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

Mundgod Taluk, Uttara Kannada District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

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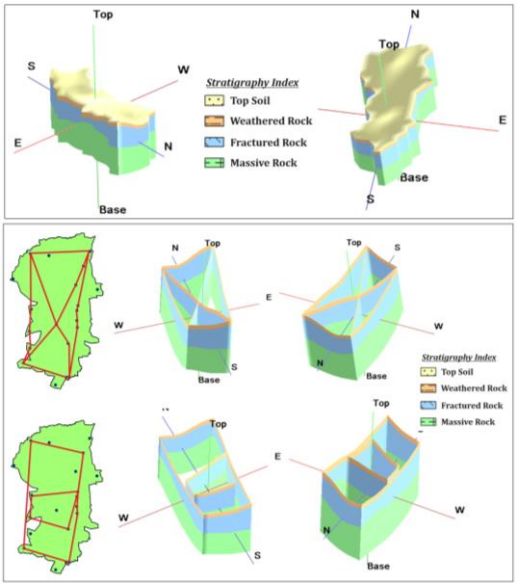
AQUIFER MAPS AND MANAGEMENT PLAN, MUNDGOD TALUK, UTTARA KANNADA DISTRICT, KARNATAKA STATE

(AAP – 2022-2023)



By

Sushanth S.Navarat, AHG, CGWB, SUO, Belagavi

MAY 2023

AQUIFER MAPS AND MANAGEMENT PLAN, MUNDGOD TALUK, UTTARA KANNADA DISTRICT, KARNATAKA STATE

AQUIFER MAPS AND MANAGEMENT PLAN, MUNDGOD TALUK, UTTARA KANNADA DISTRICT, KARNATAKA STATE

1.0 SALIENT INFORMATION

Name of the taluk: **MUNDGOD**

District: **UTTARA KANNADA**

State: Karnataka

Area: 676 sq.km.

Population: 1,06,174

Annual Normal Rainfall: 1437.6 mm

1.1 Introduction to the study area

Aquifer mapping studies have been carried out in Mundgod taluk, Uttara Kannada district of Karnataka, covering an area of 676 sq.kms under National Aquifer Mapping Project. The Mundgod taluk is located between North Latitudes 14° 42' 20" and 15° 04' 17" and East Longitudes between 74° 52' 43" to 75° 05' 28" and is falling in Survey of India Toposheets No. forms parts of 48I/16, 48J/13, 48M/4, 48N/1. The study area is bounded on the East by Haveri District, on the North by Dharwad District, on the South by Sirsi Taluk and on the West by Yellapur Taluk, Uttara Kannada District. Location map of Mundgod taluk of Uttara Kannada district is presented in Fig-1. Mundgod is taluk head quarter . There are 16 Gram-panchayats in this taluk.

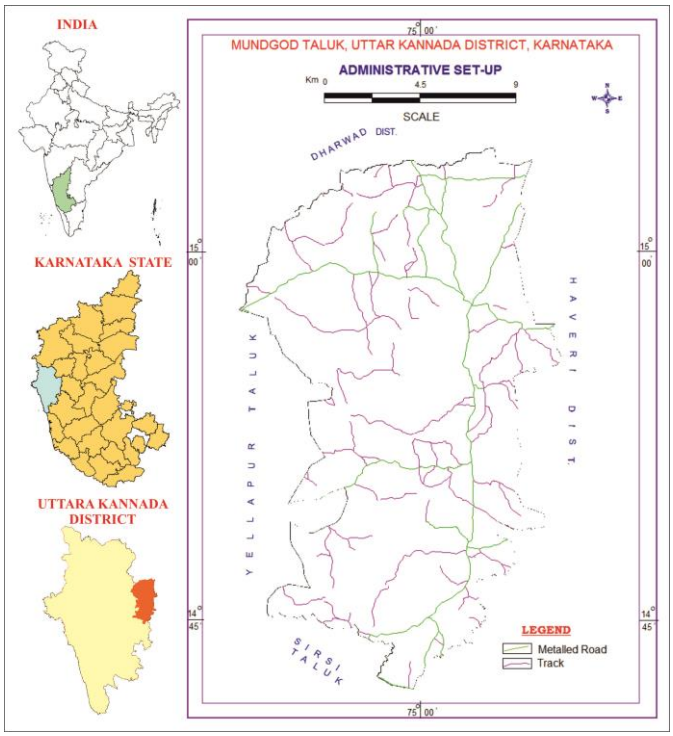


Fig-1: Location map of Mundgod taluk, Uttara Kannada District, Karnataka State

1.2 Population

According to 2011 census, the population in Mundgod taluk is 1,06,174. Out of which 57,490 are males while 48,684 are females. The average sex ratio of Mundgod taluk is 847. The Mundgod taluk has an overall population density of 157 persons per sq.km. The decadal variation in population from 2001-2011 is 17.01% in Mundgod taluk.

Table 1: Population details of Mundgod Taluk

Total Population: 106174			
No. of Male	**No. of Female**	**Total Rural Population**	**Total Urban Population**
57490	48684	83638	22536
Share of the District Population: 7.39%			
Decadal change in Population (2001-2011): 17.01 %			
Decadal change in Rural Population: 12.17 %		**Decadal change in Urban Population:** 39.34%	

Source: As per 2011 Census, District at a glance 2020-21, Govt. of Karnataka

1.3 Rainfall

Mundgod taluk enjoys semi-arid climate. Dryness and hot weather prevails in major part of the year. 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.

The data in respect of this station from the year 2022 is analyzed 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 Mundgod taluk for the year is 1437.6 mm.

Statistical analysis of the hydrometeorological data:

Computation is carried out for the annual rainfall data for the current year, 2022. The Normal rainfall received in 2022 is 1437.6 mm & actual rainfall of 1650.8 mm. The pre-monsoon, monsoon, post-monsoon and annual rainfall components are shown in Table 2.

The mean monthly rainfall at Mundgod taluk is ranging between 0.7 mm during January to 400.7 mm during July. The DEP% for pre-monsoon, SW monsoon and NE monsoon is 98, 9 & -20 % respectively. Annual average DEP% at this station works out to be 6.1 %. The 10 years average monthly, seasonal and annual rainfall data of Mundgod taluk is given in Table 3.

Table 2: Statistical Analysis of Rainfall Data of Mundgod Taluk, Uttar Kannada District (2022)

Mundgod Taluk	JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	ANNUAL RAINFALL
Normal Rainfall (mm)	0.7	1.7	8.4	56.3	93	158	257.9	400.7	271.1	151.0	1080.7	134.9	51.0	11	196.9	1437.6
Actual Rainfall (mm)	0.0	0.0	23.5	81.0	207	311	126.6	430.1	406.8	218.4	1181.9	141.8	10.1	6	157.4	1650.8
%DEP	-100	-100	180	44	123	98	-51	7	50	45	9	5	-80	-49	-20	6.1

Table 3: Annual Rainfall of Mundgod Taluk, Uttara Kannada District (2013 To 2022)

Year	JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	MON	OCT	NOV	DEC	POST	ANNUAL RAINFALL
2013	-	-	23	19	-	42	127	175	165	82	549	50	70	-	120	711
2014	-	-	39	47	108	194	86	351	285	171	893	139	47	47	233	1320
2015	-	-	18	5	102	125	238	77	152	78	545	91	26	-	117	787
2016	-	-	1	1	96	98	96	190	241	169	696	-	12	5	17	811
2017	-	-	9	2	112	123	140	256	130	181	707	107	3	-	110	940
2018	-	-	6	26	125	157	208	259	161	52	680	122	3	4	129	966
2019	-	-	1	25	22	48	123	367	778	198	1466	354	31	-	385	1898
2020	3	2	12	30	103	150	253	269	515	222	1259	150	2	1	153	1561
2021	46	30	25	82	111	294	326	364	163	155	1008	150	166	59	375	1675
2022	-	-	24	81	207	312	127	430	407	218	1182	142	10	6	158	1651

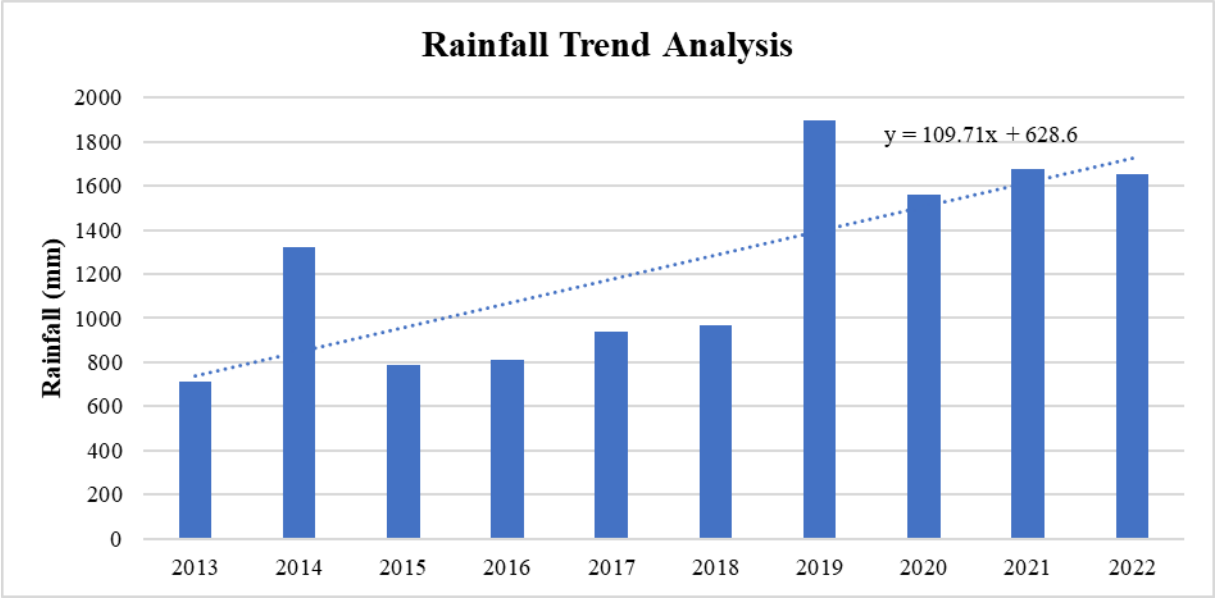


Fig-2: Long-term Rainfall Trend Analysis of Mundgod taluk of Uttara Kannada district

Assessment of Drought:

Rainfall data of Mundgod taluk has been analyzed for 108 (1901-2019) years using IMD method to assess the drought condition in Mundgod taluk. The results of the classification are listed in the Table 4. It is observed that the Mundgod taluk has experienced alternating no drought to acute drought conditions over the years.

Table 4: 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	Mundgod	15	77	14	1	1	Once in 7 years

The details of the drought assessment are discussed as herein under. Out of 108 years of analysis in Mundgod taluk, "No Drought" condition is experienced in 15 years, "Mild Drought" condition is experienced in 77 years, "Moderate Drought" condition experienced in 14 years, "Severe" in 1 years and "Acute" in 1 years in Mundgod 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 7 years** at Mundgod taluk.

1.4 Agriculture, Land use & Irrigation

Agriculture is the major occupation for the people in Mundgod taluk. Major Kharif crops are Paddy, Maize, Jowar, Pulses, Fruits and commercial crops such as arecanut, sugarcane and condiments & spices. Main crops of Rabi season are Maize, and Jowar (Table-5). Water intensive crops like paddy & sugarcane is are grown in 7145 Ha which is 47.86 % of the net sown area. Maize is grown in 41.65 % of the net sown area of taluk. The total net area sown in Kharif season is 14926 Ha whereas, the total net area sown in Rabi season is 2106 Ha (14%).

