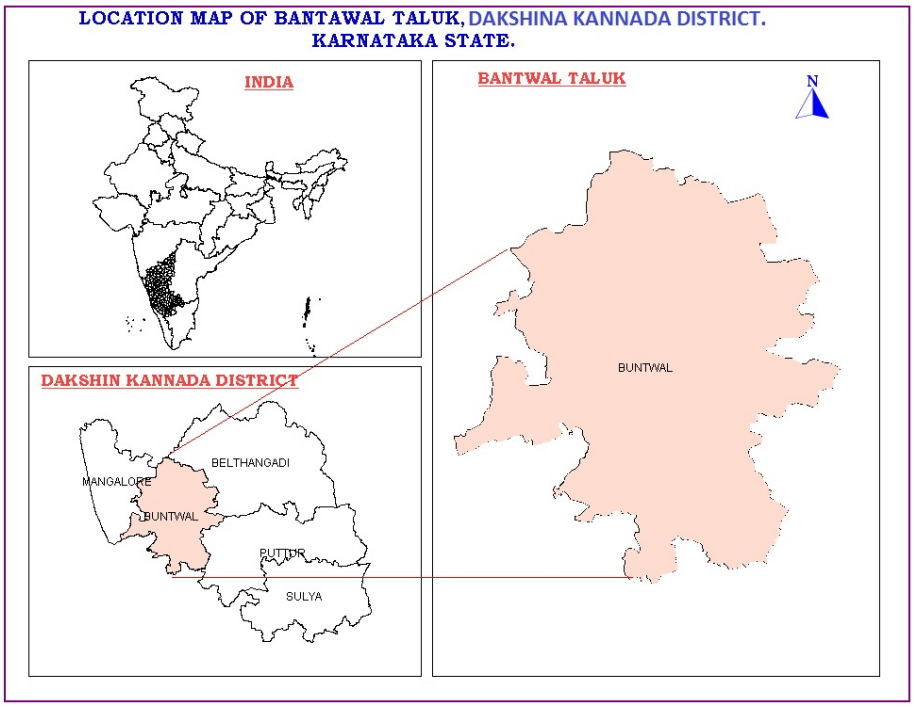


Fig. 1: Location Map of Bantwal Taluk, Dakshin Kannada district

Bantwal town is the Taluk headquarter of Bantwal Taluk. There are **3** Hoblis, **58** Gram panchayat and **72** villages in Bantwal Taluk. It is situated 420 km western side of Bangalore. The highway serves as the conduit for several arterial routes leading to neighbouring town with Mangalore. Mangalore is connected with other cities in Karnataka such as Mysore and Bangalore by National Highway 275(India) and National Highway 48(India) respectively. It is well connected with Uppala through Uppala-Mudipu-Bantwal Highway.

Population

According to 2011 census, the population of Bantwal Taluk is **3,95,380**. Out of the total population 1,96,708 constitute the male population and 1,98,672 is the female population. The urban population is 1,15,893 and rural one is 2,79,482. Decadal change in population from 2001-2011 is 9.36% in Bantwal Taluk. Decadal change in rural and urban population is -8.88% and 111.42 % respectively. The density of population is **528** persons per square km.

1.2 Rainfall

Bantwal Taluk has typical **Maritime climate**. Hot and Humid weather prevails in major part of the year. The taluk is marked by heavy rainfall, high humidity and oppressive weather in hot season. The weather is hot and humid throughout of the year. The year is usually divided into four seasons namely 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. April and May are regarded as the summer months with maximum temperature around **44 degree** Celsius and minimum temperature is around **18 degree** Celsius. The average annual rainfall is **3721 mm** and rainfall is received mainly during the south-western monsoon extending from June to September.

There is **60** rain gauge station in Bantwal Taluk, the rainfall data in respect of this station from the year 1981 to 2010 is analyzed. 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 the Taluk for the period 1981 to 2010 is **3721 mm**.

Computations were carried out for the **30** years blocks of **1981- 2010** on Mean, Standard deviation and coefficient of variation (CV) of each month pre -monsoon, monsoon, post monsoon and annual and are shown in **Table 1**.

The mean monthly rainfall at Bantwal Taluk is ranging between 0 mm during February to 1023 mm during June. The CV percent for pre-monsoon, monsoon and post monsoon season is 82, 17 & 35 percent respectively. Annual CV at this station works out to be 14 percent.

Table-1: Statistical Analysis of Rainfall Data of Bantwal taluk, Dakshin Kannada district (1981 to 2010)

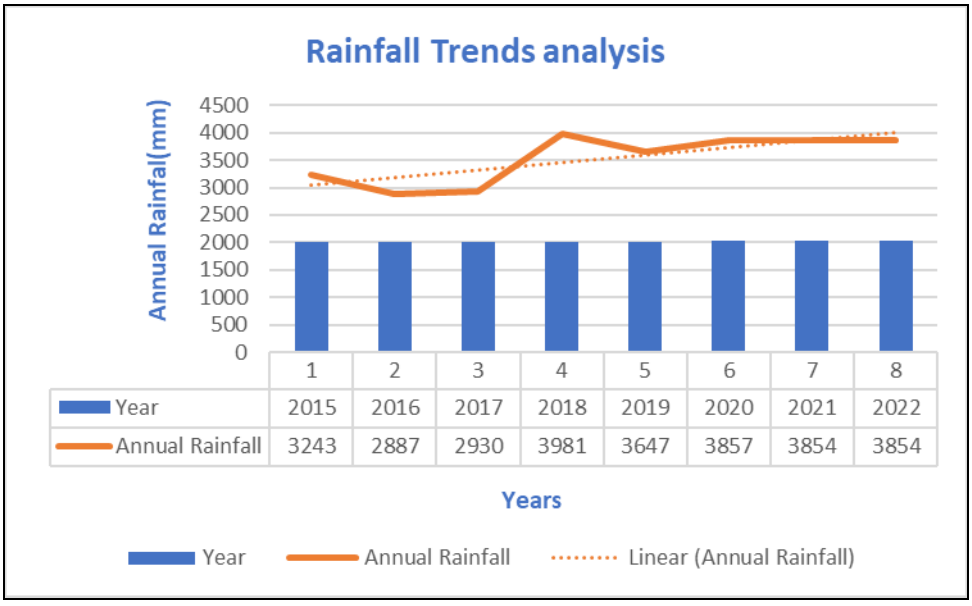
STATION		JAN	FEB	MAR	APR	MAY	PRE MONSOON	JUN	JUL	AUG	SEP	SOUTH WEST MONSOON	OCT	NOV	DEC	NORTH EAST MONSOON	ANNUAL RAINFALL
Bantwal	Normal Rainfall (mm)	1	0	17	31	167	216	1023	1078	788	283	3173	232	91	9	332	3721
	STDEV	3	0	61	31	181	176	290	362	230	195	552	109	88	18	118	510
	CV%	312	548	354	102	108	82	28	34	29	69	17	47	97	198	35	14

Annual Rainfall (2015-2022)

Computation were carried out for the annual rain fall for the year 2015-2022.The annual rainfall from **2015-2022** for month is below **(Table-2).**

Table 2: Analysis of Annual Rainfall Data of Bantwal Taluk, Dakshin Kannada District, Karnataka for the Period 2015 to 2022

ANNUAL RAINFALL (2015-2022)																
Year	JAN	FEB	MAR	APR	MAY	PRE MONSOON	JUN	JUL	AUG	SEP	SOUTH WEST MONSOON	OCT	NOV	DEC	POSTMONSOON MONSOON	ANNUAL RAINFALL
2015	0	0	6	37	181	224	742	1060	582	241	2625	292	98	4	394	**3243**
2016	0	0	1	0	196	197	926	953	505	216	2600	28	53	9	90	**2887**
2017	0	0	1	71	107	179	842	696	752	302	2592	115	44	0	159	**2930**
2018	0	0	54	0	0	54	0	0	0	0	0	0	0	0	0	**3981**
2019	0	0	0	7	22	29	567	998	1426	627	3618	0	0	0	0	**3647**
2020	3	0	13	35	170	221	971	1204	818	313	3306	225	89	16	330	**3857**
2021	2.5	0.3	13.2	34.7	168.8	219	970.9	1203.7	818	313	3305	225	89	16	330	**3854**
2022	2.5	0.3	13.2	34.7	170	218	970.9	1203.7	818.1	312.8	3305	225	89	16	330	**3854**



Rainfall Trends analysis of Bantwal Taluk

1.3 Agriculture & Irrigation

Agriculture is the main occupation in Bantwal Taluk, since 70% of the total population constitutes the rural population. The amount of rainfall and its distribution throughout the season contributes to the cropping pattern in the area. There are two agricultural seasons namely Kharif (June – October) and Rabi season (Mid October – Mid February). Most of the agriculture is through open well, bore-well and ground water is a major source of irrigation. Major Kharif crops are paddy and vegetables. Main crops of Rabi season is pulses. Among the commercial crops, Paddy is grown. Fruits and vegetables are also grown in the area (**Table 3**).

Table 3: Area wise crops grown in Bantwal Taluk

Year	Paddy	Bajra	Coconut	Arecanuts	Pulses	Sugarcane	Total plantation crop	Total fruits	Total vegetables	Total Food Grains
	Area under cultivation (in ha)									
2018 - 19	3574	4	4766	21691	15	0	2700	636	94	3593

During the year 2018-19, percentage of gross sown area of total geographical area is **49.64 %** and net sown area was **47.17 %** in Bantwal Taluk (**Table-4** and **Fig 2**). Irrigation practices by different sources in the Taluk are presented in **Table 5**.

Table 4: Land use pattern of Bantwal Taluk

Year	Total Geographical Area (ha)	Area under Forest (ha)	Area not available for cultivation (ha)	Other uncultivated land (ha)	Total fallow land (ha)	Net sown area (ha)	Area sown more than once (ha)
2018-19	71758	5069	24225	7693	924	33847	1767

Source: District at a Glance, 2019-20, Govt. of Karnataka

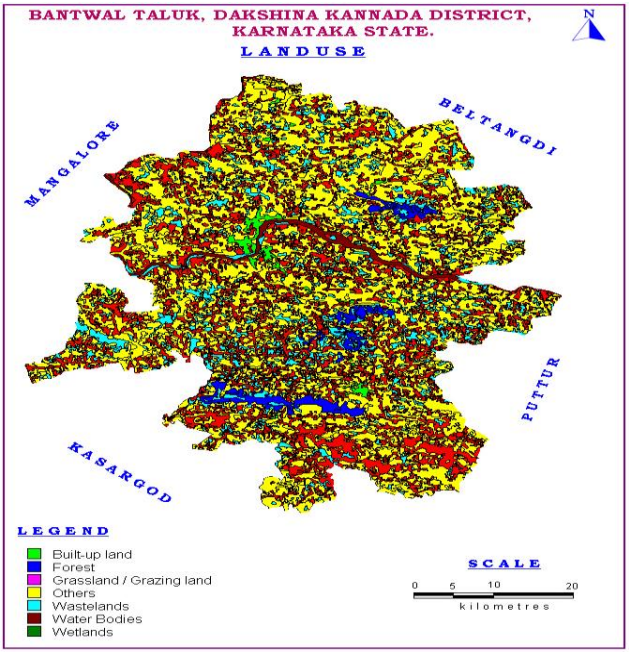
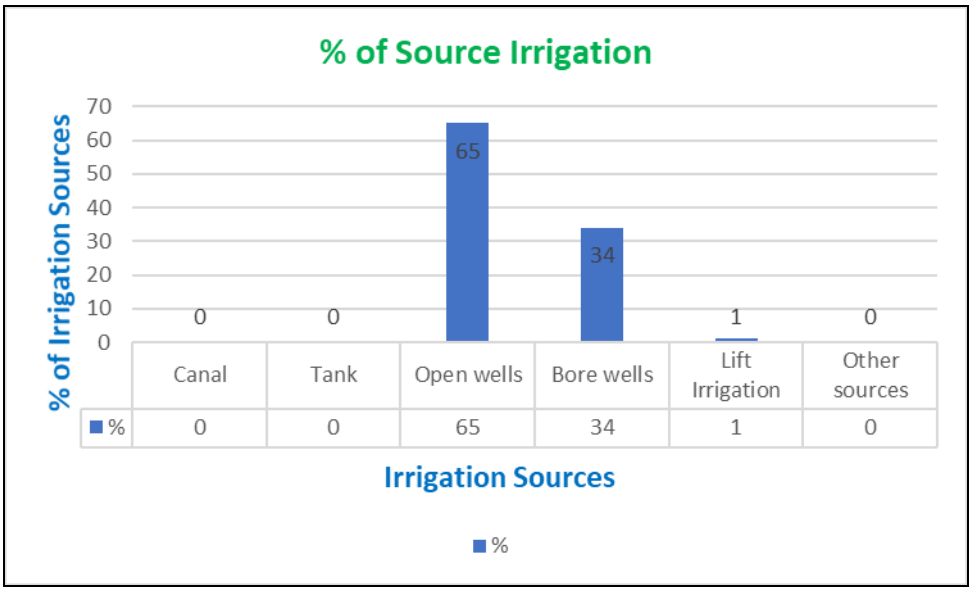


Fig. 2: Land use map

Table 5: Irrigation practice in Bantwal Taluk

Source of irrigation	No. of irrigation source	Gross area irrigated (ha)	Net area irrigated (ha)
Canals	0	0	0
Tanks	0	0	0
Open Wells	8621	5245	5134
Tube/ Bore wells	4634	19586	18178
Lift Irrigation	1	21	21
Other Sources	-	3743	3625
Total	**13256**	**28595**	**26958**

Source: District at a Glance, 2019-20, Govt. of Karnataka



Source of Irrigation in Bantwal Taluk

1.4 Geomorphology, Physiography & Drainage

Geomorphologically, Bantwal Taluk belongs to **West flowing region** which is characterized by Coastal plain in Western side, Piedmont zone in most part of taluk and Hilly area & Plateau in the central and Southern part of taluk. (**Fig. 3)**.Coastal plain is a narrow, thickly populated and intensely cultivated area adjoining the coast. There is considerable extent of barren land along the coast partly because it is sandy, rocky and marshy. The area near the sea is covered with coconut garden. The piedmont zone interspersed which is moderately cultivated with a considerable extent of fallow land, which can be put to agriculture use. The hill and plateau capped with laterite, which form plateau usually of oval or elongated configuration.

The Taluk lies in **Netravathi river sub basin**. They exhibit **dendritic to sub-dendritic drainage** pattern.(**Fig.4**.) Netravathi river originated in Bangrabalige valley, Yelaneeru ghat in Kudremukh in Chikamagaluru District of Karnataka. The river merges with Kumaradhara river at Uppinangadi before flowing to Arabian sea, south of Mangalore city. Netravathi river is Main source of Bantwal and Mangalore.