Table-5: Cropping pattern in Mundgod taluk 2020-21 (Ha)

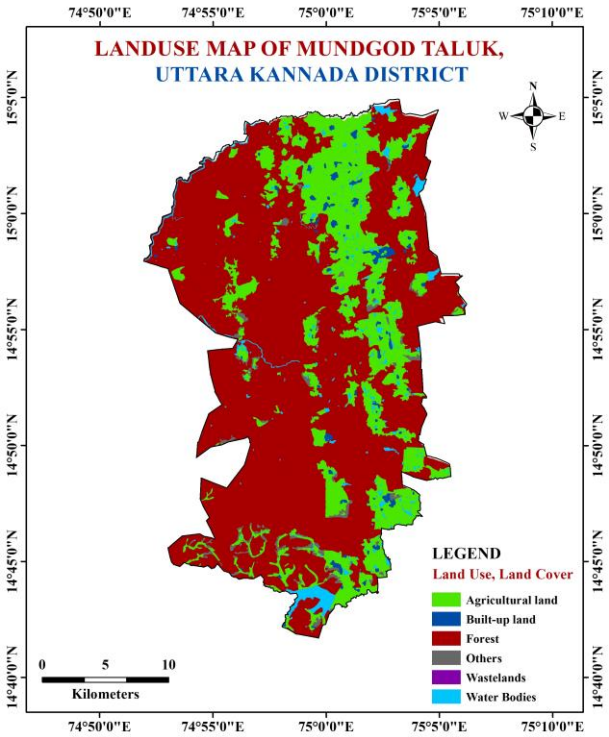
Cereals (Area in Ha)					Pulses (Area in Ha)						
Paddy	Jowar	Bajra	Maize	Other	Tur	Horse Gram	Black Gram	Green Gram	Avare	Cow Pea	Other
6470	226	2	6218	8	2	107	61	401	16	64	2
12924					660						
Total area under Food Grains: 13584											

Oil Seeds (Area in Ha)			Commercial Crops (Area in Ha)			
Groundnuts	**Sunflower**	**Soyabean**	**Condiments & Spices**	**Arecanut**	**Coconut**	**Other Comm. Crops**
57	3	22	395	1512	69	781
Total area under Oil Seeds: 78			**Total area under Commercial Crops: 2757**			

Fruits (Area in Ha)	Vegetables (Area in Ha)
1378.51	34.34

Source: District at a glance 2020-21, Govt. of Karnataka

Majority of the geographical area of Mundgod is under forest cover which is 72.34 %. Out of which, it is observed that net sown area accounts for 22.34 % and area sown more than once covers 4.59 % of total geographical area (Table-6). Area not available for cultivation is 2.69 %. Whereas, area covered by fallow land is very less. Out of the total net irrigated area 42.49 % is irrigated by means of bore wells and 39.54 % is irrigated by tanks (Table-7).



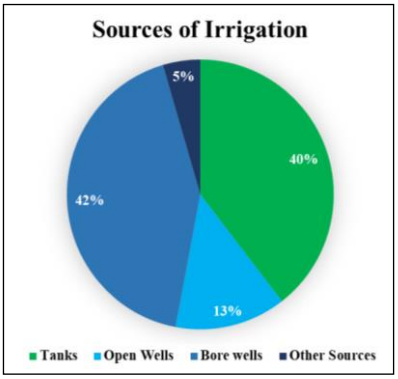
Total Geographical Area (Ha)	**66809**
Area under Forest	48333
Area not available for cultivation	1798
Fallow land	543
Net sown area	14926
Area sown more than once	3072

Fig-3: Land use Map

Table-6: Details of Land use in Mundgod taluk, 2021(Ha)
Source: District at a glance 2020-21, Govt. of Karnataka

Table-7: Irrigation details in Mundgod taluk (in ha)

Source of Irrigation	Net Area Irrigated (Ha)
Tanks	2000
Open Wells	680
Bore wells	2150
Other Sources	229
Total	5059



Source: District at a glance 2020-21, Govt. of Karnataka

1.5 Geomorphology, Physiography & Drainage

Mundgod taluk is a plateau region formed by dominant lithologies such as Metagreywackes and Argillites, which belong to "Dharwar Schists". The central north-south stretch exhibit overall "peneplane terrain" having sparsely distributed hills and tors. Portions of high-grounds as piedmonts are in western part of the taluk.

The elevation in the plains varies from 674m amsl in the South western part to 471m amsl in the North western part of the taluk. Southern and Eastern topography of the taluk is characterized by high grounds whereas northern fringe and NW parts are observed to be low lying terrain. The differential altitude is significant as it is responsible to cause irregular ground water flow patterns on the micro scale (Fig.-4 & Fig.-4a). The topography is dominantly controlled by underlying geological structures.

The entire Mundgod taluk is drained by tributaries of Bedthi river (Gangavali) which contributes to Tungabhadra sub-basin which is a part of major Krishna River Basin. The Drainage pattern is dendritic to sub-dendritic in majority of the area homogenously, except in the south, where lithology changes to laterite. Due to which, stream frequency as well stream density is reduced and which can be demarcated by visual interpretation of the drainage map. Higher infiltration and percolation potential favored by vuggy porosity in laterites is causing the reduction in stream frequency as well stream density in the southern area of the taluk. (Fig.-5).

1.6 Soil

The soils in Mundgod taluk are derived from schistose and argillite rocks in semi-arid, sub-tropical climate and these vary in depth and texture, depending on the parent rock type, physiographic settings and climatic conditions. Clayey-skeletal soils cover major part of the taluk, followed by the clayey soils (Fig.-6). These soils have skeletal texture due to more dominance of breaking & mechanical disintegration than chemical weathering. In the southern parts, clay loamy soils occur in patches.

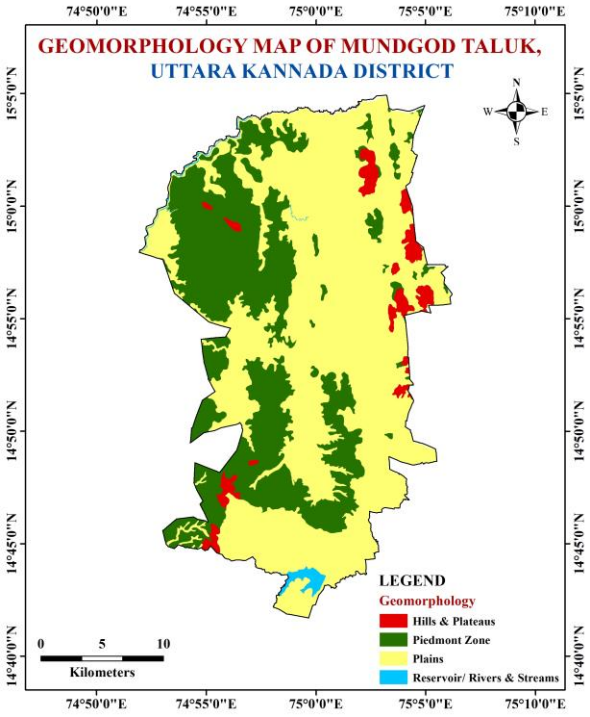


Fig-4: Geomorphology Map

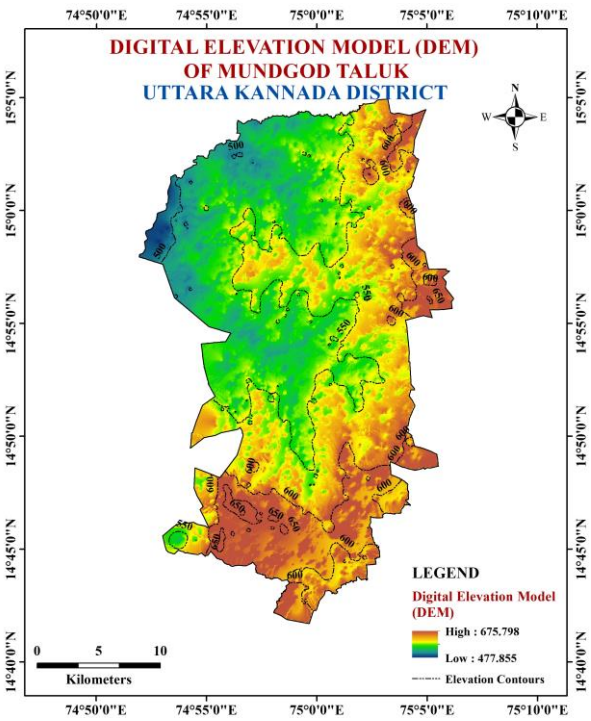


Fig-4a: Digital Elevation Model (DEM)

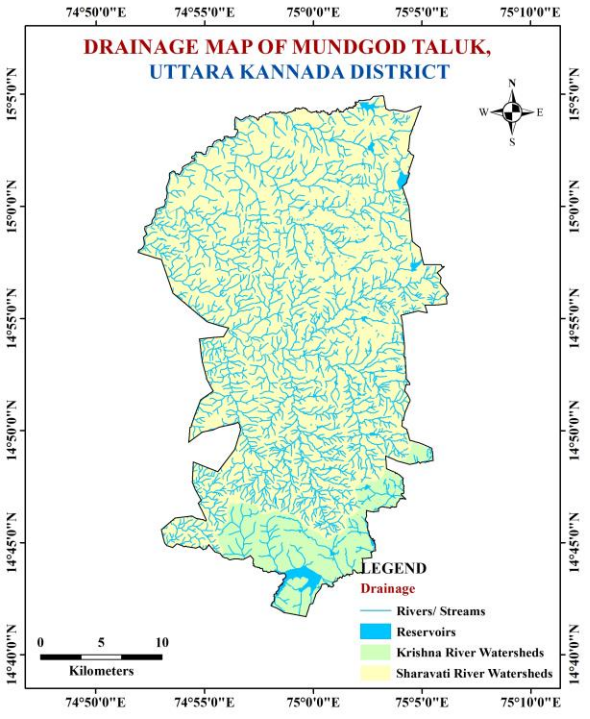


Fig-5: Drainage Map

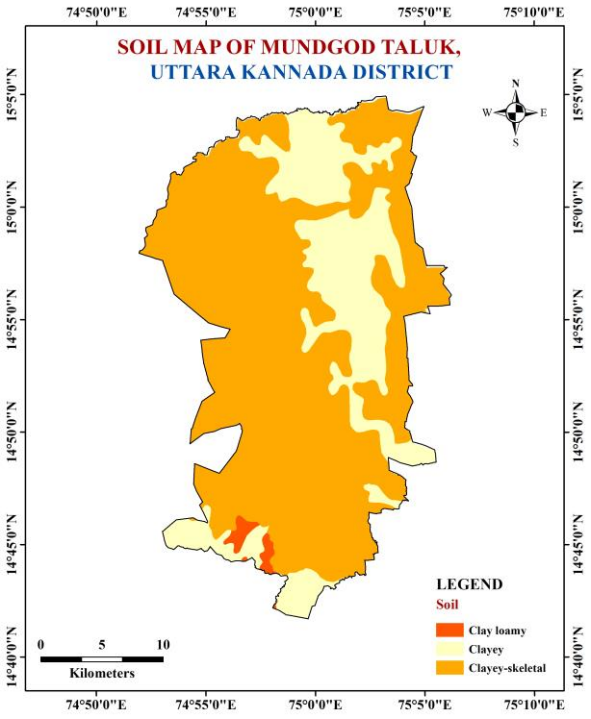


Fig-6: Soil Map

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 (GWRA'2022) (in Ham)

Taluk	Annual extractable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
Mundgod	10806.88	Phreatic	Fractured (Down to 200m)	Dynamic + Phreatic in-storage + Fractured
		16444	1926	29176.88

1.8 Existing and future water demands (as per GWRA'2022)

- Net ground water availability for future use : 8549.46 Ham
- Allocation for Domestic use for projected year 2025 : 459.24 Ham

1.9 Water Level Behavior

The water level has been monitored from the representative dugwells and borewells under NHS monitoring programme during Pre-monsoon and Post-monsoon period in the year 2022 for both Unconfined (Aquifer I) and Semi-confined(Aquifer II). The water level data from Central Ground Water Board, SWR (Table-9) and data received from Ground Water Directorate, Govt. of Karnataka (Table-10) has been integrated for fine tuning of maps and the results. The data collected is given as follows and followed by representative maps prepared by data interpolation.