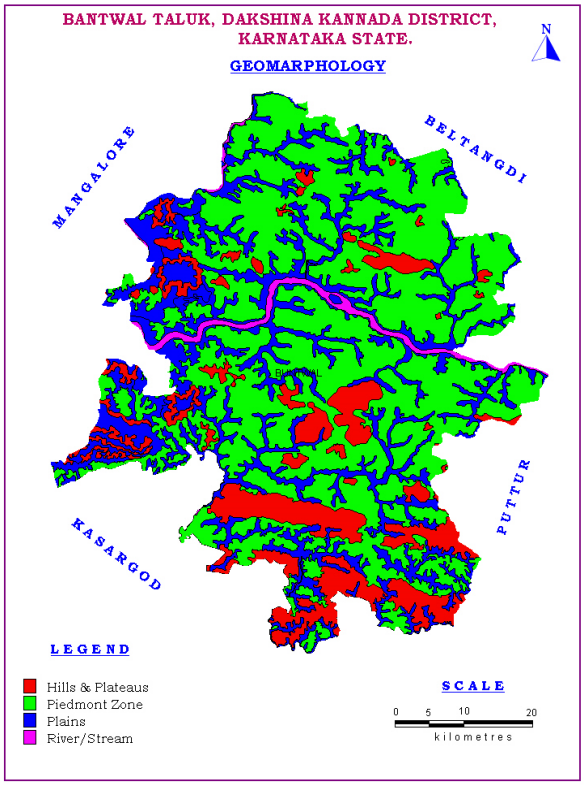


Fig. 3: Geomorphology map

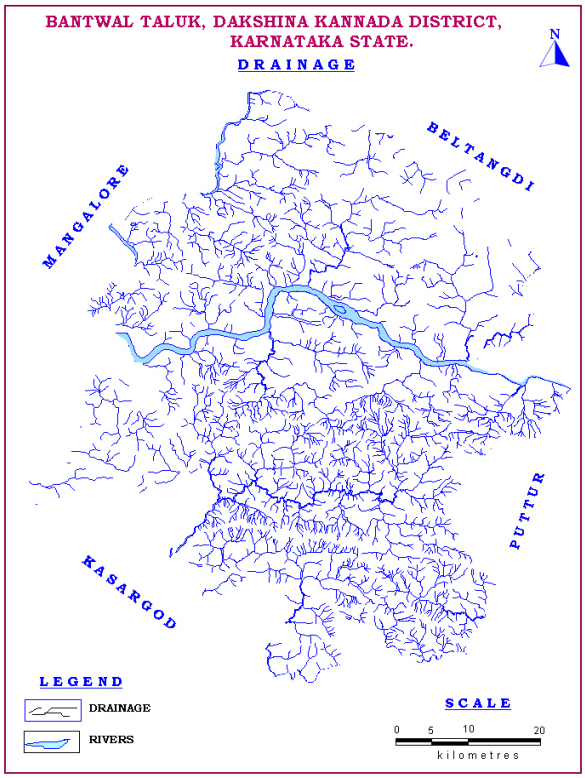


Fig. 4: Drainage map

1.5 Soil

The Taluk is mainly covered by clayey soil and varieties of **clayey soil like mixed and skeletal variety** found mostly all over the taluk.(**Fig. 5).** Soil derived from granite and gneiss with occasionally present of laterite type,characterised by High iron and aluminium content. Laterite type is suitable for Paddy, Sugarcane, Arecanut and Plantation crops. Red sandy loam are altered product of Granite gniesses, shallow to medium in depth intermixed with quartzite and gravelly material whereas the red clayey are altered product of schist. Sandy loam mostly occur near to Coastal area of Taluk.

Water holding capacity is Good. They have good Infiteration capacity and are well-suited for agriculture due to their fertility.

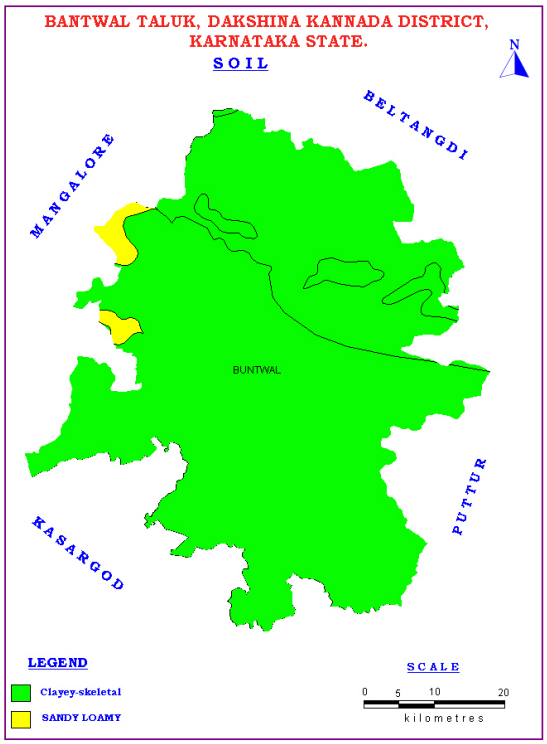


Fig. 5: Soil map

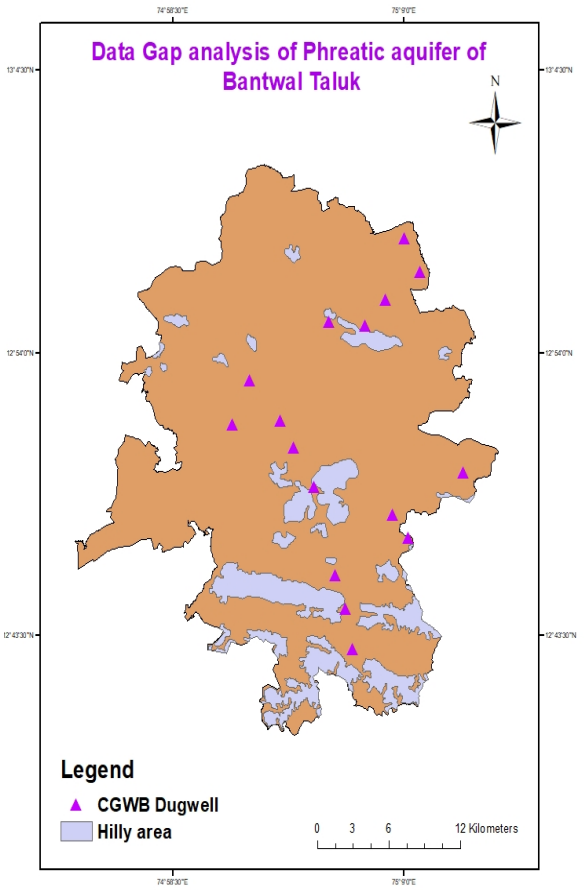
1.6 Existing and future water demands (as per GEC-2022)

Table.6 Dynamic Ground Water Resource, (2017, 2020 & 2022,in Ham)

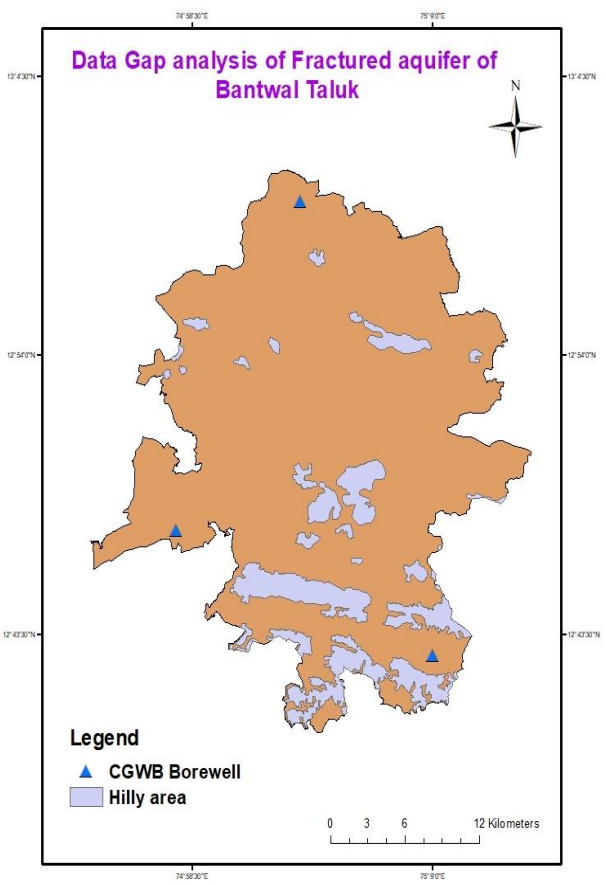
Year	Existing Gross GW extraction for Irrigation (ham)	Existing Gross GW extraction for domestic and industrial water supply (ham)	Allocation for domestic and industrial use for the next 25 years (ham)	Net GW availability for future Irrigation development (ham)	Existing stage of Groundwater development (%)
2017	4231	774	830	2352	**68**
2020	4423.18	673.41	713.80	5614.27	**47.40**
2022	5996.53	883.81	905.92	6754.19	**50.32**

1.7 Data Gap analysis and Well-Inventory with Pre-monsoon water-level Monitoring and Sample Collection

Pre-Monsoon water level monitoring generally analysed during May month. Based on the CGWB data Total **16** Dugwell and **3** Borewell present in the Bantwal taluk for Monitoring. Dugwell mostly covered in the taluk and pre-monsoon water level has been collected from the well ranges from (**0.7 – 13.7m)** in dug well **(Aquifer-1)** and (**6.27– 27 m)** in Borewell **(Aquifer-2).** From most of the 16 dugwell, water sample collection of Pre-Monsoon has been collected for Chemical Quality analyses.



Data Gap analysis of Phreatic Aquifer

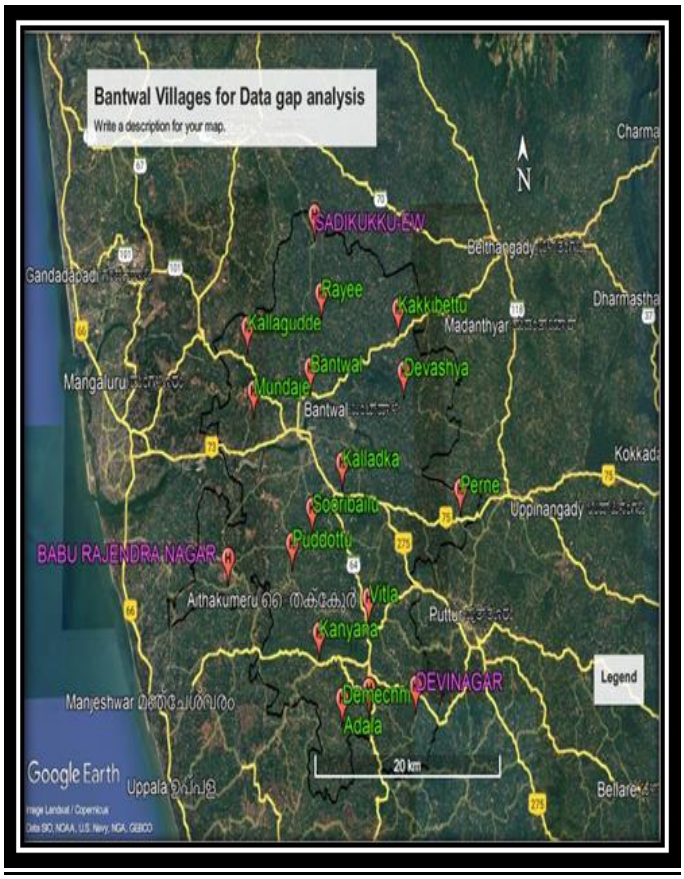


Data Gap analysis of Fractured Aquifer

3 Borewell drilled in Bantwal Taluk during Phase-1 of Drilling. Based on the available borewell data, It is showing that most of the taluk needs Data gap analysis and Well-Inventory for fractured aquifer.

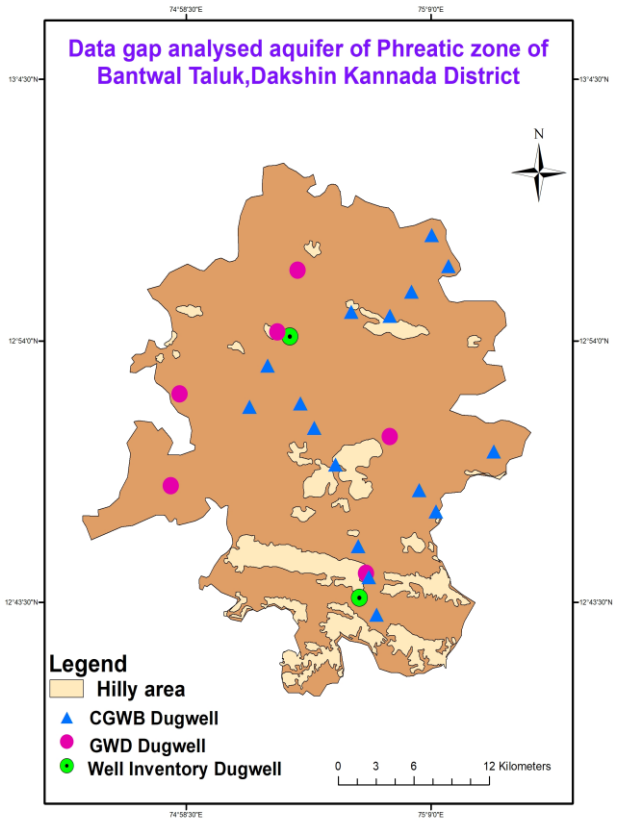
Proposed Villages should be covered under NAQUIM Studies based on Data gap analysis

S.N	VILLAGE NAME	LATITUDE	LONGITUDE	ELEVATION
1	Bantwal	12.9014	75.0368	15m
2	Rayee	12.9471	75.0581	113m
3	Kadalka	12.8418	75.0520	24m
4	Vitla	12.7642	75.0995	67m
5	Sooribailu	12.8170	75.0381	84m
6	Adala	12.7190	75.1008	108m
7	Demechhi	12.7134	75.0889	144m
8	Kanyana	12.7468	75.0616	136m
9	Puddottu	12.8056	75.0358	62m
10	Perne	12.8290	75.2030	51m
11	Devashya	12.9021	75.1410	153m
12	Kakkibettu	12.9448	75.1566	125m
13	Mundaje	12.8975	75.0029	67m
14	Kallagudde	12.9341	75.9970	26m