(a) Depth to water level ranges -

Aquifer-I

- Pre-monsoon: 0.40 – 12.90 mbgl
- Post-monsoon: 0.85 – 6.60 mbgl

Aquifer-II

- Pre-monsoon: 13.85 mbgl
- Post-monsoon: 6.93 mbgl

Table-9: Depth to water level for Pre-monsoon (May 2022) & Post-monsoon (Nov 2022) Central Ground Water Board, SWR

Sl. No.	Location	Aquifer	Depth (m)	Latitude	Longitude	May-22	Nov-22
1	Katur	Unconfined	9.13	14.81390	74.93580	2.65	1.00
2	Malgi	Unconfined	15.63	14.77080	75.01670	7.20	6.60
3	Mundgod	Unconfined	10.10	14.98330	75.07500	0.40	0.85
4	Vadageri	Unconfined	15.90	14.87500	75.04860	7.69	4.47

Table-10: Depth to water level for Pre-monsoon (May 2022) & Post-monsoon (Nov 2022) GWD, Govt. of Karnataka

Sl. No.	Location	Aquifer	Depth (m)	Latitude	Longitude	May-22	Nov-22
1	Katur	Unconfined	7.85	14.86000	75.03600	1.50	1.50
2	Mainalli	Unconfined	13.20	14.97800	74.88700	12.90	6.40
3	Malgi	Unconfined	14.15	14.74700	75.00600	6.70	7.10
4	Mundgod	Unconfined	8.00	14.97000	75.03700	1.10	1.65
5	Mainalli	Semi-confined	60.00	14.97700	74.88800	13.85	6.93

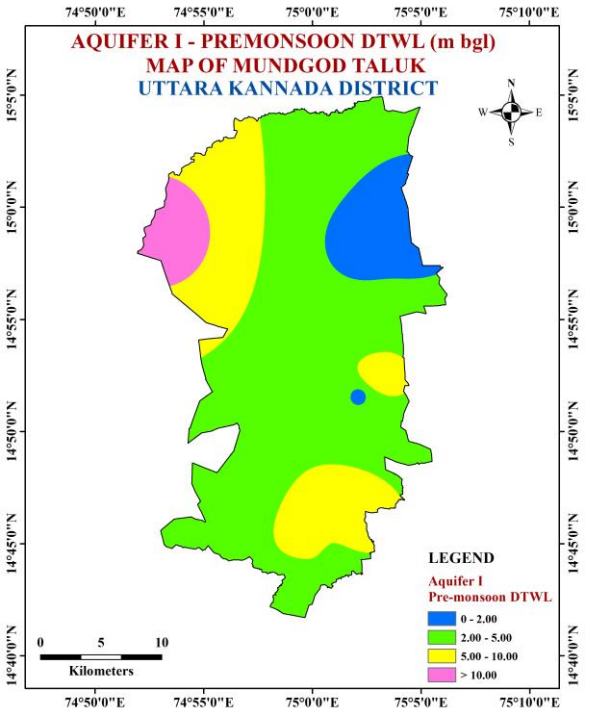


Fig-7: Aquifer I Pre-monsoon DTWL (May 2022)

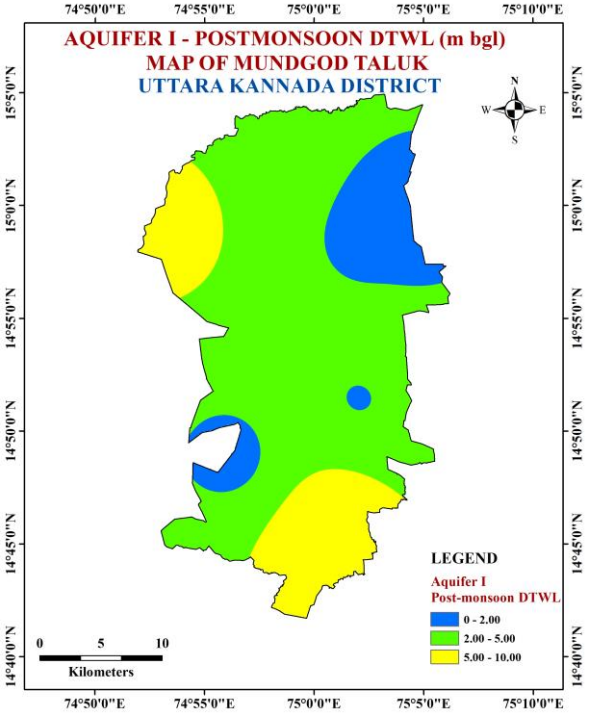


Fig-8: Aquifer I Post-monsoon DTWL (Nov 2022)

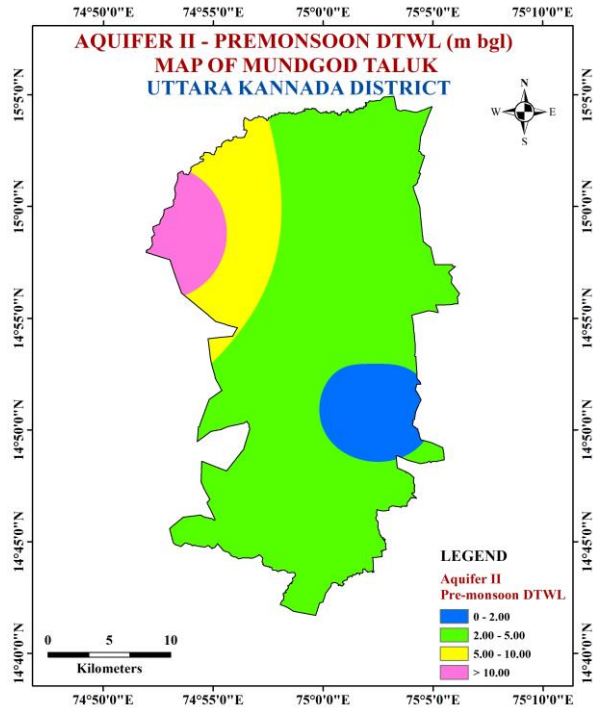


Fig-9: Aquifer II Pre-monsoon DTWL (May 2022)

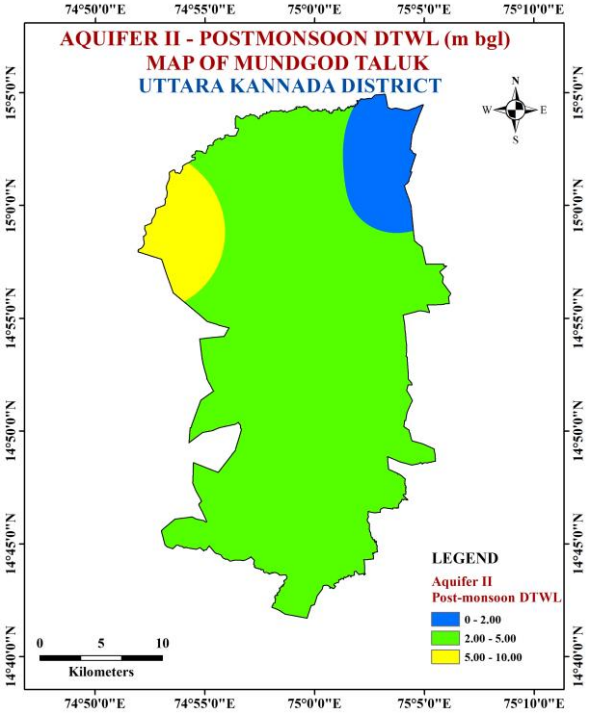


Fig-10: Aquifer II Post-monsoon DTWL (Nov 2022)

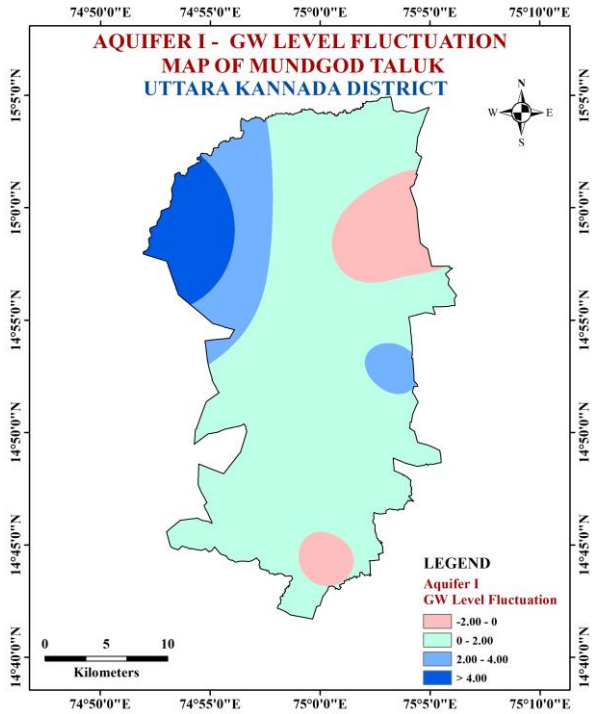


Fig-11: Aquifer I Groundwater level fluctuation map

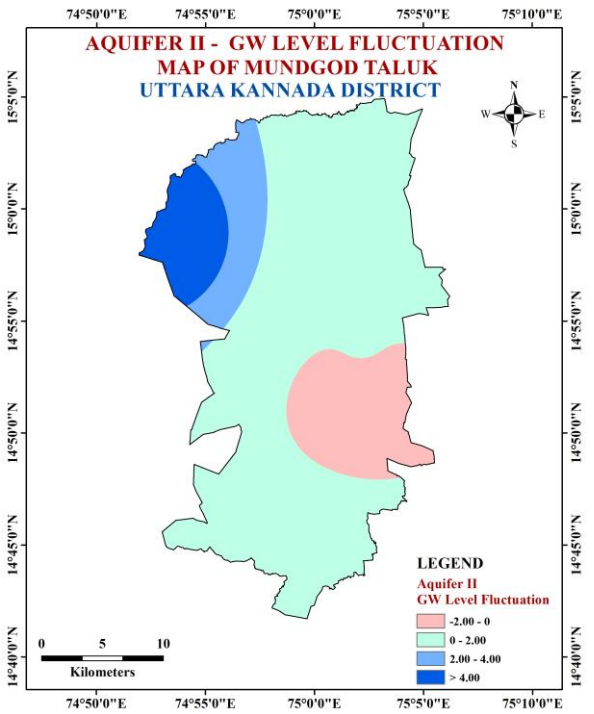


Fig-12: Aquifer II Groundwater level fluctuation map

The depth to water level of Unconfined/Phreatic aquifer (Aquifer I) & Semi-confined/ Fractured aquifer (Aquifer II) throughout the area was monitored and represented using maps(Fig-7,8,9,10). During Pre-monsoon time, both the aquifers experience desaturation in the north-western part presented by DTWL more than 10m and in the eastern part of the taluk, DTWL is observed to be at shallower depth ranging less than 5m, especially for aquifer-I in the north-eastern part due to effect of Bachanaki reservoir.

The seasonal fluctuation (Fig.-11,12) shows fall of -2.00m for phreatic aquifer in the north-eastern part and a small patch in the south-eastern part. Majority of the area experiences rise in the water level in the mean range of 0-4.00m. In case of fractured aquifer, the fall in water level up to -2.00m is highlighted in the central-east domain. But, rest of the area shows rise in water level in the mean range of 0-4.00m.

Table-10: Decadal Pre-monsoon Depth to water level data (2014-2022)

Village	WELL	May-14	May-15	May-16	May-17	May-18	May-19	May-21	May-22
Katur	DW	0.95	1.78	2.25	1.38	1.45	1.35	0.85	1
Malgi	DW	6.11	7.32	8.13	6.03	6.58	5.58	4.08	6.6
Mundgod	DW	0.6	1.15	1.7	1.37	1.25	0	0.5	0.85
Vadageri	DW	4.8	5.4	5.7	5.43	5	3.98	3.43	4.47

Table-11: Decadal Post-monsoon Depth to water level data (2014-2022)

Village	WELL	Nov-14	Nov-15	Nov-16	Nov-17	Nov-18	Nov-19	Nov-21	Nov-22
Katur	DW	0.95	1.78	2.25	1.38	1.45	1.35	0.85	1
Malgi	DW	6.11	7.32	8.13	6.03	6.58	5.58	4.08	6.6
Mundgod	DW	0.6	1.15	1.7	1.37	1.25	0	0.5	0.85
Vadageri	DW	4.8	5.4	5.7	5.43	5	3.98	3.43	4.47

The decadal pre-monsoon & post-monsoon water level data (Table-10,11) is analyzed for presenting the data as long-term trend. The long-term trend uses the past data and provides a probability linear projection by which, one can get better understanding of whether in near future, the groundwater level is rising or falling(depleting). The long-term trends for NHS monitoring wells namely Mundgod and Vadageri are prepared (Fig.-13,14). These long-term trends show rising nature in both the Pre-monsoon & Post-monsoon periods.