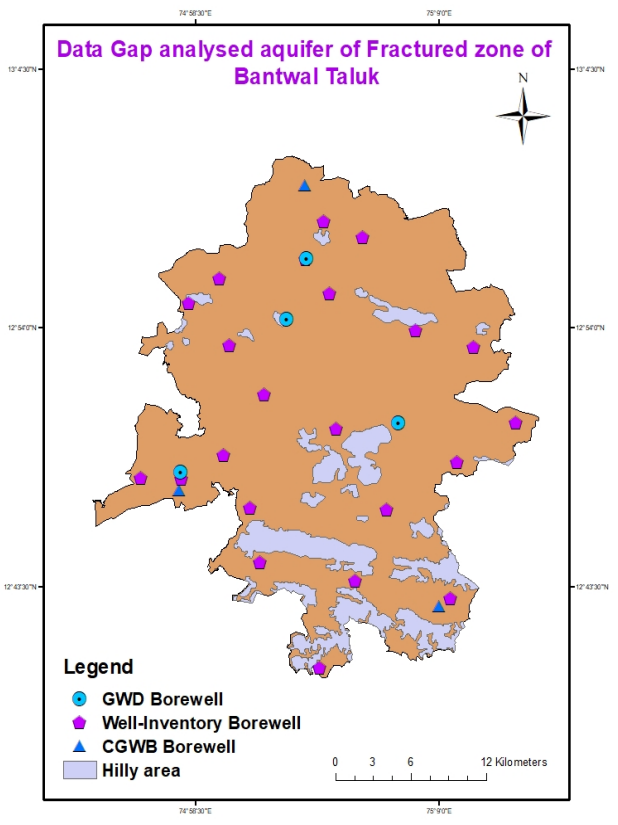


1.8 Data Gap analysed aquifer of Phreatic and Fractured aquifer

Based on the presence of Dugwell data, the Phreatic zone is covered mostly in all reliable zone except hilly areas and 2 Dugwell inventory has been done and 6 state government well utilized for data gap. Ground water exploration programme of CGWB was carried out in three phases in the district. There are few wells have been drilled in Bantwal Taluk during 1st phase, which reveals that the weathered, jointed and fractured granite is the potential aquifer system. 3 Borewell drilled in Bantwal Taluk during Phase-1 of Drilling. Based on the available borewell data, It is showing that most of the taluk needs Data gap analysis and Well-Inventory for fractured aquifer. Data Gap analysis and Well-inventory conducted in total **25** villages in entire taluk and 4 state government well utilized. Based on the Well-Inventory, Total depth of well drilled, Discharge, Weathered zone, casing and Fractured zone data has been collected.



Data Gap analysed aquifer of Phreatic zone



Data Gap analysed aquifer of Fractured zone

1.9 Water level behavior

A. DEPTH TO WATER LEVEL of Aquifer-I:

The distribution of depth to water level of Phreatic aquifer in different depth ranges is presented. Salient features of the depth to water level scenario during **May 2022** and **Nov 22** are given below. **(Fig-6)**

Pre-Monsoon 2022 DTWL of Aquifer-I -(Fig-6A)

A perusal of the water level data reveals that the depth to water level ranged from **0.7 m bgl to 13.70 m bgl** .Depth to water level of less than 2 m bgl has been recorded in 1 % of wells analysed, 2 to 5 m bgl water level has been recorded in 18 % of wells analysed, 5 to 10 m bgl water level has been recorded in 73 % of wells analysed and the ranges of 10 to 15 m bgl water level has been recorded in 5 % of wells analysed.

Post-Monsoon 2022 DTWL of Aquifer-I -(Fig-6B)

A perusal of the water level data reveals that the depth to water level ranged from **0.22 m bgl to 14 m bgl** . Depth to water level of less than 2 m bgl has been recorded in 1 % of wells analysed, 2 to 5 m bgl water level has been recorded in 20 % of wells analysed, 5 to 10 m bgl water level has been recorded in 69 % of wells analysed and the range of 10 to 14 m bgl water level has been recorded in 10 % of wells analysed.

Table-7: Depth to water level of Pre-monsoon and post-Monsoon

Sr. No	Village	Source	Pre-monsoon Depth to water May-2022 (mbgl)	Post-monsoon Depth to water Nov-2022 (mbgl)	Seasonal Fluctuation
1	Bantwal-1	**Dug Well**	7.30	4.32	2.98
2	Bollangadi	**Dug Well**	4.72	5.4	-0.68
3	Kabaka	**Dug Well**	9.21	4.45	4.76
4	Kalladka	**Dug Well**	8.25	6.25	2
5	Kaval Maduru	**Dug Well**	7.45	8.34	-0.89
6	Kelagina Ogga	**Dug Well**	6.45	5.4	1.05
7	Kudupadaru	**Dug Well**	6.30	9.25	-2.95
8	Mani	**Dug Well**	13.70	14.01	-0.31
9	Mittur	**Dug Well**	8.07	6.21	1.86
10	Nayanaadu	**Dug Well**	5.16	6.98	-1.82
11	Punjalkatte	**Dug Well**	13.70	9	4.7
12	St.Perne	**Dug Well**	6.75	5.95	0.8
13	Subashnagar	**Dug Well**	5.52	5.6	-0.08
14	Ukkuda	**Dug Well**	5.85	6.05	-0.2

15	Veerkambha	**Dug Well**	0.7	0.22	1
16	Vittala	**Dug Well**	8.05	8.1	-0.05
17	Bantwal pz	**Borewell**	13.98	14.40	-0.42
18	Vittal pz	**Borewell**	27	19.61	7.39
19	Mani BW	**Borewell**	6.25	6.65	-0.4
20	Mudipu BW	**Borewell**	24.29	30.14	-5.85
21	Rayi BW	**Borewell**	14.45	12.15	2.3

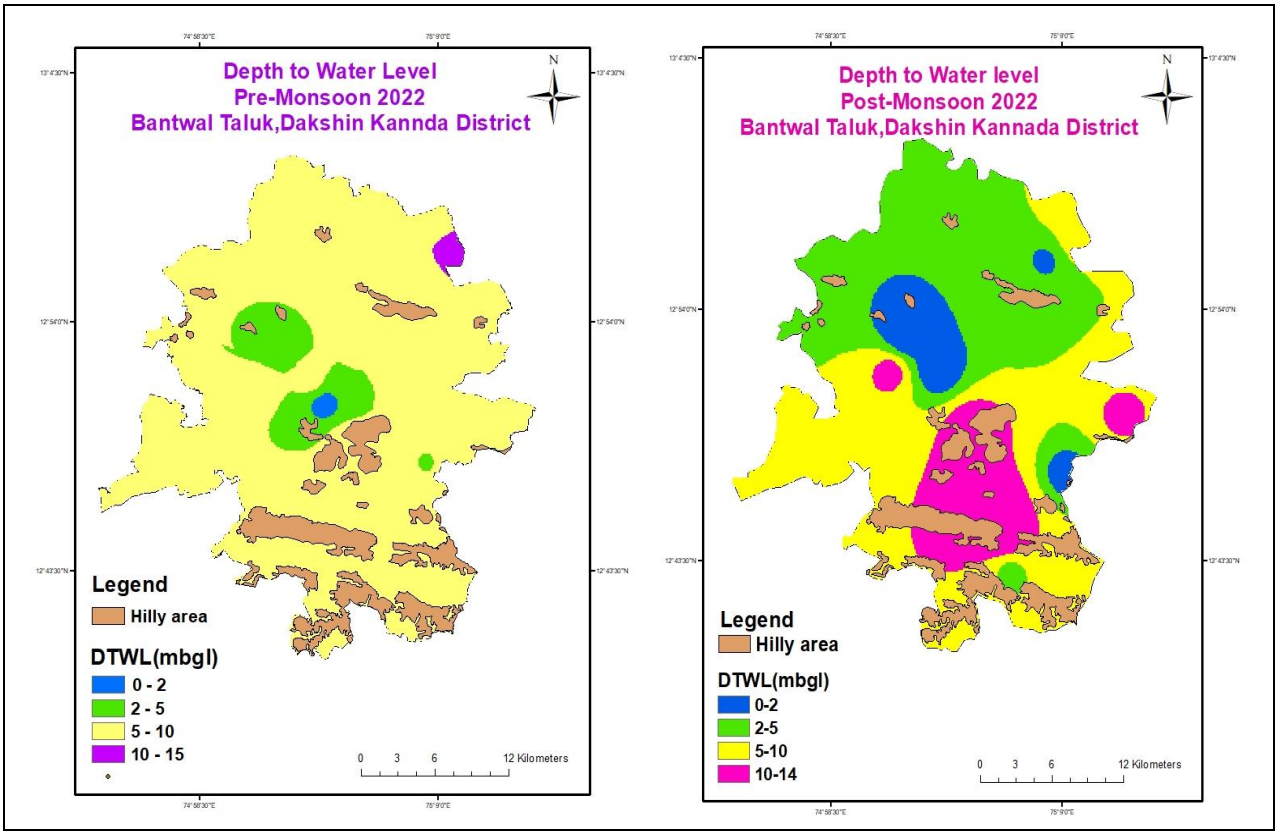


Fig 6A & 6B: Pre-monsoon 22 and Post-Monsoon 22 Phreatic water level map

B. DEPTH TO WATER LEVEL OF PIEZOMETRIC SURFACE:

The distribution of depth to water level of Piezometric surface in different depth ranges is presented. Salient features of the depth to water level scenario during **May 2022** and **Nov 22** are given below.

Pre-Monsoon 2022 DTWL of Aquifer-II-(Fig-6C)

A perusal of the water level data reveals that the depth to water level ranged from **6.25 m bgl to 27 m bgl** . Depth to water level in the range of 0 to 15 m bgl has been recorded in 65 % of wells analysed and 15 to 30 m bgl water level has been recorded in 35 % of wells analysed.

Post-Monsoon 2022 DTWL of Aquifer-II -(Fig-6D)

A perusal of the water level data reveals that the depth to water level ranged from **6.65 m bgl to 30.14 m bgl** . Depth to water level in the range of 0 to 15 m bgl has been recorded in 70 % of wells analysed, 15 to 20 m bgl water level has been recorded in 15 % of wells analysed and the range more than 20 m bgl water level has been recorded in 15 % of wells analysed.

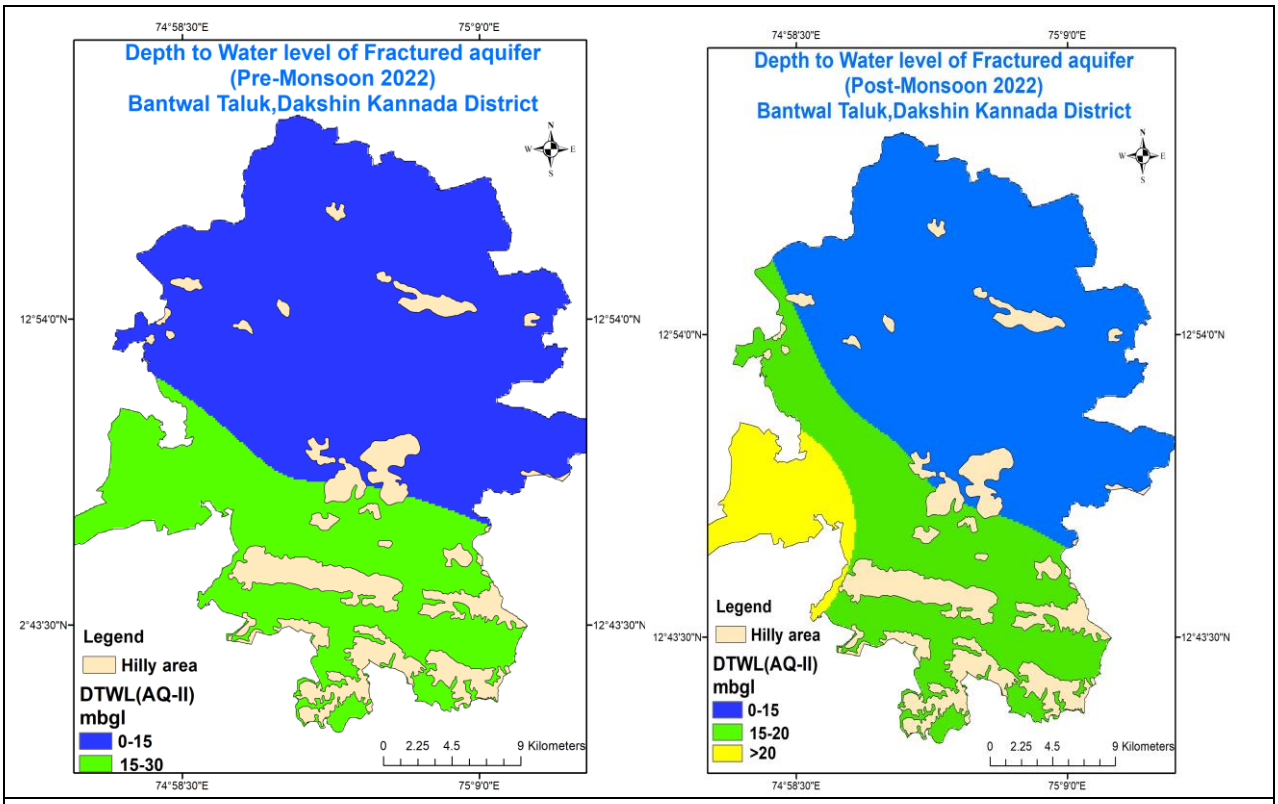


Fig 6C & 6D: Pre-monsoon 22 and Post-Monsoon 22 Fractured water level map

C. SEASONAL FLUCUATION OF AQ-I (May 2022-Nov2022) –

The distribution of ground water monitoring wells of **Aq-I** showing rising and falling in different ranges of fluctuation is presented. **(Fig-6E)**

Rise in the water level in the range of 0-2 m has been observed in **82%** of wells analysed, 2-4 m rise has been observed in **6%** of wells and more than 4m rise has been observed in **4%** of wells analysed. The fall in water level in the range of 0-2 m has been observed in **8%** of wells analysed.

SEASONAL FLUCUATION OF AQ-II (May 2022-Nov2022) –

The distribution of ground water monitoring wells of **Aq-II** showing rising and falling in different ranges of fluctuation is presented. **(Fig-6F)**

Rise in the water level in the range of 0-5 m has been observed in **50%** of wells analysed and more than 5m rise has been observed in **15%** of wells analysed. The fall in water level in the range of 0-5 m has been observed in **35%** of wells analysed.

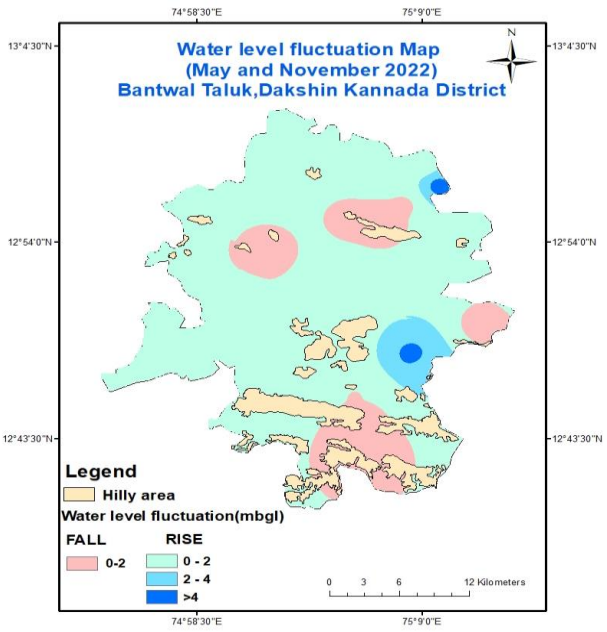


Fig-6E Seasonal Fluctuation Map of Bantwal Taluk of Aquifer-I

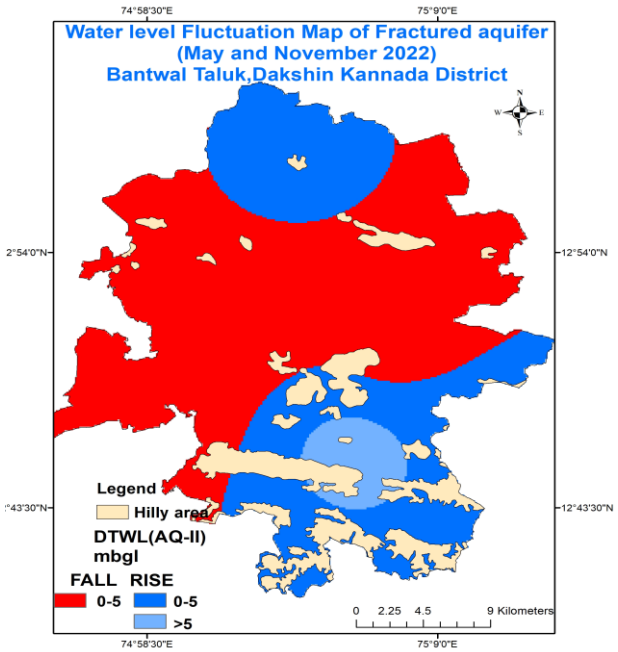


Fig-6F Seasonal Fluctuation Map of Bantwal Taluk of Aquifer-II

D. ANNUAL FLUCTUATION OF PRE & POST MONSOON-

Annual Fluctuation of Pre-Monsoon (May 21 to May 22)-

The distribution of ground water monitoring wells falling in different ranges of fluctuation is showing in **Fig-6G**. A comparison of water level shows that a fall in the water level is recorded in 55 % of wells analysed, while 45 % recorded rise. Salient features of the comparison of water levels are given below.

Rise in the water level in the range of 0-2 m has been observed in **31%** of wells analysed and more than 2 m rise has been observed in **14%** of wells analysed. The fall in water level in the range of 0-2 m has been observed in **46%** of wells analysed and more than 2 m fall has been observed in **9 %** of wells analysed.

Annual Fluctuation of Post-Monsoon (Nov 2021 to Nov 22)-

The distribution of ground water monitoring wells falling in different ranges of fluctuation is showing in **Fig-6H**. A comparison of water level shows that a fall in the water level is recorded in 82 % of wells analysed, while 18 % recorded rise. Salient features of the comparison of water levels are given below.

Rise in the water level in the range of 0-2 m has been observed in **9 %** of wells analysed and more than 2 m rise has been observed in **9 %** of wells analysed. The fall in water level in the range of 0-2 m has been observed in **59%** of wells more than 2 m fall has been observed in **23%** of wells.

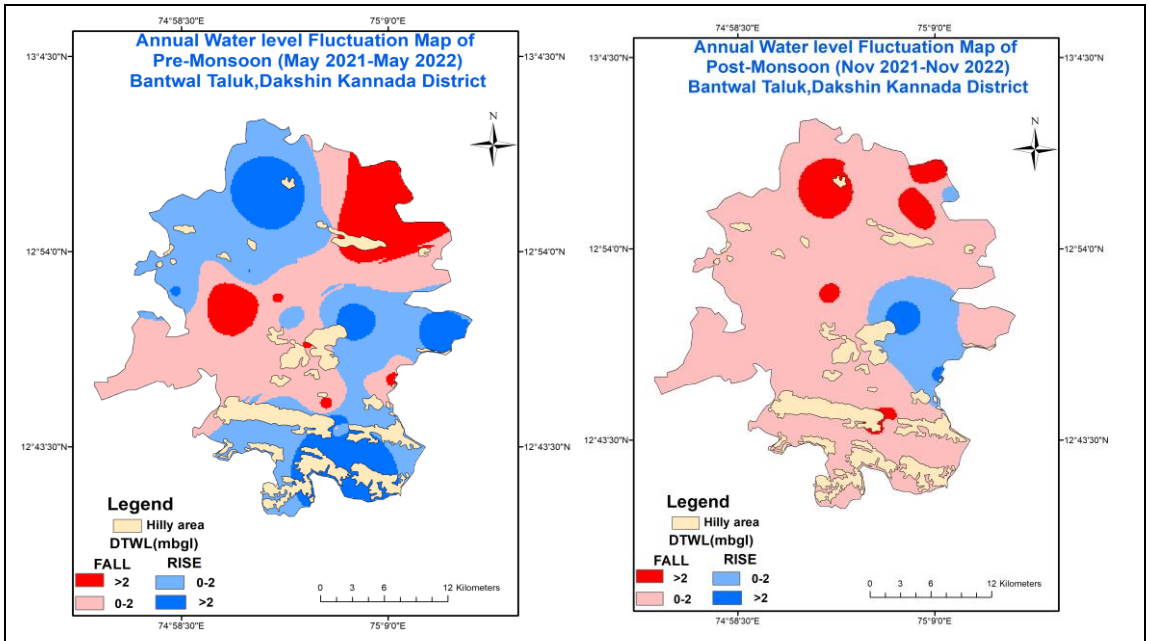


Fig 6G & H: Annual water level fluctuation Map of Pre monsoon & Post-Monsoon

E. DECADAL AVERAGE PRE & POST MONSOON—

Decadal average Pre-Monsoon (2013-2022) DTWL-

A perusal of the water level data reveals that the depth to water level ranged from **4.12 m bgl to 12.34 m bgl**. **(Fig-6I)** Depth to water level in the range of 0 to 5 m bgl has been recorded in **18 %** of wells analysed, 5 to 10 m bgl water level has been recorded in **59 %** of wells analysed and 10 to 15 m bgl water level has been recorded in **23 %** of wells analysed.

Decadal average Post-Monsoon (2013-2022) DTWL-

A perusal of the water level data reveals that the depth to water level ranged from **2.08 m bgl to 8.95 m bgl** . **(Fig-6J)** Depth to water level in the range of 0 to 3 m bgl has been recorded in **18 %** of wells analysed, 3 to 5 m bgl water level has been recorded in **27 %** of wells analysed and 5 to 10 m bgl water level has been recorded in **55 %** of wells analysed.

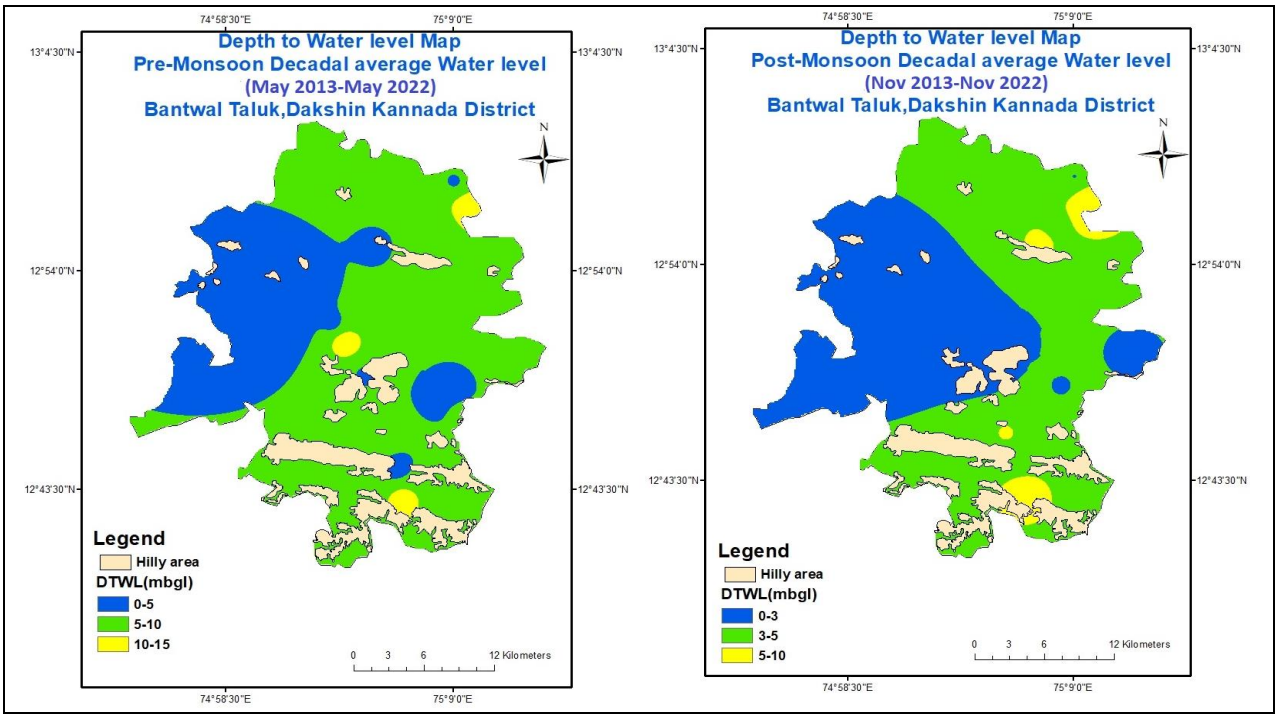


Fig 6I &J: Decadal average Pre Monsoon and Post-Monsoon water level map

F. DECADAL FLUCTUATION OF PRE & POST MONSOON-

Decadal Fluctuation of Pre-Monsoon (May 2012-21 to 22)-

The distribution of ground water monitoring wells falling in different ranges of fluctuation is showing in **Fig-7**. A comparison of water level shows that a fall in the water level is recorded in 18 % of wells analysed, while 82 % recorded rise. Salient features of the comparison of water levels are given below.

Rise in the water level in the range of 0-2 m has been observed in **18%** of wells analysed, 2-4 m rise has been observed in **56%** of wells analysed, more than 4-10 m rise has been observed in **4%** of wells analysed and more than 10 m rise has been observed in **4%** of wells analysed. The fall in water level in the range of 0-2 m has been observed in **18%** of wells.

Decadal Fluctuation of Post-Monsoon (Nov 2012-21 to 22)-

The distribution of ground water monitoring wells falling in different ranges of fluctuation is showing in **Fig-8**. A comparison of water level shows that a fall in the water level is recorded in 73 % of wells analysed, while 27 % recorded rise. Salient features of the comparison of water levels are given below.

Rise in the water level in the range of 0-2 m has been observed in **23 %** of wells analysed, 2-5 m rise has been observed in **4 %** of wells analysed. The fall in water level in the range of 0-2 m has been observed in **32%** of wells and the more than 2 m fall has been observed in **41%** of wells.