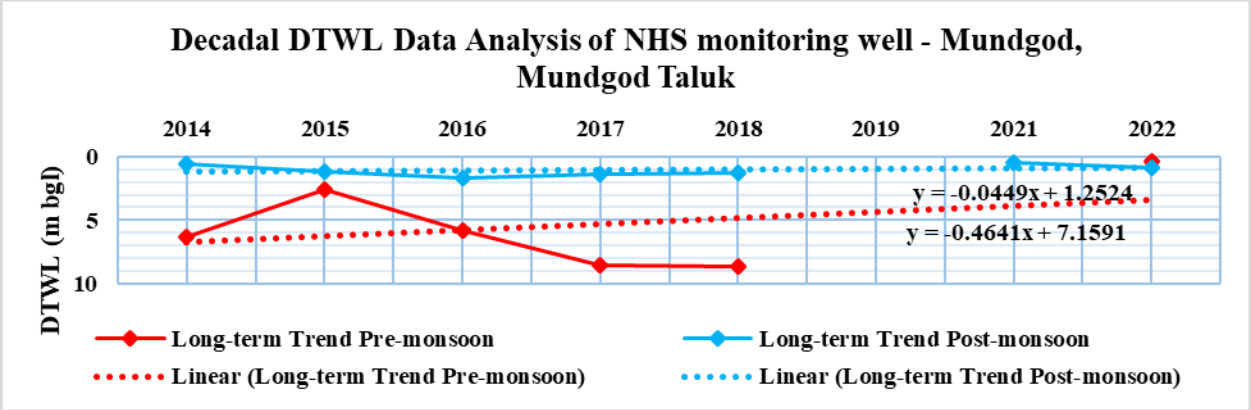


Fig-13: Hydrograph of Mundgod NHS well showing Decadal Long-term DTWL trends of Pre-monsoon & Post-monsoon Period

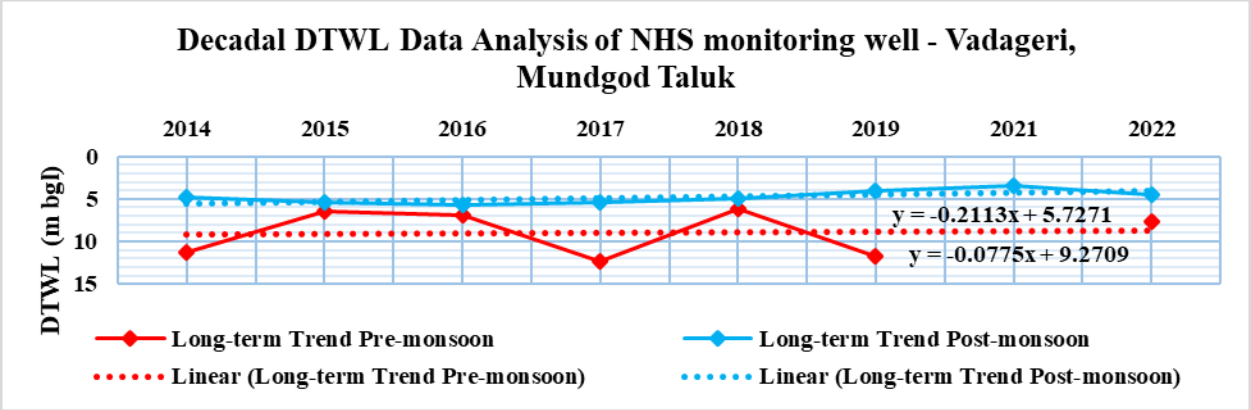


Fig-14: Hydrograph of Vadageri NHS well showing Decadal Long-term DTWL trends of Pre-monsoon & Post-monsoon Period

The log-term, decadal approach towards the data is significant and is indicative of the groundwater level rise or fall in the near future. The mean premonsoon DTWL in the area ranges between 5 – 10m (Fig.-15) whereas, in Postmonsoon, it ranges between 0 – 5m (Fig.-16). The decadal fluctuation maps indicate that, during Premonsoon period, majority of the area experiences rise in the water level more than 4m, except a small patch in the south-east (Fig.-17). During Postmonsoon, the area experiences rise in the water level in the range of 0 – 2m, except in the south-eastern part which shows fall upto -2.00m (Fig.-18).

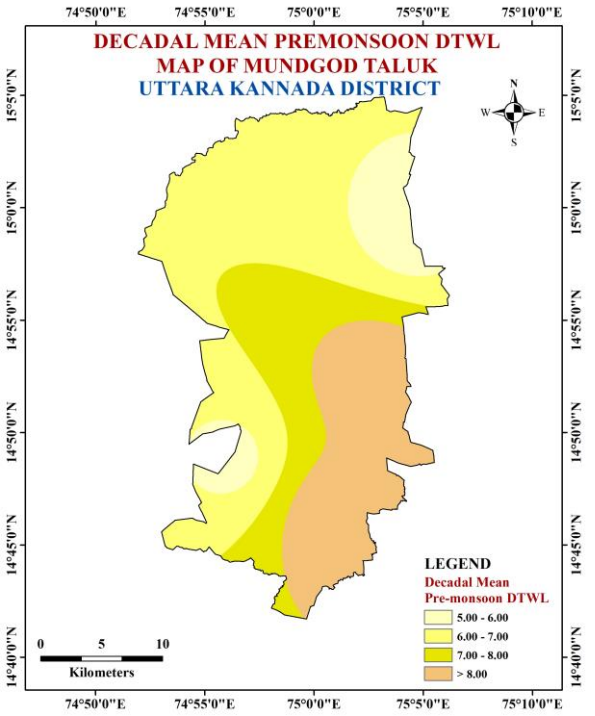


Fig-15: Decadal Mean Pre-monsoon DTWL map (2014-2022)

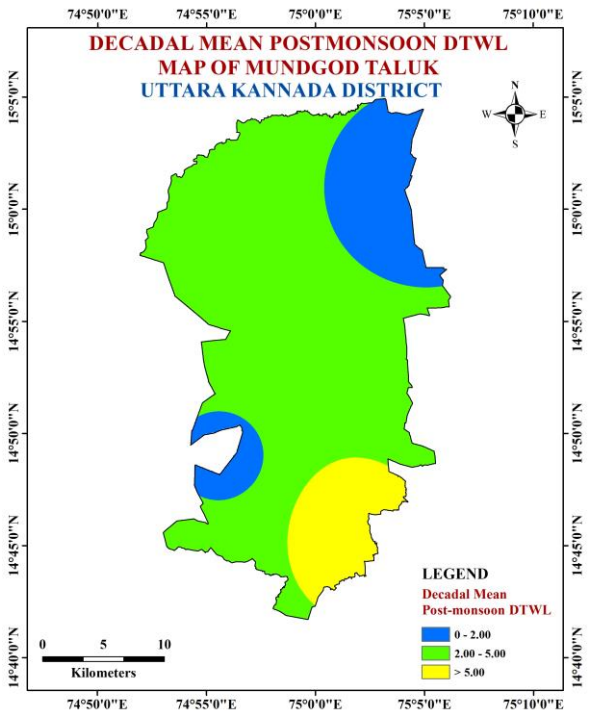


Fig-16: Decadal Mean Post-monsoon DTWL map (2014-2022)

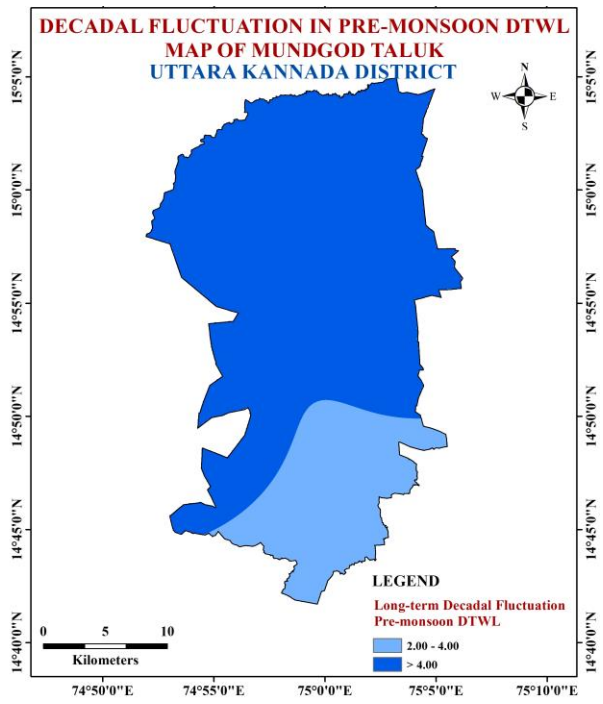


Fig-17: Decadal Fluctuation Pre-monsoon DTWL Map (2014-2022)

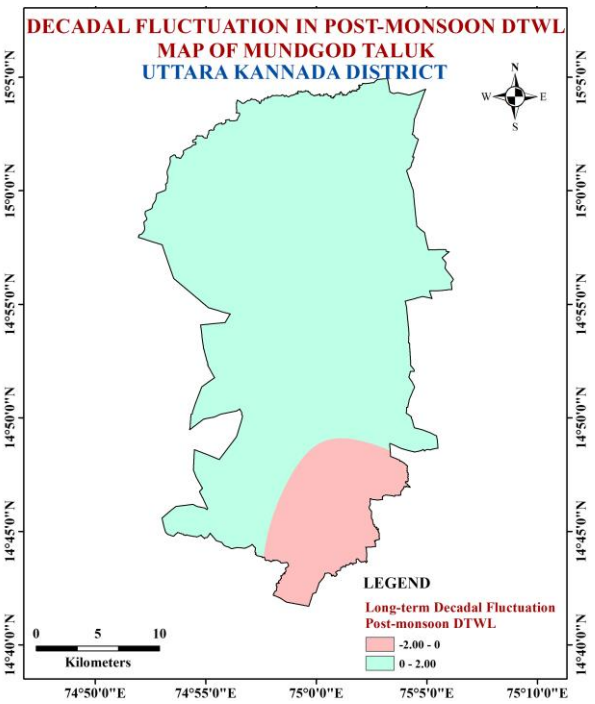
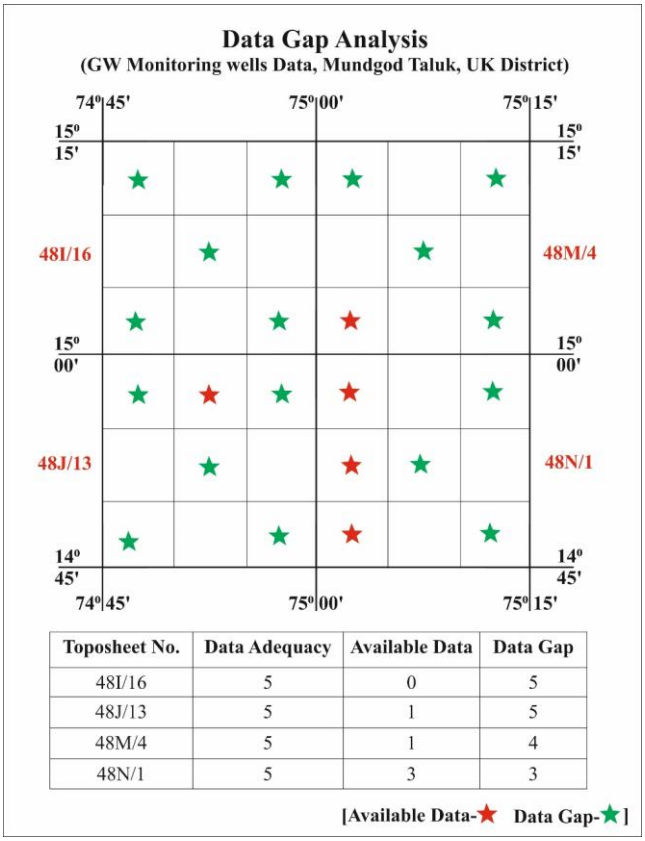


Fig-18: Decadal Fluctuation Post-monsoon DTWL Map (2014-2022)

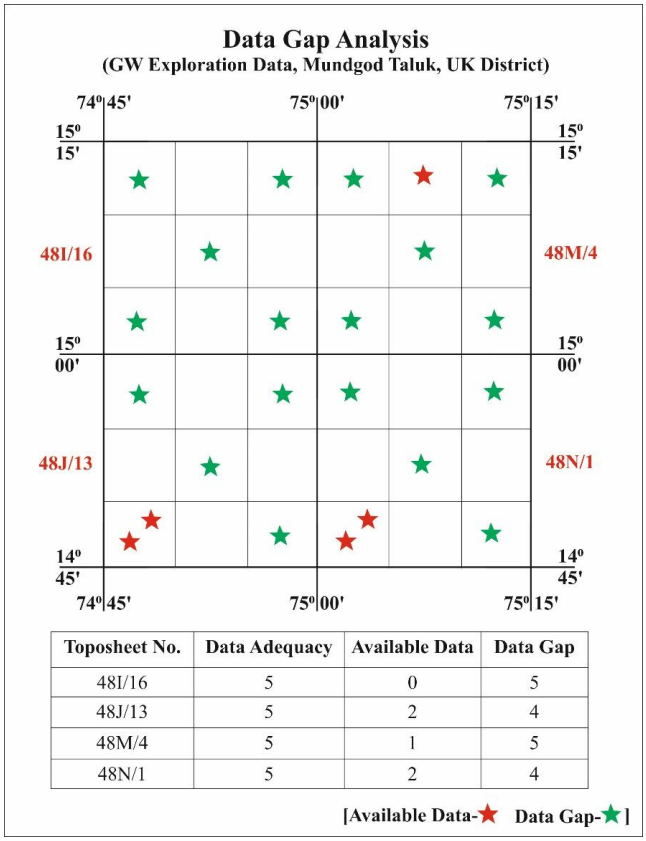
2.0 DATA-GAP ANALYSIS

During the literature survey, previous available data has been considered for data-gap analysis. Using toposheets quadrants, the data adequacy is plotted along with the available data. The toposheet quadrants – 1A, 1C, 2B, 3A, 3C are preferred for data generation. If the data available lies in the quadrants enlisted above, the rest of the quadrants which are lacking the data are considered for data generation. In this case, for groundwater exploration – the exploratory wells which were drilled during Pre-NAQUIM and NAQUIM period are taken in account as available data. The NHS monitoring wells already established in the area are considered as available data and the rest of the quadrants are taken up for data generation in the form of establishing new key wells by well inventory survey.