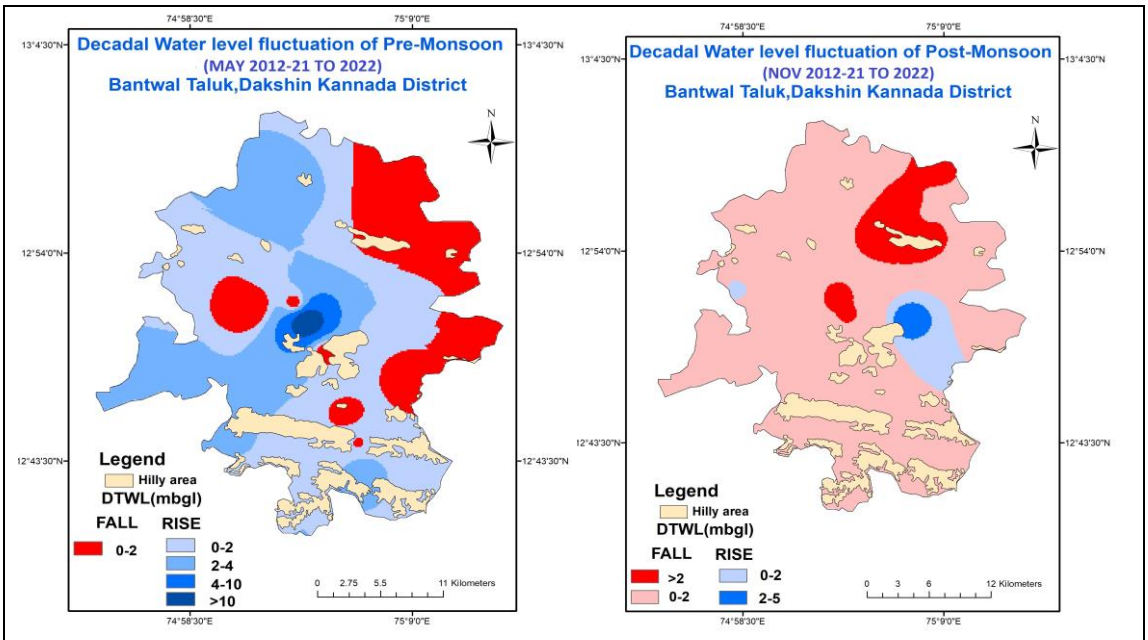
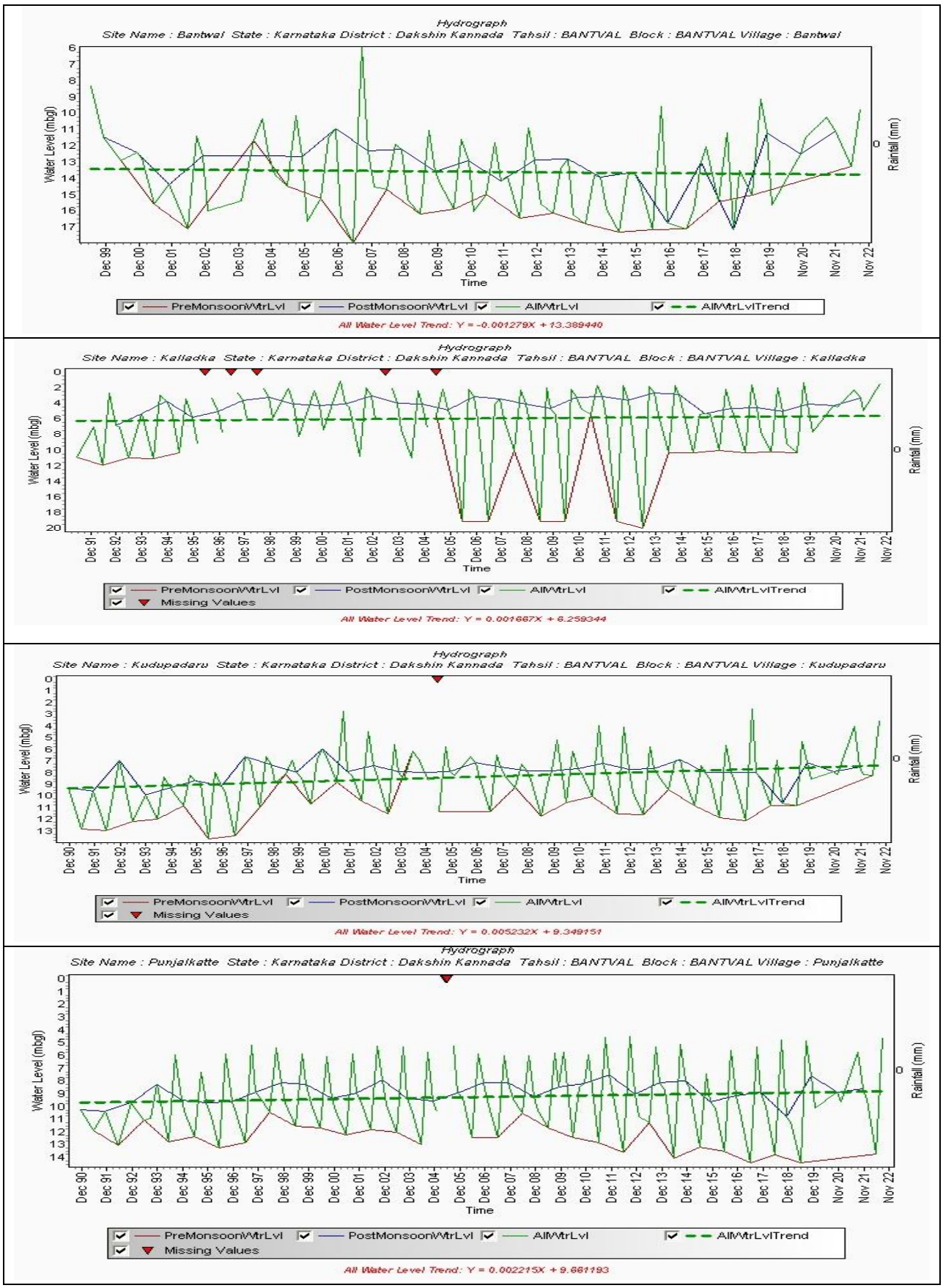


Fig 7 & 8: Decadal water level fluctuation Map of Pre monsoon & Post-Monsoon

G. Long term water level trend & Hydrographs of Bantwal taluk-



2 AQUIFER DISPOSITION

Banded Gniessic Complex occupy nearly 80% of all over the taluk whereas laterite occurs in the rest 10% in the western part of the Taluk (**Fig 8**) and Charnockite is mostly in Southern portion of taluk. The gneisses comprise of migmatites associated with biotites and hornblendes. The granites are grey in colour and are fine to coarse grain in nature. Ground water occurs under water table to semi confined condition depending upon disposition of aquifer which is mainly granite and schist. Ground water occur under water table to semi confined condition in granite whereas in schist groundwater occur in weathered, jointed and fractured zone under water table condition.

Ground water exploration programme of CGWB was carried out in three phases in the district. There are few wells have been drilled in Bantwal Taluk during 1st phase, which reveals that the weathered, jointed and fractured granite is the potential aquifer system.

Majority of the dug well in granitic gneiss ranges in depth from **10.3m to 32.2m** having a weathered zone from **3m to 28m**. Water level lies in the range of **0.7 to 13.70 m bgl** mbgl.

Pumping test of 500 minutes conducted on open well in Bantwal have revealed that the discharge ranges between **1 to 4.5 lps** with a drawdown of 14.5 m and unit area specific capacity of 22.18 lpm/m/m.

2.1 Number of aquifers:

In **Bantwal** Taluk, there are mainly two types of aquifer systems;

i. Aquifer-I (Phreatic aquifer, weathered zone) comprising of **Granitic Gneiss**

ii. Aquifer-II (Fractured zone) comprising of **Fractured Granitic gneiss**

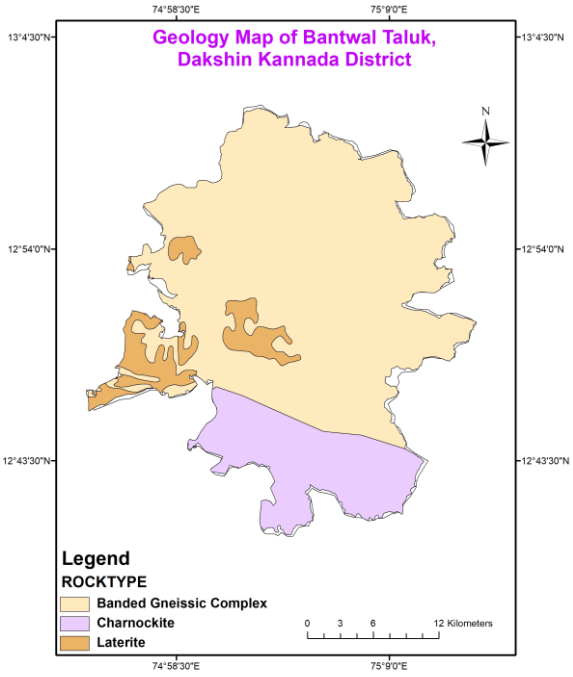


Fig 9: Geology Map

Fig 9 showing the Geology of Bantwal taluk, Banded Gneissic Complex is found most of the part of taluk, Laterite in western part of taluk in Coastal area and Charnockite in Southern part of taluk.

Table-8: Details of Ground Water Exploration

S. No	Location	Lat	Long	Depth m bgl	Casing (m)	Litholo gy	SWL (mbgl)	Q (lps)	T (m^2/day)
1	**Hithlu**	12.71735	75.15804	140	28.9	ARCN GRGN	8.38	1.22	3
2	**Kedilu**	12.80907	75.1627	180	26.6	ARCN GRGN	6.69	4	0.07
3	**Ira**	12.814	74.99537	180	20	ARCN GRGN	14.29	3	-
4	**Karopadi**	12.74155	75.02146	221	20	ARCN GRGN	9.517	1	476
5	**Kanthale**	12.97202	75.06685	195	18	ARCN GRGN	-	2.5	-
6	**Sajipamuda**	12.85527	75.02447	185	20	ARCN GRGN	-	1.5	-
7	**Navagrama**	12.67026	75.06399	165	35	ARCN GRGN	-	4	-
8	**Golthamajalu**	12.83195	75.07584	177	33	ARCN GRGN	-	3	-
9	**Malladka**	12.83618	75.20522	215	33	ARCN GRGN	-	2	-
10	**Vamadapadavu**	12.96122	75.095	190	21	ARCN GRGN	-	3	-
11	**Salethur**	12.77845	75.01416	180	20	ARCN GRGN	-	4.5	-
12	**Rayee**	12.94679	75.05413	200	19	ARCN GRGN	-	4	-
13	**Balepuni**	12.79807	74.96508	195	33	ARCN GRGN	-	4	-
14	**Montugoli**	12.79886	74.93601	198	33	ARCN GRGN	-	4	-
15	**Kakkepadavu**	12.88688	75.1749	160	33	ARCN GRGN	-	4	-
16	**Panjikal**	12.92349	75.07157	185	18	ARCN GRGN	-	3	-
17	**Kallige**	12.88851	74.99952	165	17	ARCN GRGN	-	3	-
18	**Badagabelluru**	12.93376	74.99208	189	20	ARCN GRGN	-	1.5	-
19	**Ammunje**	12.91656	74.97025	185	21	ARCN GRGN	-	2	-
20	**Alike**	12.72896	75.08973	185	17	ARCN GRGN	-	3	-
21	**Devashya**	12.89824	75.13317	190	17	ARCN GRGN	-	2	-
22	**Paleri**	12.77743	75.11207	195	16	ARCN GRGN	-	2.5	-

Table-9 Basic characteristics of each aquifer

Aquifers	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Weathered Gniess/Schist	Fractured Gniesses/Schist
Thickness range (mbgl)	35	Fractures upto 200 mbgl
Depth range of occurrence of fractures (mbgl)	4-30	15-185
Range of yield potential (lps)	Poor yield	1-4.5
Specific Yield	2%	0.2%
T (m^2/day)	-	0.07-476
Quality Suitability for Domestic &Irrigation	Suitable	Suitable

2.2 Depth wise Aquifer System

The data generated from ground water monitoring wells, hydrogeological inventories, exploratory and observation wells, various thematic layers was utilized to decipher the aquifer disposition of the area. In the taluk, if we consider the vertical distribution of aquifer, two types of aquifer system are observed i.e., Aquifer – I which is a shallow phreatic aquifer and Aquifer – II which constitutes the deeper fractured aquifer.

2.2.1 Aquifer-I (Shallow Phreatic aquifer)

Aquifer – I comprises of Laterite and weathered granitic gneiss. The spatial distribution of depth of occurrence and aquifer thickness of Aquifer-I is depicted in **Fig. 9A** and the hilly area,Drainage map and borewell location is also included in map. It indicates that the depth of occurrence of aquifer – I ranges from 15 to 35 m bgl. However, it mainly occurs in the depth range of 20 to 30 m bgl covering 45% of the area mostly in the all part of the taluk. The depth of occurrence of 15 to 20 m bgl is observed in about 45% of area mainly in Northern and southern parts of the taluk. The deep depth of occurrence of 30 to 35 m bgl is observed in about 10% of the areas mostly in isolated patch in all part.

The perusal of the map for aquifer thickness indicates that it ranges from 2 to 15 m, however aquifer thickness of 5 to 10 m is observed in about 80% of the area covering northern, central and southern parts of the State. The aquifer thickness of 2 to 5 m is observed in 10% of the areas covering northern and western parts. The maximum thickness of 10 to 15 m observed in 10% mostly in patches in all over the taluk.

2.2.2 Aquifer-II (Deeper Fractured aquifer)

It comprises of fractured Granite Gneiss, laterite and Charnockite rock. The spatial distribution of depth of occurrence and aquifer thickness of Aquifer-II is depicted in **Fig. 9B** and the hilly area, Drainage map and borewell location is also included in map. It indicates that the depth of occurrence of aquifer – II ranges from 110 to 190 m bgl. However, it mainly occurs in the depth range of 130 to 140 m bgl covering 70% of the area throughout the taluk. The depth of occurrence of 110 to 130 m bgl is observed in about 15% in patches in all taluk. The depth of Occurrence of 140-160 is observed in 5% in Northern, Western and Eastern part of taluk. The deeper depth of occurrence of 160 to 190 is observed in 10% in Northern, Western and Eastern part of taluk. The perusal of the map for fractured aquifer thickness indicates that it ranges from 6 to 19 m, however aquifer thickness of 8 to 12 m is observed in about 75% of the area covering all parts of the taluk. The aquifer thickness of 6 to 8 m is observed in 10% of the areas covering mostly all parts. Thickness of 12-16 m is observed in Northern, eastern and western part

of taluk. The higher fractured aquifer thickness of 16 to 19 m is observed in 10% of the Northern, eastern and western areas.

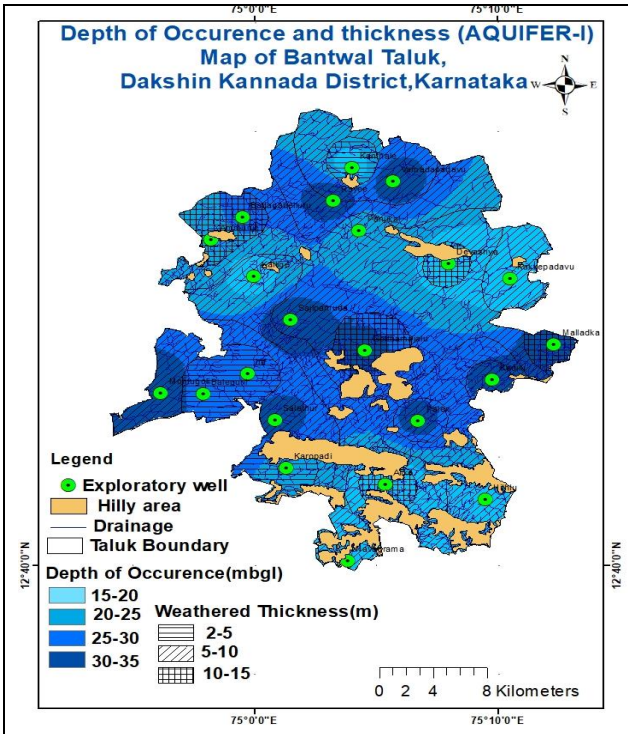


Fig-9A Depth of Occurrence and thickness Map (Aq-I)

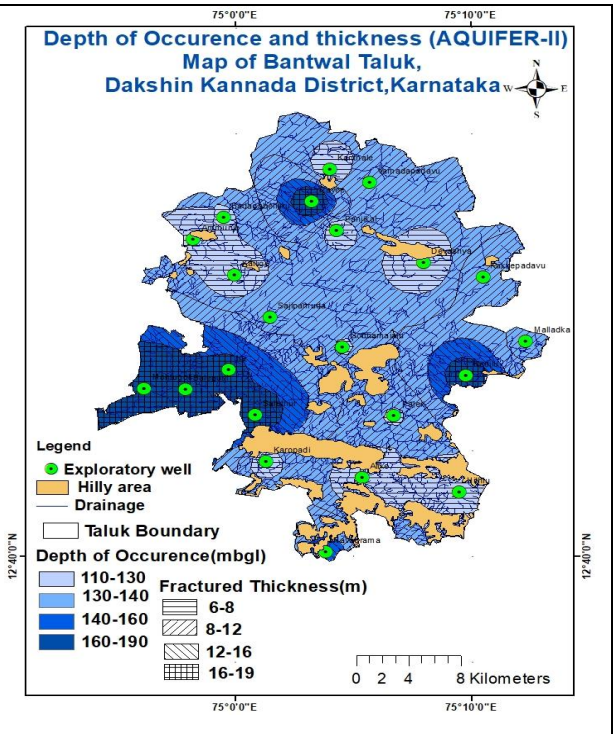


Fig-9B Depth of Occurrence and thickness Map (Aq-II)

2.3 3 D aquifer disposition and Cross-Sections

Aquifer disposition – The drilling data obtained from other departments is utilised for generating aquifer disposition maps through Rock works software. The **2D** and **3D** outputs thus obtained is presented in **Fig-10,Fig-11 & to Fig-12.**

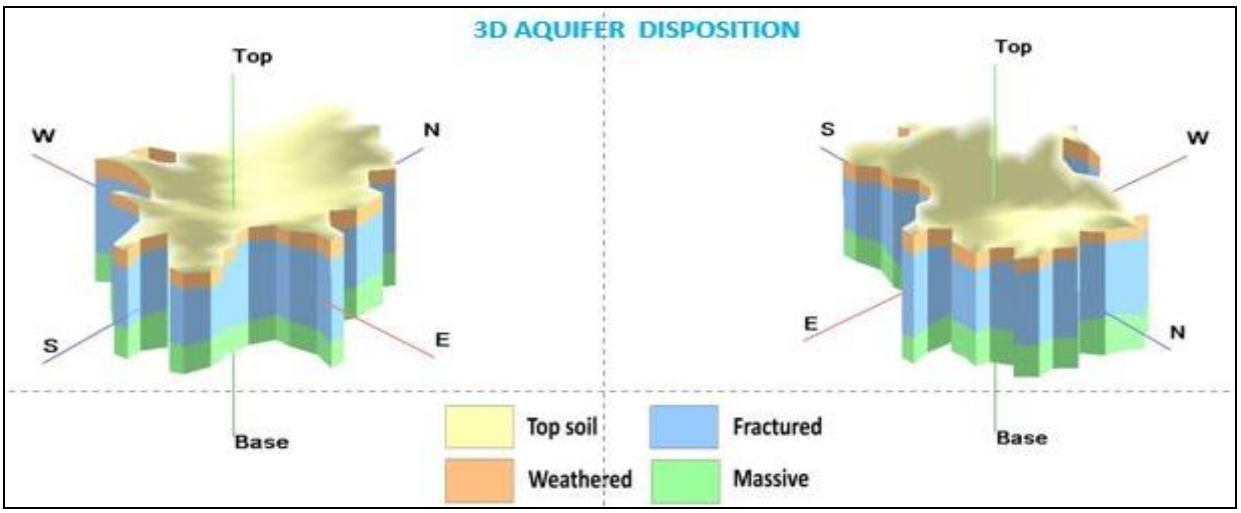


Fig-10: 3D aquifer Disposition

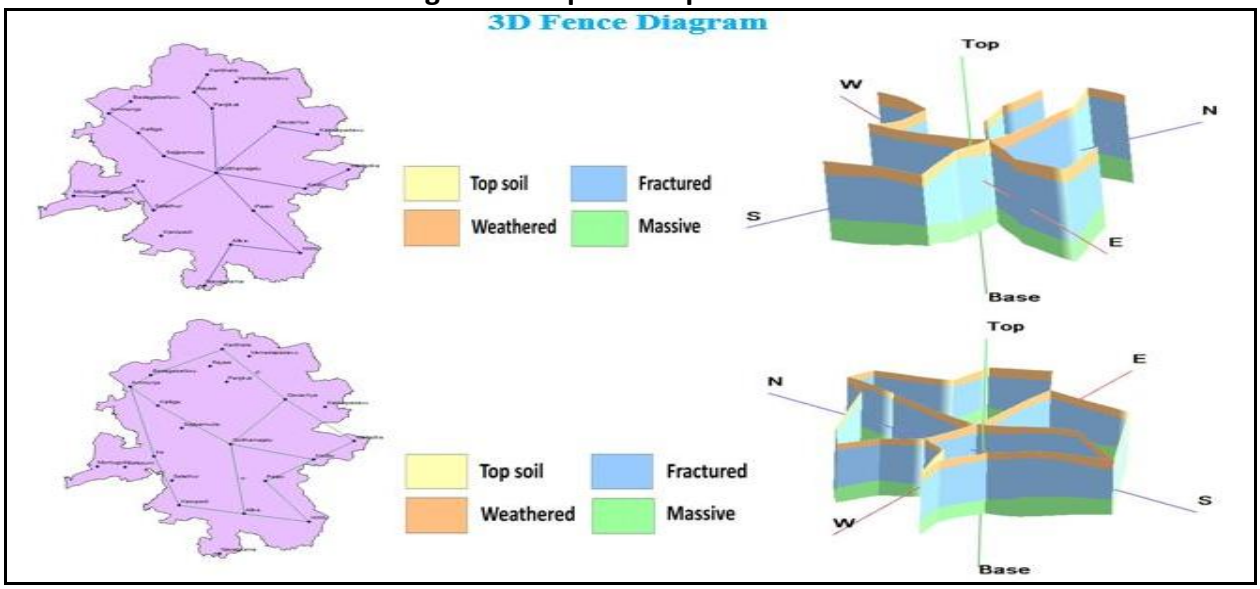


Fig-11: 3D Aquifer Fence Diagram

The fence diagram indicating the disposition of various aquifers is presented in Fig.-11. In northern and central part of the area the presence laterite at top followed by Banded gneissic complex, whereas in southern part granite and gneisses are followed by Charnockites. The 3-D representation is presented in Fig. -10. The disposition of Aquifer-I and Aquifer-II followed by massive formation can be observed in the 3-D aquifer disposition. The depth of the top soil is in the range of 0 to 5 m bgl, followed by weathered aquifer observed upto 45 m, which is followed by fractured aquifer which is disposed upto 185 m bgl depth followed by massive formation devoid of any ground water.

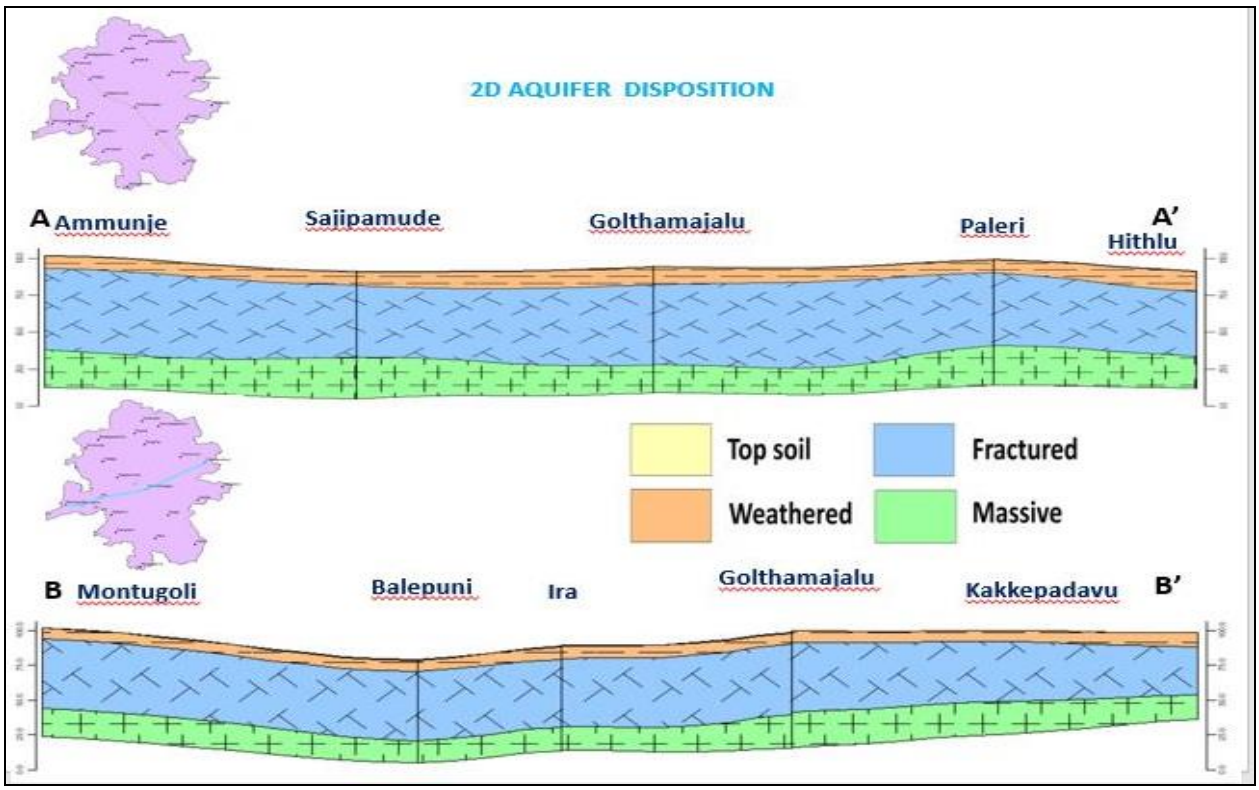


Fig-12: Cross sections in different directions

To study the aquifer disposition in detail, various hydrogeological cross section indicating aquifer geometry has been prepared viz. A-A' representing north – south direction, B-B' representing West-East respectively. (**Fig.-12**)

Hydrogeological cross section A-A' (**Fig.-12**) represents north – south direction and data of 25 exploratory wells has been utilised. It can be clearly seen from the north to South part i.e., from Ammunje to Hithlu, the thickness of Aquifer-I (shallow aquifer) and Aquifer-II (deeper aquifer) is same. On the contrary, the thickness of Massive rock is less in A and more in A'.

Hydrogeological cross section B-B' (**Fig.-12**) represents west to east direction and data of 25 exploratory wells has been utilised. It can be clearly seen from the section from West to east part, from Montugoli to Kakkepadavu, the thickness of Aquifer-I (shallow aquifer) and Aquifer-II (deeper aquifer) is same. On the contrary, the thickness of Massive rock is less in B and more in B'.

2.3 Hydrogeology of Phreatic and Fractured aquifer:-

Majority of the dug well in granitic gneiss ranges in depth from **10.3m to 32.2m** having a weathered zone from **3m to 35m**. Discharge of well is almost <1 lps. Transmissivity is very less and Water level lies in the range of **0.7 – 13.7** mbgl.

0-20 m **weathered thickness** found in major part of taluk, 20-30m thickness found in some eastern, western and southern part of taluk and more than 30m found in patches in taluk. **(Fig-13).**

Bore well in Fractured granitic gneiss ranges in depth upto **200 m** having a weathered zone from **16m to 35m** and Fractured zone from **15-185 mbgl**. Transmissivity of the Bantwal taluk is **0.07-476 m2/day**, Discharge ranges between **1 to 4.5 lps** with a drawdown of 14.5 m and unit area specific capacity of **22.18 lpm/m/m**.

Hydrogeology Map of Bantwal taluk showing that Banded Gneissic Complex is found most of the part of taluk, Laterite in western part of taluk in Coastal area and Charnockite in Southern part of taluk. Yield of the taluk revealed that <1 lps found in western part of taluk, 1-3 lps in almost entire taluk and >3 lps

found in some patched which show high yielding of the taluk. Lineament found in Western part of taluk. **(Fig-14).**

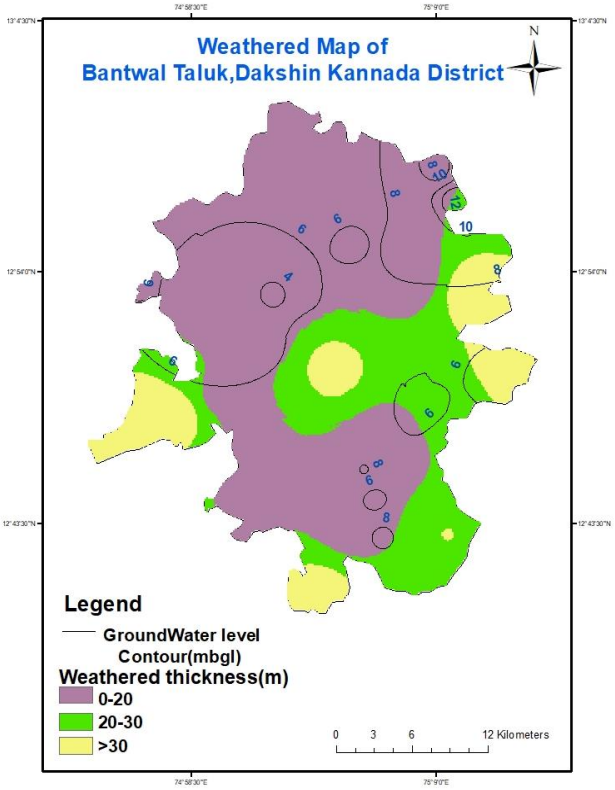


Fig-13 Weathered Map of Bantwal Taluk

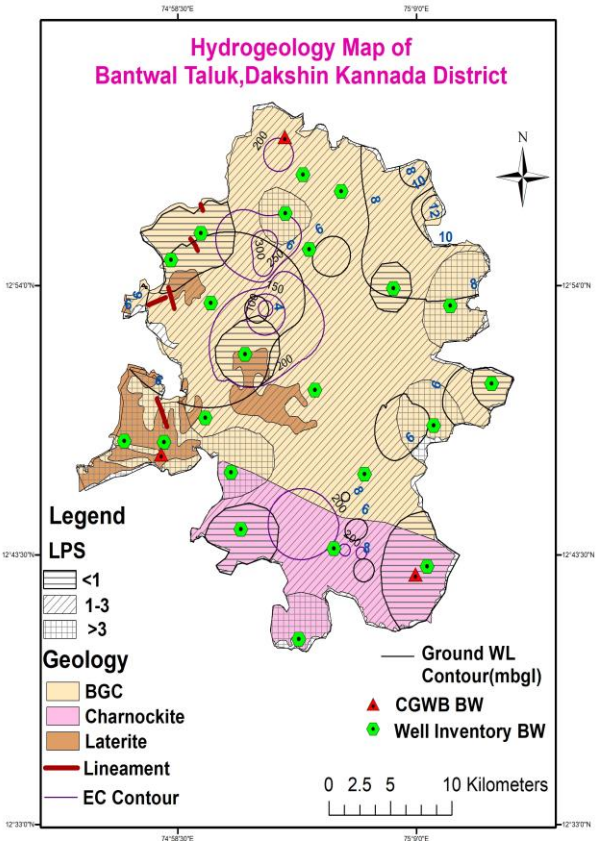


Fig-14 Fractured Map of Bantwal Taluk

3 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

3.1 Aquifer wise resource availability and extraction (2022)

Taluk	Annual Extract GW resource (ham)	Existing Gross GW extraction for Irrigation (ham)	Existing Gross GW extraction for domestic and industrial water supply (ham)	Existing Gross GW extraction for all uses (ham)	Allocation for domestic and industrial use for the next 25 years (ham)	Net GW availability for future Irrigation development (ham)	Stage of GW development (%)	Category
Bantwal	13671.31	5996.53	883.81	6880.34	905.92	6754.19	50.32	**Safe**

Table-10 Comparison of ground water availability and draft scenario in Bantwal taluk

Taluk	2017			2020			2022		
	GW Availability	GW Draft	Stage of GW withdrawal	GW Availability	GW Draft	Stage of GW withdrawal	GW Availability	GW Draft	Stage of GW withdrawal
Bantwal	7343	5006	**68**	10751.24	5096.58	**47.40**	13671.31	6880.34	**50.32**

From the above comparison**(Table-10),** it can be observed that the stage of ground water extraction is more during 2017 and less in 2020 and again the stage of ground water extraction increases in 2022.