Toposheet No.	Data Adequacy	Available Data	Data Gap
48I/16	5	0	5
48J/13	5	1	5
48M/4	5	1	4
48N/1	5	3	3

Fig-19: Data Gap Analysis of GW Monitoring Data



Toposheet No.	Data Adequacy	Available Data	Data Gap
48I/16	5	0	5
48J/13	5	2	4
48M/4	5	1	5
48N/1	5	2	4

Fig-20: Data Gap Analysis of GW Exploration Data

As per the data gap analysis of GW monitoring wells data for Mundgod Taluk, there is total data gap of 17 points (Fig.-19). And as per the data gap analysis of GW exploration data for Mundgod Taluk, there is total data gap of 18 points (Fig.-20). The well inventory survey of dugwells and borewells in the area was carried out to fill the data gap according to the toposheets.

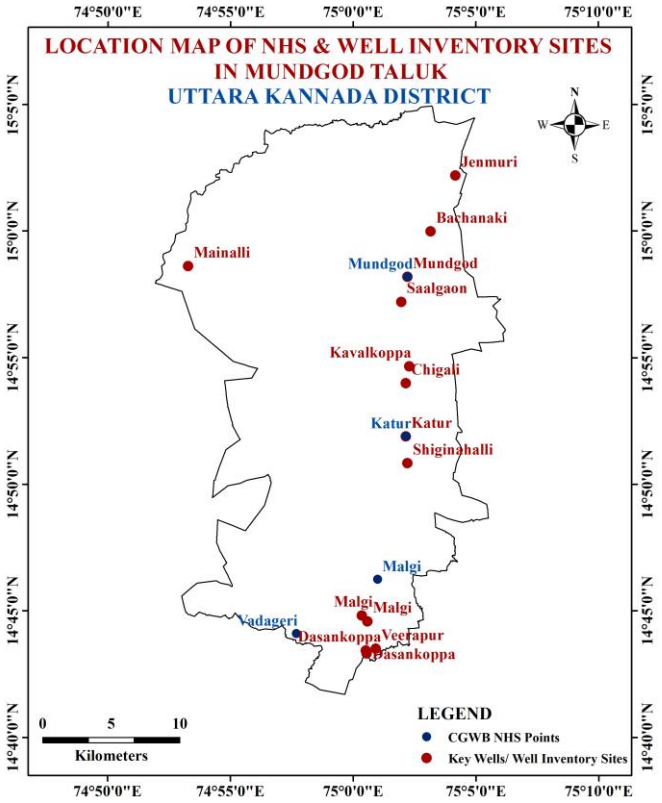


Fig-21: Location map of NHS wells & new GW Monitoring wells

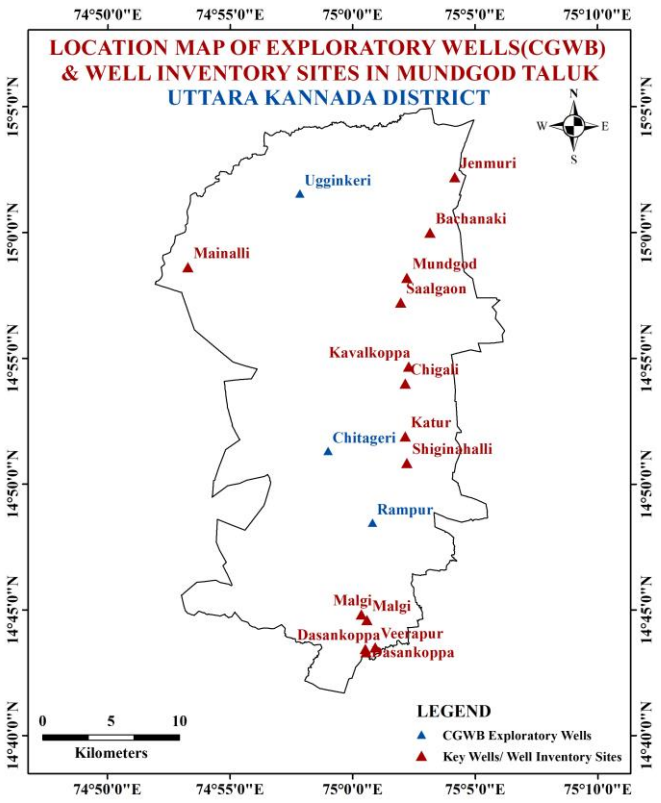


Fig-22: Location map of CGWB Exploratory Wells & Well inventory Key wells

The fieldwork was conducted in the taluk and well inventory survey was completed. With generation of sufficient data through the fieldwork, the requirement from the data-gap analysis is met upto the mark. The previous data points and newly established key wells pertaining to NHS groundwater level monitoring and groundwater exploration are presented in the maps above for correlation purpose (Fig.-21,22).

3.0 HYDROGEOLOGY

Karnataka state stands as a Hard-rock terrain out of the diversified terrain classification of aquifers in the Indian Peninsula. The occurrence and movement of groundwater in the subsurface is broadly governed by geological framework i.e., regional structural setup, fracture orientation, lithology and its Porosity (primary & secondary) and Permeability. The principle aquifers in the area are Schistose rocks such as Metagreywackes with minor occurrences of phyllites and schists (Fig.-23). These rocks are devoid of primary porosity but characterized by secondary porosity. The weathered zone contains the unconfined or phreatic aquifers. Whereas, the fractures formed in the schistose rocks during structural deformation will lead to the secondary porosity. The intersection of such fracture sets develops the pathway for groundwater to translocate in the subsurface.

3.1 Aquifer Types

In Mundgod taluk, there are mainly two types of aquifer systems -

i. **Aquifer-I (Phreatic aquifer)** Weathered Schistose rocks (Laterite/ Metagreywackes)
ii. **Aquifer-II (Fractured aquifer)** Fractured Schistose rocks (Metagreywackes)