3.2 Chemical quality of ground water and contamination

The interpretation from Chemical Analysis results (Phreatic and fractured aquifer) of ground water samples in Bantwal taluk is summarized below. The results are presented in **Figures wise.**

(a) Aquifer – I: 16 samples were collected from NHS dug wells representing **Aquifer – I** in Bantwal Taluk and chemical analysis result indicate that the-

EC value is in the ranges of **79 to 337** m/mhos/cm at 25°C. All the sample shows under desirable limit**. (Fig-15)** The value of **pH** ranges from 6.08 to 7.18. **Cl** ranges from 7 mg/l to 50 mg/l. **(Fig-16)** The value of **NO_3** ranges from 1.61 to 21 mg/l. All the sample shows under desirable limit as per BIS, 2012 drinking water standards. **(Fig-17)** All the samples show fluoride within desirable limit as per BIS, 2012. **(Fig-18)**

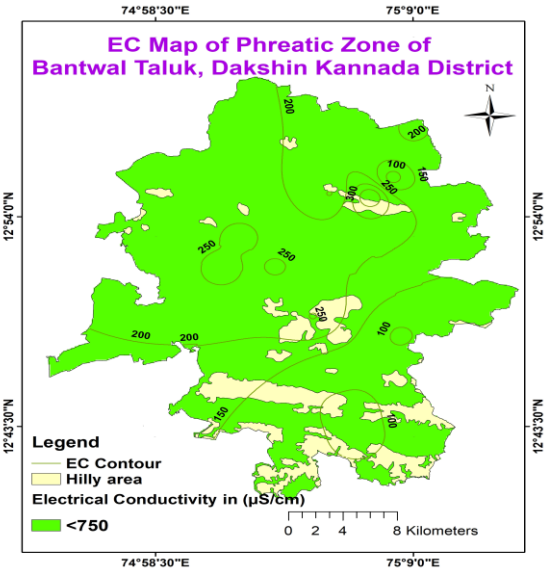


Fig-15 EC Map of Phreatic Zone

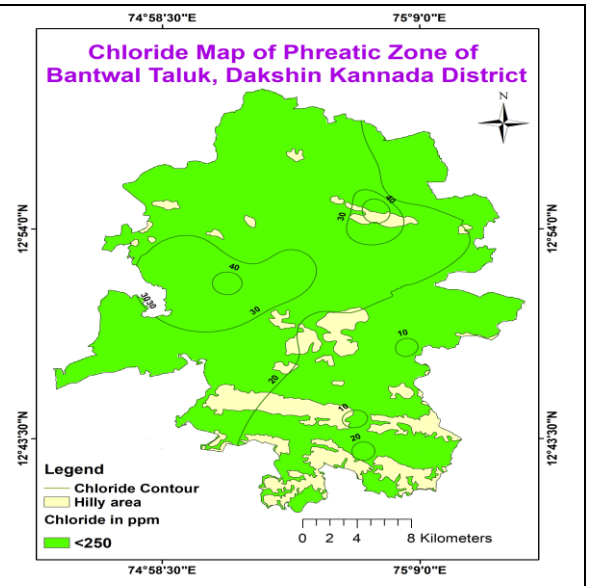


Fig-16 Chloride Map of Phreatic Zone

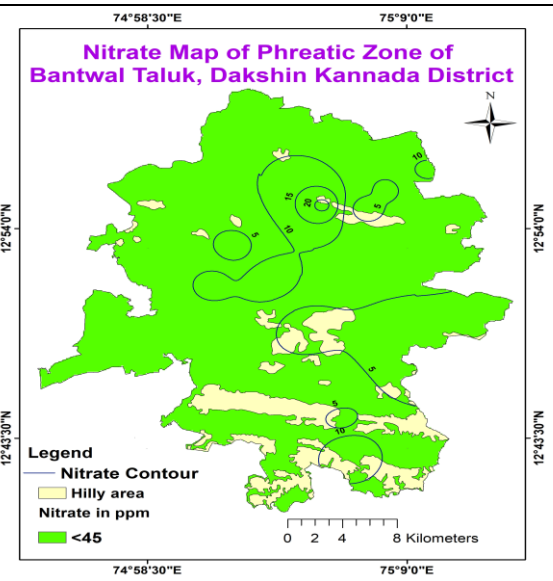


Fig-17 Nitrate Map of Phreatic Zone

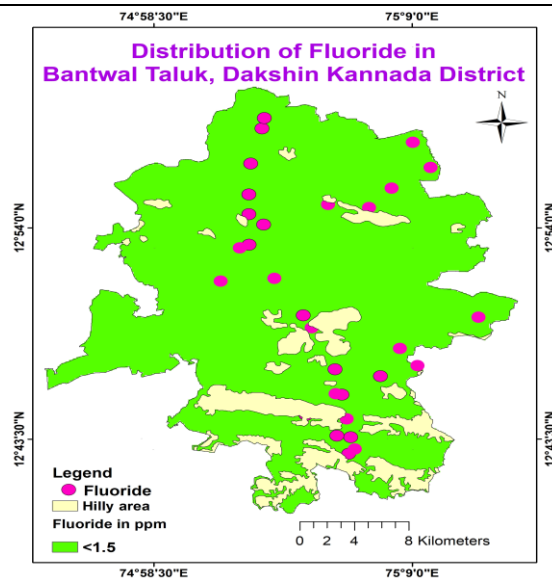


Fig-18 Distribution of Fluoride

(b) Aquifer-II: 15 samples were collected from borewells and Hand pump which represented the **aquifer II** in Bantwal Taluk.

EC value in groundwater is in the ranges of 80 to 350 m/mhos/cm at 25ºC. All the sample shows under desirable limit**. (Fig-19)** The value of **pH** ranges from 5.3 to 7.6.

Cl ranges from 7 mg/l to 28 mg/l. **(Fig-21)** The value of **NO_3** ranges from 5 to 34 mg/l. All the sample shows under desirable limit as per BIS, 2012 drinking water standards. **(Fig-20)** All the samples show fluoride value within desirable limit as per BIS, 2012 standards. **(Fig-18)**

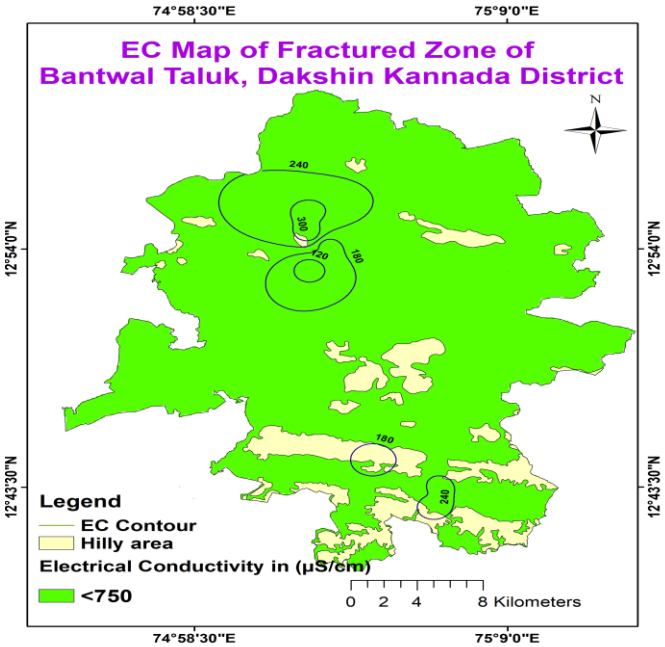


Fig-19 EC Map of Fractured Zone

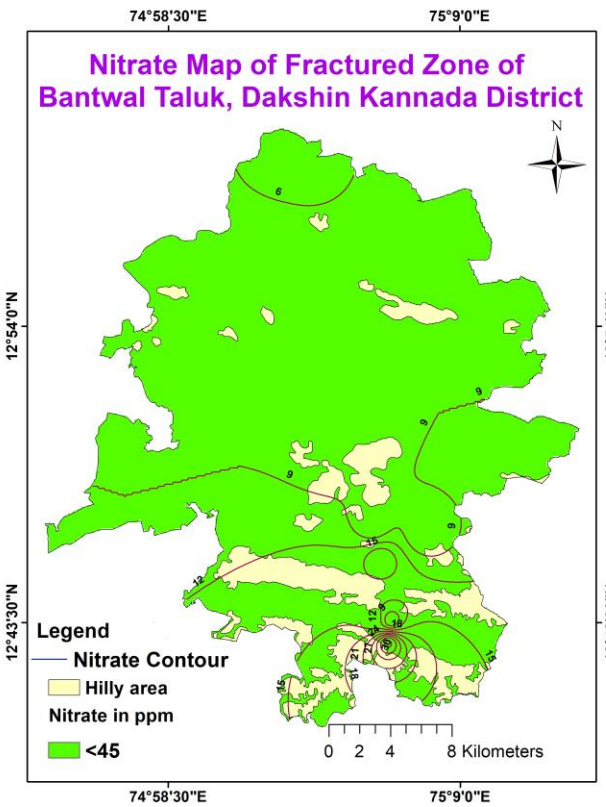


Fig-20 Nitrate Map of Fractured Zone

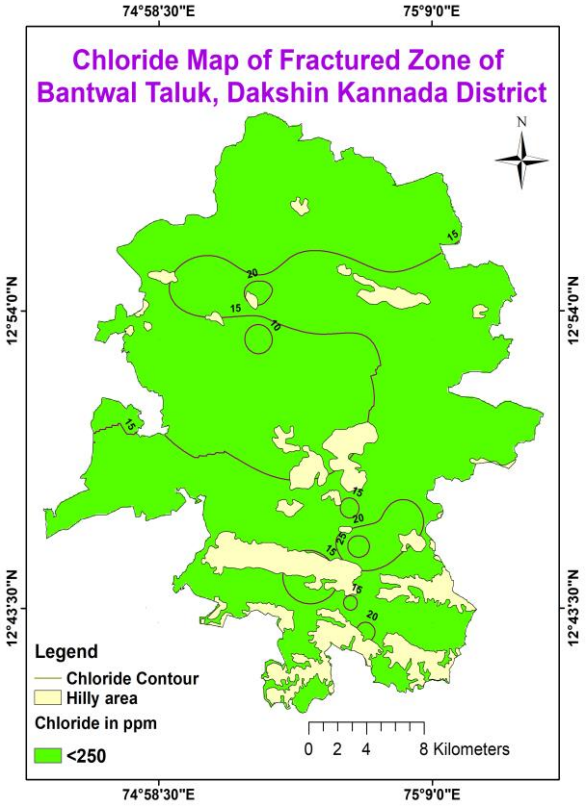


Fig-21 Chloride Map of Fractured Zone

In general, ground water quality in Bantwal Taluk is good and potable and are found to be under permissible limit. Ground water samples have been found suitable for agriculture & irrigation purposes.

4 GROUND WATER RESOURCE ENHANCEMENT

4.1 Artificial recharge and proposed interventions

Increase in agricultural activity and excessive ground water withdrawal has resulted in depletion of ground water table, reduction in yield of bore wells and deterioration of ground water quality. Bantwal Taluk can be drought prone. Thus, there is need for ground water management, enhancement of storage capacity of aquifers, protection of ground water quality and proper utilization of ground water.

Aquifer wise space available for recharge and proposed interventions

Table 11A: Quantity of water proposed to be made available through non-committed surface runoff

Non committed monsoon runoff available **(MCM)**	46.337
Artificial Recharge Structures Proposed	
Area feasible for artificial recharge structures (sq. km)	652
Number of Check Dams feasible	0
Number of Percolation Tanks feasible	42
Number of Point Recharge structures feasible	144
Tentative total cost of the project (Rs. in lakhs)	858.783
Recharge capacity of sub surface dyke (MCM)	6.951
Recharge capacity of percolation tank (MCM)	23.169
Recharge capacity of Check dam (MCM)	11.584
Recharge capacity of filter bed (MCM)	4.634
Excepted recharge (MCM)	**34.753**

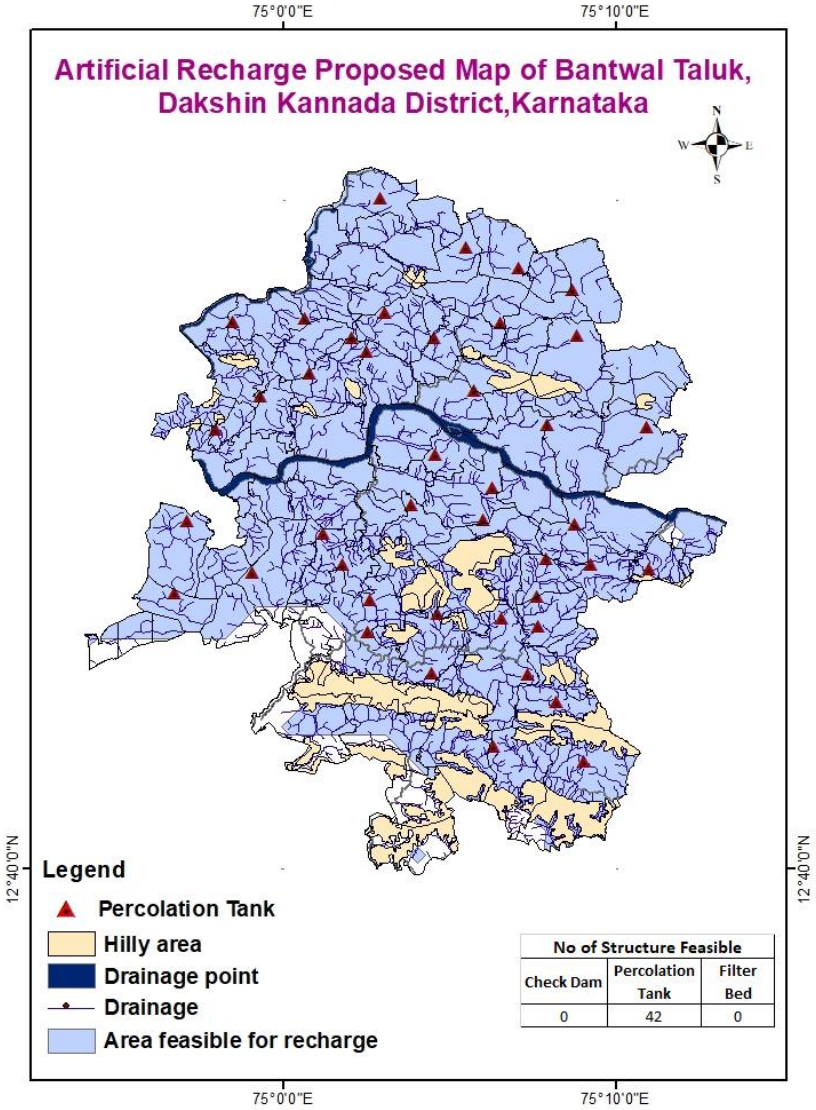


Fig-22 Artificial Recharge structure Proposed Map

Table:11B Tentative location of Villages for Proposal of Artificial Recharge structure