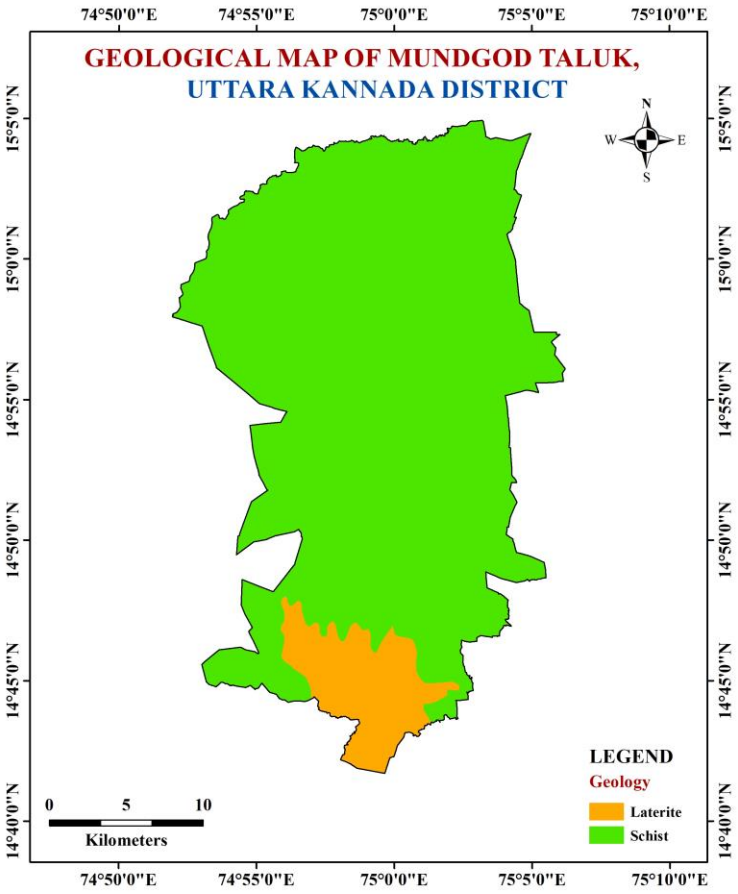


Fig-23: Geology Map

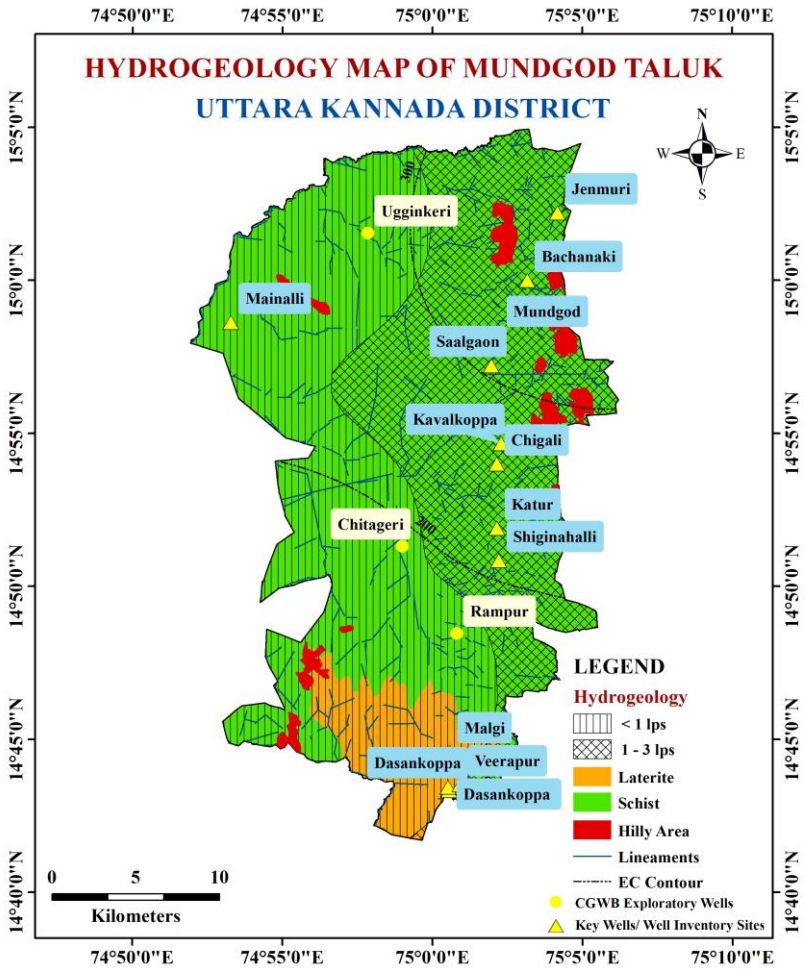


Fig-24: Hydrogeology Map

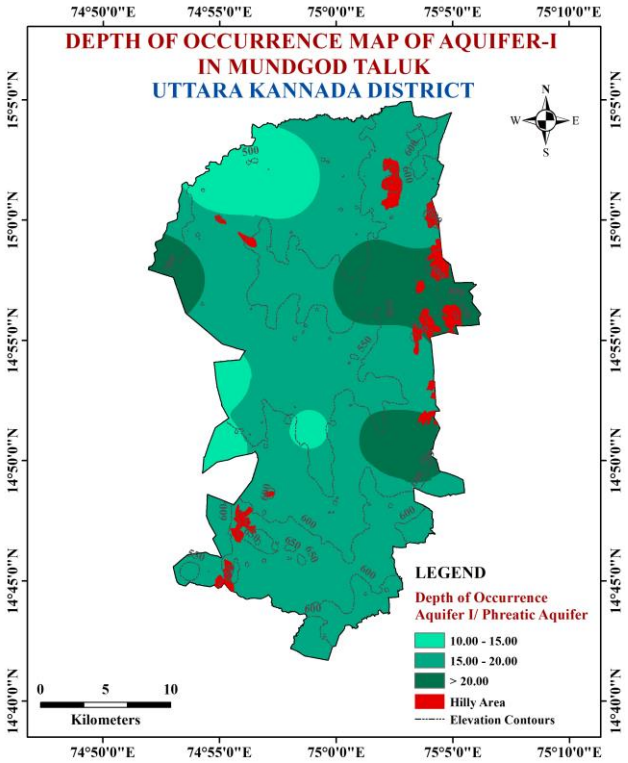


Fig-25a: Depth of Occurrence- Aquifer I

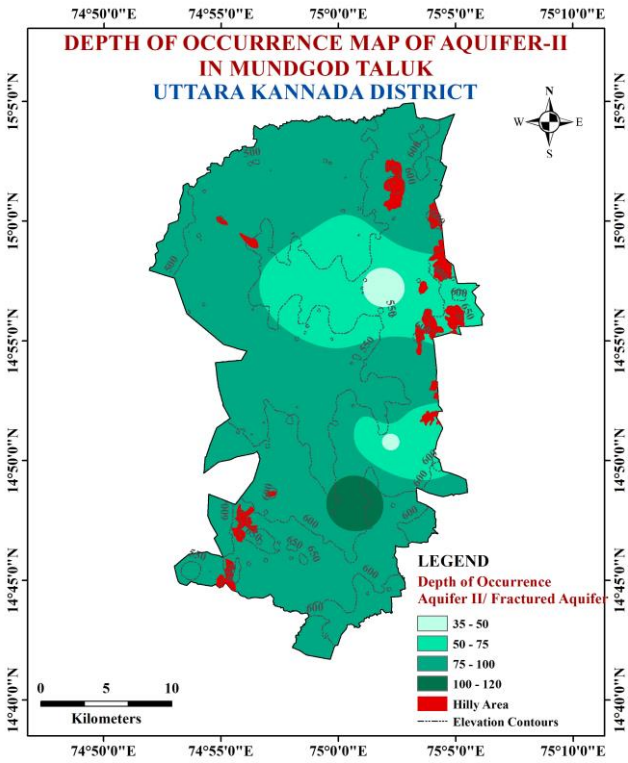


Fig-25b: Depth of Occurrence- Aquifer II

In Mundgod taluk, Schists and metagreywacke(argillites) are the main water bearing formations (Fig-24).

i. Aquifer-I (Phreatic aquifer) -

Aquifer I or Phreatic/ Unconfined Aquifer comprises lithology such as Laterites and Weathered Metagreywackes with occurrences of Phyllites with primary porosity induced by intense chemical weathering due to tropical climate. The spatial distribution of the Aquifer I is represented in the Map (Fig.-25a). The depth of occurrence is observed to be in the range from 10m in Northwestern area to the maximum upto more than 20m in the Eastern parts of Taluk, which is predominantly a Hilly area. The depth to phreatic aquifer is maximum in the hilly terrain, compared to the low-lying area.

ii. Aquifer-II (Fractured aquifer) -

Aquifer II or Fractured/ Semi-confined Aquifer comprises lithology such as Metagreywackes with occurrences of Phyllites with Secondary or Fractured porosity induced in the rock by active deformational tectonics in brittle domain during the geological past. The spatial distribution of the Aquifer II is represented in the Map (Fig.-25b). The depth of occurrence is observed to be shallower in the Central-eastern parts of the Taluk in the range of 35-75m. Around 65% of the area is covered by fractures ranging from 70-100m. At one location in the south-eastern corner, deeper fractures are encountered upto the depth of 120m.

Ground water occurs within the weathered and fractured Metagreywacks, schist unconfined condition and semi-confined condition. In Mundgod taluk bore wells were drilled up to the depth of 188.05 to 200 mbgl. Yield ranges from 0.3 to 2.00 lps. The basic characteristics of each aquifer are summarized in Table-14.

Table-12: Details of Ground Water Exploration, CGWB

Sl. No.	Location	Latitude	Longitude	Depth Drilled (mbgl)	Lithology	APT Results	
						Q in LPS	T in m2/day
1	Ramapur EW	14.00778	75.0136111	200	Metagreywacke	0.3	7.34 (Slug test)
2	Chitageri EW	14.00778	75.0136111	200	Metagreywacke	0.13	3.10 (Slug test)
3	Ugginkeri EW	15.70889	74.9641667	188.05	Metagreywacke	0.43	-

Table-13: Details of Well Inventory data collected from dugwells & borewells

Sl. No.	Location	Latitude	Longitude	Lithology	DW/ BW/ HP	Depth (m)	Casing/ Parapet (m bgl)	Fracture (m bgl)	Yield (lps)	MP (m)	DTWL (m bgl)
1	Dasankoppa	14.722	75.009193	Laterite	DW	`16.00	4.00	`15.80	-	0.78	3.74
2	Kavalkoppa	14.911095	75.038125	Schist/ Metagreywacke	DW	15.00	4.50	15.00	-	0.80	2.30
3	Malgi	14.743139	75.009716	Laterite	DW	12.50	4.00	12.00	-	0.68	3.30
4	Bachanaki	14.999868	75.0527244	Schist/ Metagreywacke	BW	85.30	24.50	41.00	1.50	0.58	2.90
5	Chigali	14.899875	75.0358302	Schist/ Metagreywacke	BW	85.50	23.00	43.50	1.00	0.70	2.60
6	Dasankoppa	14.724	75.008608	Laterite	BW	48.30	23.00	16.00, 42.50	1.00	0.45	4.10
7	Jenmuri	15.03664	75.0694926	Schist/ Metagreywacke	BW	81.50	24.20	42.50	1.50	0.55	2.30
8	Katur	14.864929	75.0358962	Schist/ Metagreywacke	BW	54.50	24.80	39.00	2.00	0.52	1.30
9	Saalgaon	14.953508	75.032802	Schist/ Metagreywacke	BW	85.30	24.30	38.00	1.50	0.42	3.50
10	Shiginahalli	14.847298	75.037006	Schist/ Metagreywacke	BW	45.70	24.30	42.60	2.00	0.25	1.10
11	Veerapur	14.72515	75.0154665	Laterite	BW	80.20	25.00	14.00, 38.00	1.00	0.51	3.50

Table-14: Basic characteristics of each aquifer

Aquifers	Prominent Lithology	Sets of Fracture	Depth range of fractures (mbgl)	Range of yield potential (lps)	T (m^2/day)	GW Quality for Domestic & Irrigation use
Weathered Zone (Aq.-I)	Weathered Metagreywacke/ Laterite	1-2	17 to 30.5	Low yield	-	Suitable
Fractured Zone (Aq.-II)	Fractured / Jointed metagreywacke	1-2	30 to 43.5	0.3 - 2.00	3.10-7.34	Suitable

3.2 3D Aquifer disposition model, Aquifer Fence diagram & 2D Cross-sections

The 3D aquifer disposition model, aquifer fence diagram and 2D aquifer cross-sections have been prepared using Rockworks software for understanding the spatial distribution of aquifers beneath the subsurface. (Fig.-26,27,28). The data from Basic Data Reports of Exploratory Borewells drilled by CGWB in the Taluk, is used during preparation of these models. To fill the data gap, key wells were established during the fieldwork in the area, and well inventory data collected during the fieldwork is compiled and used along with the CGWB exploration data.

The 2D cross-sections prepared across the Taluk, to reveal the subsurface spatial distribution of aquifers. Therefore, cross-sections were prepared along North-South and East-West Directions. The thickness of the range of fracture sets can be observed to increase from North towards South, also the fractured thickness in the Eastern part is more. Massive, unfractured lithology is encountered at shallower depths in the Western part compared to other parts of the Taluk (Fig.-26).

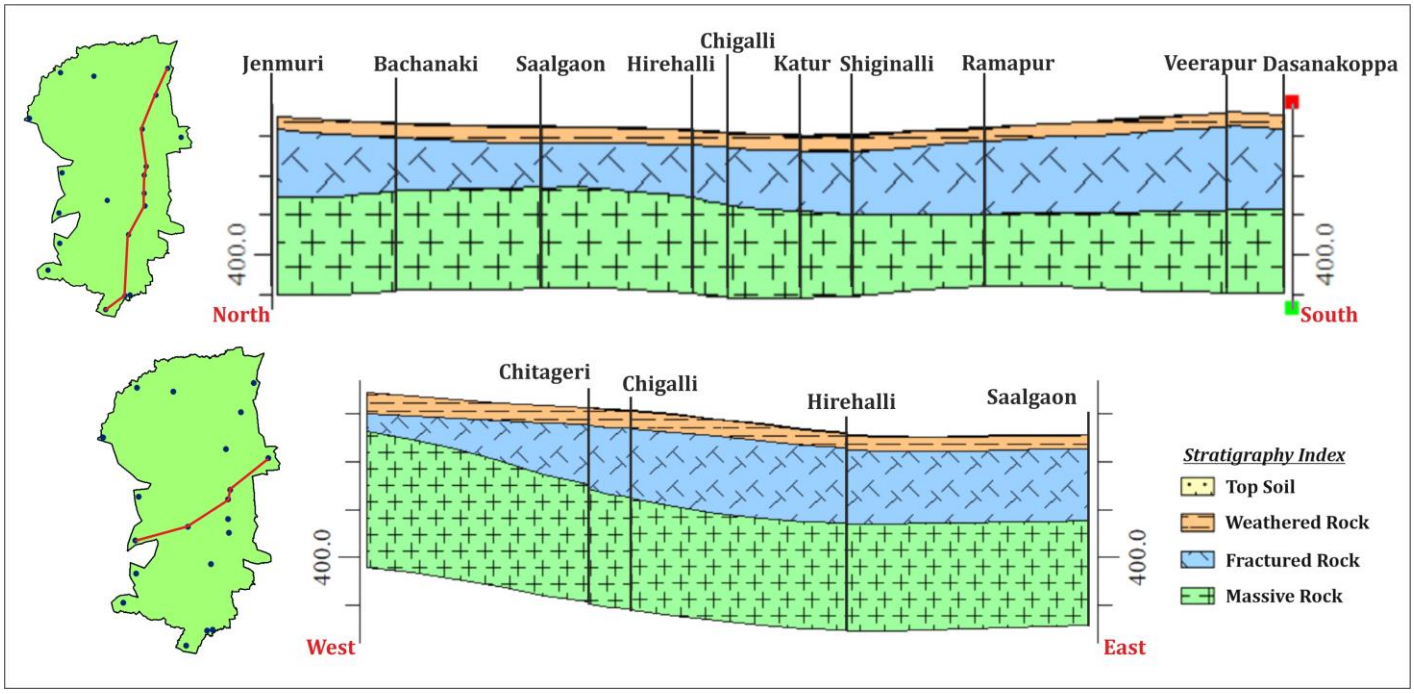


Fig-26: 2D Aquifer cross-section along North-South and East-West directions

The 3D model for aquifer disposition in prepared. The 3D aspect for the aquifers in the entire taluk, provides the scope to observe variation in the soil cover thickness, the thickness of fractured lithology and the depth of first occurrence of massive lithology (Fig.-27).