Sr. No	Village	AR Structure Proposed	Longitude	Latitude
1	Punacha	Percolation tank	75.15061	12.72041
2	Kepu	Percolation tank	75.10512	12.72793
3	Vitlamudnuru	Percolation tank	75.13672	12.74975
4	Vitla	Percolation tank	75.12225	12.76376
5	Vitlapadnuru	Percolation tank	75.07427	12.76444
6	Kolnadu	Percolation tank	75.04224	12.78493
7	Idikidu	Percolation tank	75.12777	12.78760

8	Vitla	**Percolation tank**	75.10902	12.79150
9	Veerakamba	**Percolation tank**	75.07707	12.79383
10	Kolnadu	**Percolation tank**	75.04336	12.80051
11	Netlamudnuru	**Percolation tank**	75.12675	12.80261
12	Kyrangala	**Percolation tank**	74.94599	12.80438
13	Ira	**Percolation tank**	74.98456	12.81438
14	Perni	**Percolation tank**	75.18263	12.81616
15	Manchi	**Percolation tank**	75.02998	12.81828
16	Kepala	**Percolation tank**	75.15366	12.81850
17	Netlamudnuru	**Percolation tank**	75.13151	12.82136
18	Manchi	**Percolation tank**	75.02016	12.83369
19	Kadesvalya	**Percolation tank**	75.14554	12.83856
20	Pajeer	**Percolation tank**	74.95194	12.84043
21	Balthila	**Percolation tank**	75.09992	12.84088
22	Golthamajalu	**Percolation tank**	75.06437	12.84837
23	Balthila	**Percolation tank**	75.10478	12.85686
24	Shambhuru	**Percolation tank**	75.07594	12.87356
25	Kodamannu	**Percolation tank**	74.96633	12.88596
26	Uli	**Percolation tank**	75.18149	12.88686
27	Maninalkuru	**Percolation tank**	75.13216	12.88824
28	Kallige	**Percolation tank**	74.98882	12.90259
29	Kavalapaduru	**Percolation tank**	75.09569	12.90539
30	Amatadi	**Percolation tank**	75.01356	12.91377
31	Bantwala	**Percolation tank**	75.04180	12.92473
32	Kuriyala	**Percolation tank**	75.03431	12.93175
33	Moodanadugodu	**Percolation tank**	75.07571	12.93175
34	Kavala Mooduru	**Percolation tank**	75.14696	12.93254
35	Kodambettu	**Percolation tank**	75.10858	12.93894

36	Badagabelluru	**Percolation tank**	74.97477	12.93959
37	Arla	**Percolation tank**	75.01118	12.94115
38	Punjikal	**Percolation tank**	75.05072	12.94412
39	Pilathabettu	**Percolation tank**	75.14437	12.95531
40	Ajjibettu	**Percolation tank**	75.11769	12.96628
41	Chennayithodi	**Percolation tank**	75.09144	12.97674
42	Sanghabettu	**Percolation tank**	75.04879	13.00115

Table 12: Present ground water availability and draft scenario (2022) in Bantwal Taluk and expected improvement in Stage of Ground Water Development in future, on implementation of artificial recharge schemes-

Taluk	Cumulative 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 Ground Water Availability after Artificial Recharge Structure Implementation	Stage of Ground Water Development after Artificial Recharge Structure Implementation	Expected Improvement in Overall Stage of Ground Water Development
	HAM	**HAM**	**%**	**HAM**	**HAM**	**HAM**	**%**
Bantwal	13671.31	6880.34	**50.32**	**3475.3**	17146.61	40.12	**10.2**

4.2 Water Use Efficiency by Micro Irrigation Practices

It is observed that wells and bore wells are the source for **23,312 ha** of net irrigation in the taluk constituting about 86% of the irrigated area. Adoption of water use efficiency (WUE) techniques will contribute in ground water resource enhancement in the long run by way of saving of water. Efficient irrigation practices like Drip irrigation & sprinkler needs to be adopted by the farmers in the existing 23,312 ha of net irrigated area by wells & bore wells. At present (2020), the irrigation draft is **5996.53** ham.

The water efficient methodology may be applied for growing arecanut which is grown in 21691 ha and is largely ground water dependent as compared to the other crops which are mainly grown during kharif. Efficient irrigation techniques will contribute in saving ground water by 10845.5 ham

considering 50% of the arecanut area is dependent on ground water irrigation and thus will improve stage of development marginally by **10.63%.** However, in long run the practice of Efficient irrigation techniques will add to the ground water resource in large extent. **(Table-13).**

Table 13: Improvement in GW availability (2022) due to saving by adopting water use efficiency

Net annual ground water availability after implementation of AR Structure	Existing gross ground water draft for all uses	Existing stage of ground water development after implementation of AR Structure	Arecanut grown area	Arecanut area considered for WUE (50%)	Saving due to adopting WUE measures @ 0.57 m in Arecanut grown area	Cumulative annual ground water availability	Expected improvement in stage of ground water development after the implementation of the WUE project	Expected improvement in overall stage of ground water development
HAM	HAM	%	HA	HA	HAM	HAM	%	%
17146.61	6880.34	40.12	21691	10845.5	6181.935	23,328	29.49	20.83

4.3 Ground Water Development Plan

In Bantwal taluk, the present stage of ground water extraction (2022) is merely **50.32 %** with net ground water availability of **13671.31** ham and total extraction of **6880.34** ham. The ground water draft for irrigation purpose is @ **5996.53** ham, thus indicating that ground water irrigation needs to be encouraged in the area. Also the less ground water development is most probably linked to the low ground water potential areas and limited aquifer thickness in Aquifer-II. To overcome these, it is imperative to have a robust ground water resource development plan for the area, which can be implemented in scientific manner. The implementation of the plan needs to based on site specific detailed hydrogeological, geophysical and scientific surveys for pinpointing the sites for construction of dugwells and Borewells.

In view of above, the focus of proposed ground water development plan is to up the ante of ground water development from the present 50% to 60% in a systematic way by adopting scientific approach. About 1433 dugwells (15-30 m depth; 3 to 5 m diameter @ Rs. 3.00 lakh/dugwell) are recommended to be constructed in feasible areas. Further 119 borewells (40-100 m depth; 150 mm dia @ Rs. 2.00 lakh/borewell) are also recommended to be drilled in feasible areas. Additional irrigation potential which can be created considering crop water requirement of 0.65 m (Ha) will be **2034 ha**. The detailed ground water development strategy to uplift the ground water use in the feasible areas is presented in **Table–14.**

Table–14: Feasibility of additional GW abstraction structures based on GWRA 2022 availability

Balance GWR available to make SOE 60%	DW unit draft	BW unit draft	No. of DW feasible @ 65% with unit draft of 0.6ham	No. of BWs feasible @ 35% with unit draft of 3.9 ham	Cost of Proposed DW's/year @ unit cost of Rs. 3 lakhs	Cost of Proposed BW's @ unit cost of Rs. 2 lakhs	Additional irrigation potential created by DW's considering crop water requirement of 0.65 m (Ha)	Additional irrigation potential created by BW's considering crop water requirement of 0.65 m (Ha)	Total irrigation potential created by DW's and BW's
1322.45	0.6	3.9	1433	119	4298	237	1322	712	2034

Note- Hydrogeological and scientific intervention is needed for pinpointing the sites for construction of dugwells and Borewells

4.4 Change in cropping pattern

Change in cropping pattern is necessary since cultivation of water intensive crops like arecanut is prevalent in the Taluk. Though only 21691 hectares is covered under arecanut and paddy is also prevalent in taluk, which covered 3574 hectare in Bantwal taluk which can effect groundwater availability. At present (2022), the stage of ground water extraction is @ 50.32% and taluk has been categorised as Safe, thus change in cropping pattern has not been suggested.

4.5 Other interventions proposed

- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- If excess nitrate & fluoride concentration is found in ground water samples, its require remedial measures viz.
    - Dilution of nitrate rich ground water through artificial recharge & water conservation.
    - Roof top rain water harvesting.

5 SUMMARY AND RECOMMENDATIONS

The main ground water issues are Low Ground Water Development, Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, Deeper Water Levels particularly in Aquifer-II in some parts of areas which are all inter-related or inter dependent and Inferior Ground Water Quality due to nitrate contamination major part of the area. The summary of ground water management plan of Bantwal taluk is given in **Table-15.**

Table 15: Summary of Management plan of Bantwal taluk

Stage of GW Extraction and Category (2022)	50.32 %, Safe
Annual Extractable GW Resource (Ham)	13671.31
Total Extraction (Ham)	6880.34
Total GW Resources (Dynamic & Static up to the depth of 200 mbgl) (Ham)	13671.3
Ground Water Draft for Irrigation (Ham)	5996.53
Ground Water Resource Enhancement by Supply side Interventions	
No of Proposed AR structures SSD PT CD	 1 42 0
Expected Additional Recharge to GW due to AR (Ham)	3475.3
Additional Irrigation Potential that can be created (Ha)	4200
Total Estimated Expenditure (Rs. in Cr.)	8.58
Change in Stage of GW Extraction (%)	50.32 to 40.12
Ground Water Resource Savings by Demand side Interventions	
Expected Saving due to adopting WUE measures in arecanut area (Ham)	6181.935
Change in Stage of GW development (%)	50.32 to 29.49
Ground Water Resource Development Plan	
Balance GWR available to enhance SOE 60% (Ham)	1322.45
No. of wells proposed **DW** – Depth: 15 to 30 m, Dia: 3 to 5 m, Unit Cost –Rs. 3.00 lakh, Av. Annual Gross draft – 0.6 ham **BW** – Depth: 40 to 100 m, Dia: 150 mm, Unit Cost – Rs. 2.00 lakh, Av. Annual Gross draft – 3.9 ham	 1433 119
Additional irrigation potential created considering crop water requirement of 0.65 m (Ha)	2034
Increase in Stage of GW Extraction (%)	50.32 to 60

As per the resource estimation – 2022, Bantwal taluk falls under Safe category with the stage of ground water extraction is **50.32 %.** However, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk in the coming days to avoid water crisis in the future. It is suggested to adopt a scientific and multi-pronged ground water management strategy covering supply side interventions, demand side interventions, ground water development interventions and ground water quality protection aspects as mentioned in the management plan suggested above

- **Ground water resource enhancement by supply side interventions**: Quantity of surface water available through non-committed surface run-off is estimated to be 46.337 MCM. This can be used to recharge the aquifer mainly through percolation tanks (42), check dams (0) and sub surface dyke structures (1). The volume of water expected to be conserved/recharged @75% efficiency is

3475.33 ham through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 8.58 Cr. The additional area which can be brought under assured ground water irrigation will be about 0.042 Lakh hectares.

- **Ground water resource enhancement by demand side interventions**: At present about 86 % of irrigation is by wells and bore wells (ground water). The micro irrigation practices like drip and sprinkler irrigation are comparatively less practiced in comparison with traditional surface flooding mode of irrigation. The micro irrigation water efficient methodology needs to be adopted for growing water intensive arecanut crop which is grown in 21691 ha and considering 50% area is dependent on ground water irrigation, efficient irrigation techniques will contribute in saving ground water by 10845.5 ham @ 0.57 m and thus will improve stage of development by 20.83% from 50.32 to 29.49%. However, in long run the practice of efficient irrigation techniques will add to the ground water resource in large extent..
- **Change in cropping pattern**: Farmers are facing inadequacy of groundwater for agriculture during summer. Change in cropping pattern is necessary since cultivation of water intensive crops like arecanut is prevalent in the Taluk. Though generally 21691 hectares is covered under arecanut and paddy is also prevalent in taluk, which covered 3574 hectare in Bantwal taluk which can effect groundwater availability. At present (2022), the stage of ground water extraction is @ 50.32% and taluk has been categorised as Safe, thus change in cropping pattern has not been suggested.
- **Ground Water Resource Development Plan:** The present stage of ground water extraction (2022) is merely 50.32 % with net ground water availability of 13671.31 ham and total extraction of 6880.34 ham. The ground water draft for irrigation purpose is @ 5996.53 ham, thus indicating that ground water irrigation needs to be encouraged in the area. To overcome the low ground water development, it is imperative to have a robust ground water resource development plan for the area, which can be implemented in scientific manner. The implementation of the plan needs to based on site specific detailed hydrogeological, geophysical and scientific surveys for pinpointing the sites for construction of dugwells and Borewells.
- In view of above, the focus of proposed ground water development plan is to up the ante of ground water development from the present 50% to 60% in a systematic way by adopting scientific approach. About **1433 dugwells** (15-30 m depth; 3 to 5 m diameter @ Rs. 3.00 lakh/dugwell) are recommended to be constructed in feasible areas. Further **119 borewells** (40-100 m depth; 150 mm dia @ Rs. 2.00 lakh/borewell) are also recommended to be drilled in feasible areas. Additional irrigation potential which can be created considering crop water requirement of 0.65 m (Ha) will be **2034 ha.**
- **Drinking water Supply:** In view of ground water contamination may be with higher concentration EC,Fluoride and Nitrate, drinking water supply from surface water needs to be explored/ ensured.
- **Regulation and control:** Taluk is categorized as **"Safe".** However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority needs to be strictly implemented in the taluk so that quality of ground water will improve in due course of time.
- **Participatory management:** Awareness programmes and practice of participatory approach needs to be strengthened with the involvement of all the stake holders for sustainable management.

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