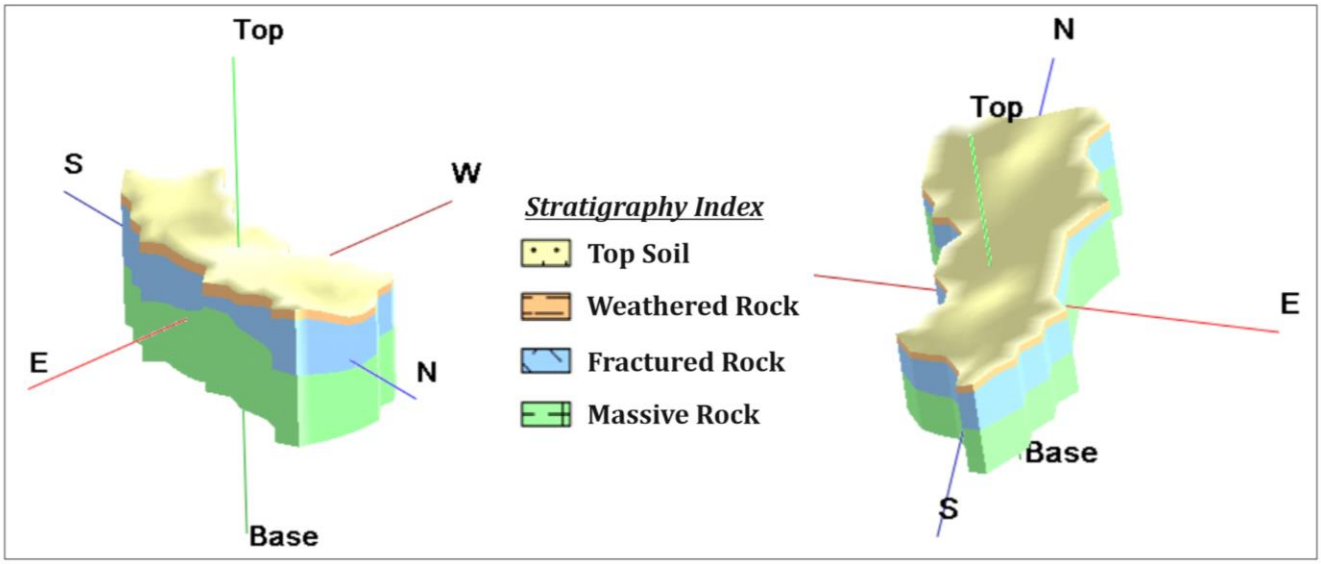
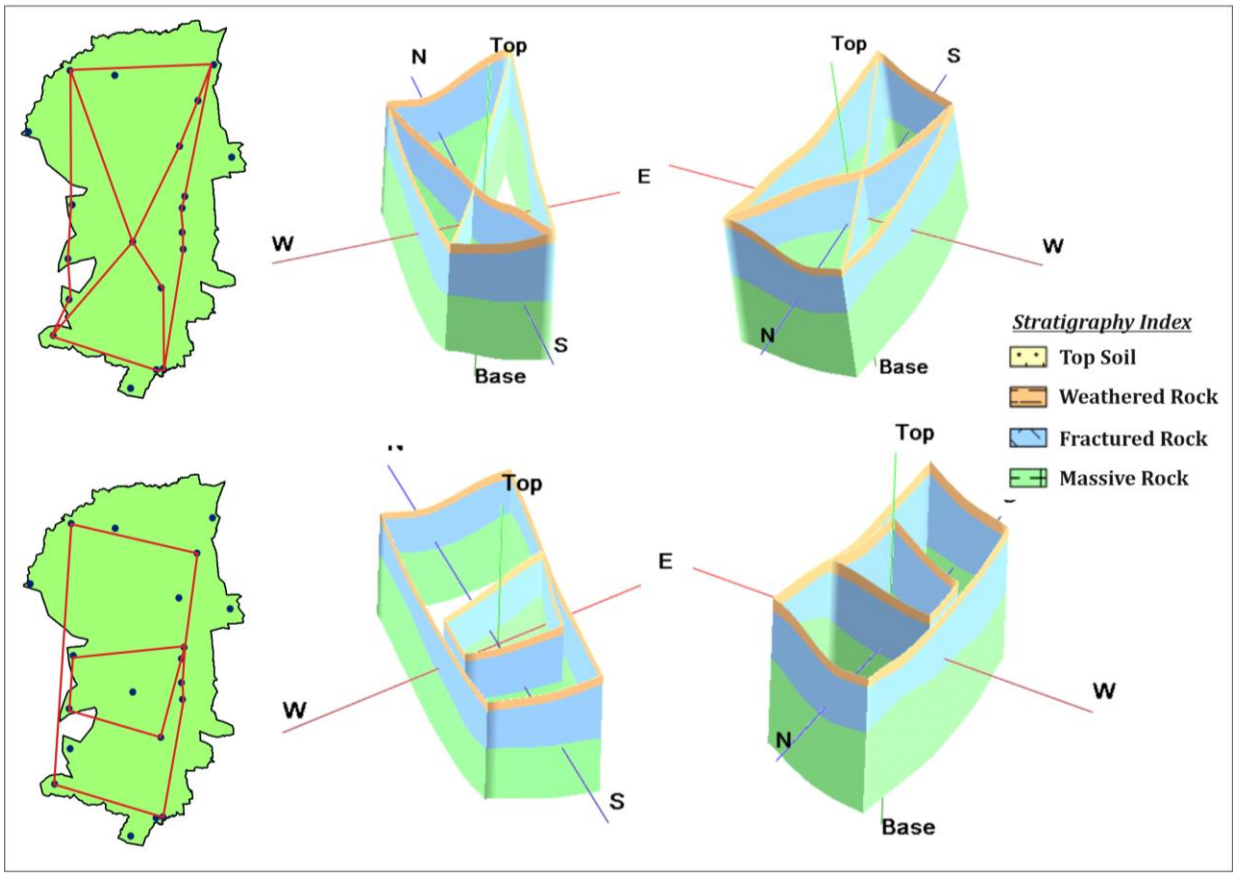


Fig-27: 3D Aquifer disposition model



The 3D fence diagrams for the Taluk, provide information on the aquifer geometry across the coverage area, which is the boundary of Taluk. Variation in the thickness of layers is observed in these diagrams (Fig.-28).

4.0 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

4.1 Aquifer wise resource availability and extraction

The main groundwater issues faced in this area are desaturation of phreatic aquifers (Aquifer I) during peak summer time. This is observed predominantly in the area having laterite as the unconfined aquifer. The groundwater in Laterite formation undergoes desaturation easily as the rock is highly porous and permeable. Therefore, construction of structures such as subsurface dykes may be recommended, to obstruct the movement of groundwater under the influence of gravity.

(a) Present Dynamic Ground Water Resource (GWRA'2022)

The Ground Water Resources Assessment (GWRA 2022) for Karnataka State has been carried out with cooperation received from GWD, Govt. of Karnataka. The stage of extraction is estimated from percentage of Total Annual Extraction for all uses per available Annual Groundwater Resources. As the present stage of extraction is 20.65% (which lies below 70%), it is found under SAFE category.

Taluk	NET ANNUAL GROUND WATER AVAILABILITY	EXISTING GROSS GROUND WATER DRAFT FOR DOMESTIC PURPOSE	EXISTING GROSS GROUND WATER DRAFT FOR INDUSTRIAL PURPOSE	EXISTING GROSS GROUND WATER DRAFT FOR IRRIGATION	EXISTING GROSS GROUND WATER DRAFT FOR ALL USES	ALLOCATION FOR DOMESTIC USE FOR PROJECTED YEAR 2025	NET GROUND WATER AVAILABILITY FOR FUTURE USE	STAGE OF GROUND WATER EXTRACTION	Category
Mundgod	10806.88	433.87	2.98	1795.20	2232.05	459.24	8549.46	20.65%	**Safe**

(b) Present total Ground Water Resource (GWRA'2022)

The phreatic and fractured In-storage component of groundwater along with the dynamic component is considered for representing the total groundwater resource availability in the taluk.

Taluk	Annual extractable GW resources (in ham)	Fresh In-storage GW resources (in ham) (2017)		Total availability of GW resource (in ham) (2022)
		Phreatic	Fractured	Dynamic + phreatic in-storage + fractured in-storage
Mundgod	10806.88	16444	1926	29176.88

(c) Comparison of groundwater availability and draft scenario

The dynamic groundwater resources 2017, 2020 and as on 2022 are summarized and compared in the table below. It is observed that the groundwater availability in 2022 has increased significantly compared to that in 2020 and in 2017. Stage of groundwater extraction has been improved from 33% in 2017 to 23% in 2020 to 20.65% in 2022. As Mundgod taluk falls under SAFE Category, there is scope for groundwater resource development through additional wells. In the view of the prevailing practice of abstraction structures, borewells are the preferred structures in this area.

Taluk	GW availability (in ham)	GW draft (in ham)	Stage of GW extraction	GW availability (in ham)	GW draft (in ham)	Stage of GW extraction	GW availability (in ham)	GW draft (in ham)	Stage of GW extraction
	2017			2020			2022		
Mundgod	3954	1297	33%	5322	1218	23%	10806.88	2232.05	20.65%

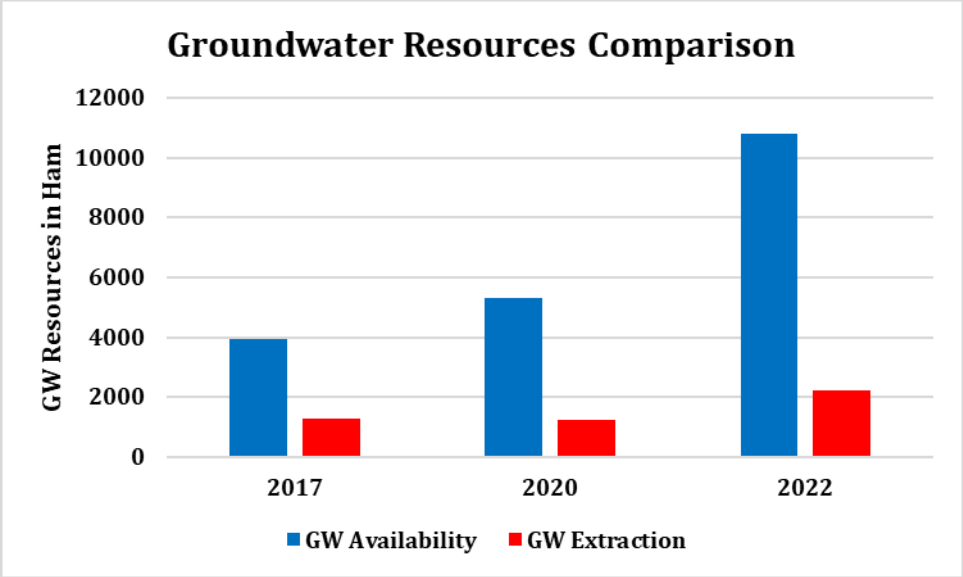


Fig-29: Groundwater resource comparison between 3 consecutive years of assessment

4.2 Chemical Quality of Ground Water and Contamination

The groundwater samples were collected from dugwells and borewells of various parts of Mundgod Taluk and were analyzed in the Chemical laboratory of CGWB, SWR, Bengaluru. Interpretation from Chemical Analysis results (Table-15) in Mundgod taluk is mentioned as below:

- **ELECTRICAL CONDUCTIVITY:** In general, EC values range from 120 to 380 µS/cm at 25°C (Fig-30).
- **CHLORIDE**: Chloride concentration in ground water ranges between 11 and 25 mg/l (Fig-31).
- **NITRATE:** Nitrate concentration in ground water ranges from 0.95 and 30.81 mg/l (Fig-32).
- **FLUORIDE:** Fluoride concentration in ground water is found only at one location which is 0.25 mg/l (Fig-33).

Table-15: GW Quality of ground water in Mundgod taluk of Uttara Kannada district (May 2022)

Sl. No.	Location	DW/BW	Latitude	Longitude	PH	EC	Cl	NO3	F
1	Katur	DW	14.8139	74.9358	7.73	170	18	7.56	ND
2	Malgi	DW	14.7708	75.0167	8.27	120	11	0	ND
3	Mundgod	DW	14.9833	75.0750	8.14	380	21	0.95	0.25
4	Vadageri	DW	14.8750	75.0486	8.33	220	25	30.81	ND

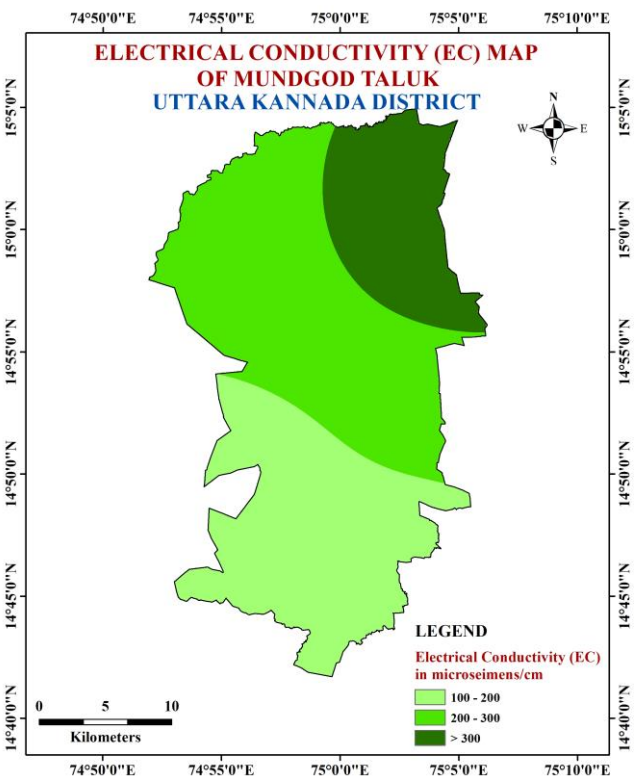


Fig-30: Distribution of Electrical Conductivity

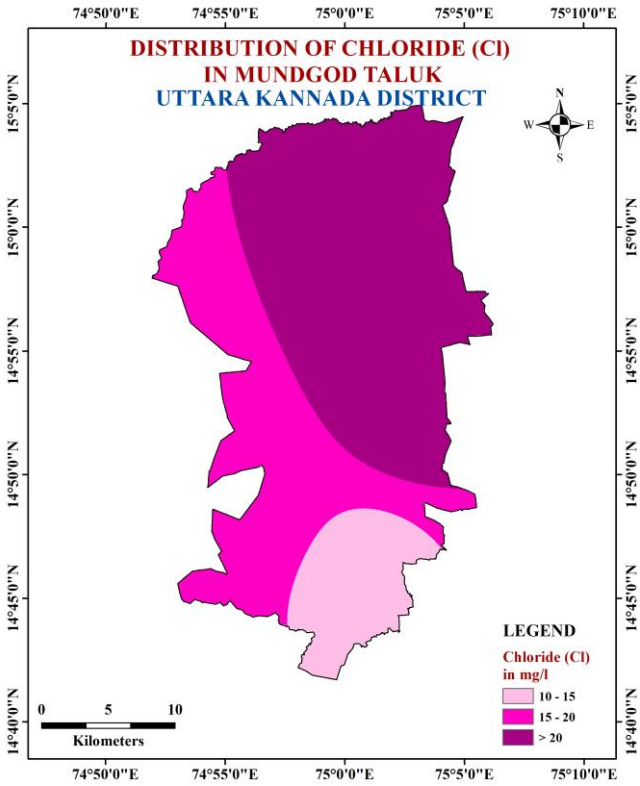


Fig-31: Distribution of Chloride

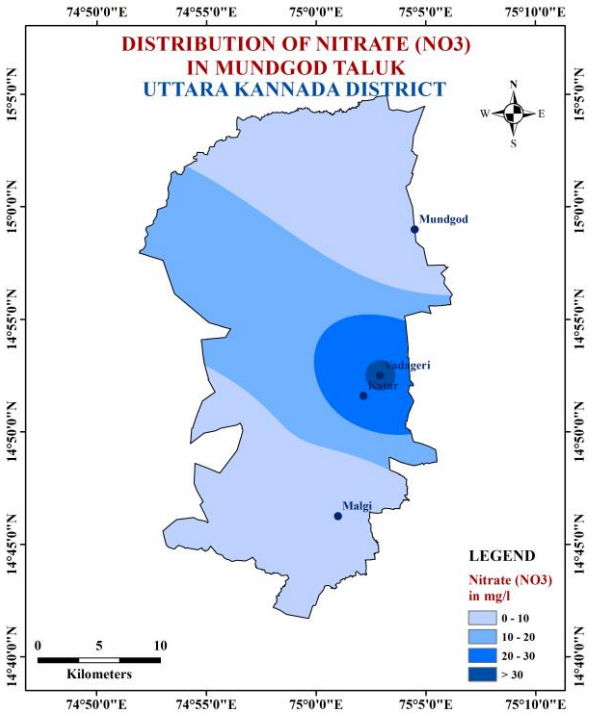


Fig-32: Distribution of Nitrate

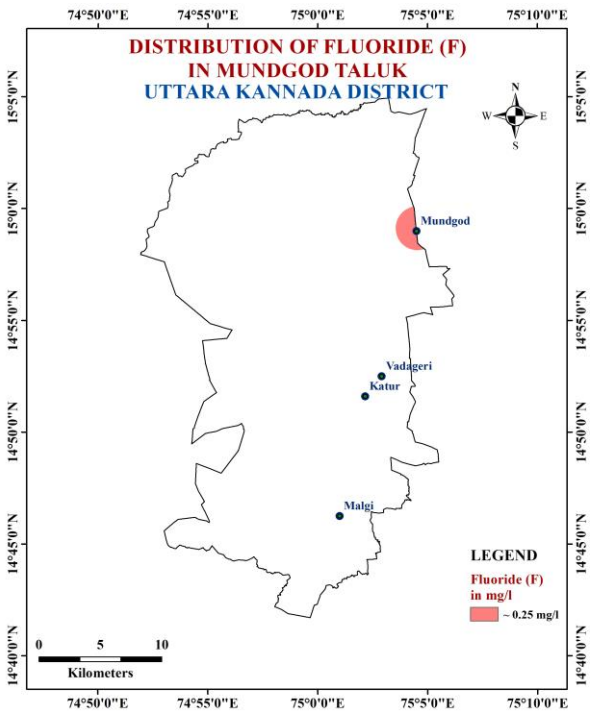


Fig-33: Distribution of Fluoride

The groundwater issues are mainly related to the desaturation of phreatic aquifer during peak summer time. In terms of groundwater quality, no severe quality issues are reported from the area. From the analysis of collected groundwater samples, except for the occurrence of minor amount of nitrate (>30, <45 mg/l) in the sample from Vadageri; it is observed that, groundwater quality issues are minimal in the area. Majority of the area of the taluk is occupied by forest cover and due to lack of accessibility, number of drilled borewells is comparatively on lesser side. As, the stage of groundwater extraction is in the Safe category, the taluk requires groundwater development by means of construction of abstraction structures such as borewells.

5.0 GROUND WATER RESOURCE ENHANCEMENT

5.1 Resource Enhancement by Supply Side Interventions

Recharge dry phreatic aquifer (Aq-I) in the taluk, through construction of artificial recharge structures, viz; check dams, percolation tanks & Sub surface dyke (Table-16). 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-16: Groundwater resource enhancement through artificial recharge

Artificial Recharge Structures Proposed	Mundgod taluk
Non committed monsoon runoff available (MCM)	11.062
Total no. of Existing Artificial Recharge Structures	101
Number of Proposed Check Dams	53
Number of Proposed Percolation Tanks	0
Number of Proposed Sub surface dyke	0
Tentative total cost of the project (Rs. in lakhs)	535.884
Excepted recharge (MCM)	8.297

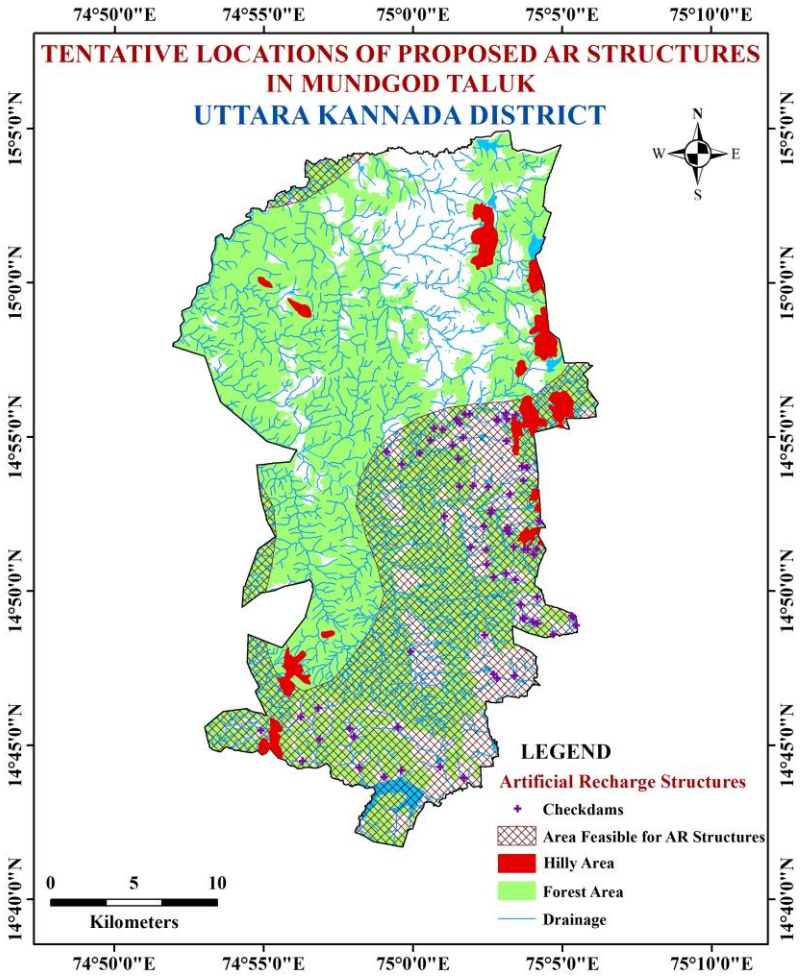


Fig-34: Tentative Locations of Proposed AR Structures

5.1.1 Benefit of Artificial recharge scheme

Artificial recharge structures namely Check Dams, Percolation Tanks, Filter Beds, Subsurface Dyke 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 indicates 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.

5.2 Resource Savings by Demand Side Interventions

5.2.1 Advanced Irrigation Practices

Mundgod taluk falls under Safe category with the stage of groundwater extraction of 20.65%. However, Water Use Efficiency (WUE) practices like Drip irrigation needs to be strengthened to save irrigation water by way of precision farming mechanism. This ultimately enhances the area under irrigation potential.

5.2.2 Water Use Efficiency by Micro Irrigation Practices

As per the observation made from statistical data, dugwells and bore wells are the source for 2830 ha of net irrigation in the taluk. 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 2830 ha of net irrigated area by dugwells & bore wells. The water efficient methodology may be applied for growing Paddy, Arecanut and Coconut which are grown in 6470 ha, 1512 ha and 69 ha respectively and is largely ground water dependent as compared to the other crops, especially Paddies which are mainly grown during kharif.

Table-17: Improvement in stage of extraction of groundwater through artificial recharge

Sl. No.	Resource Details	As per GWRA 2022
1	Net Groundwater Availability in Ham	10806.88
2	Existing Stage of Groundwater extraction in %	20.65
3	Existing Gross Groundwater Draft for all uses in Ham	2232.05
4	Expected Recharge from Artificial recharge structures in Ham	829.7
5	Expected improvement in stage of ground water extraction after implementation of AR structures in %	19.18%
6	Expected improvement in overall stage of groundwater extraction in %	1.47

5.2.3 Change in Cropping Pattern

Agriculture is the main occupation in Mundgod taluk. Water intensive crops like Paddy, Arecanut and Coconut which are grown in 6470 ha, 1512 ha and 69 ha respectively of net sown area of 14926 ha. However, oil seeds are grown during kharif and rabi. At present (2022), the stage of ground water extraction is 20.65% and taluk has been categorised as Safe, thus change in cropping pattern has not been suggested.

5.3 Regulation and Control

Mundgod taluk has been categorized as **Safe**, since the stage of ground water extraction has reached 20.65% (GWRA 2022), it may be encouraged to extract the ground water with care so that further ground water exploitation should not happen in the taluk. However, mandatory guideline issued by Government of Karnataka like rain water harvesting and Artificial recharge structures should be constructed. Ground water recharge component needs to be made mandatory in the non-command area of the taluk for further development of ground water.

5.4 Other interventions proposed

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

6.0 SUMMARY AND RECOMMENDATIONS

The summary of Management plan of Mundgod taluk is given below. As per the Ground Water Resource Assessment' 2022, Mundgod taluk falls under Safe category with the stage of groundwater extraction is 20.65%. 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 groundwater 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 1106.2 Ham. This can be used to recharge the aquifer mainly through check dams (53). The volume of water expected to be conserved/recharged is 829.7 Ham through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 535.884 Lakhs. Groundwater development in the area may be recommended by drilling of borewells as abstraction structures.

Table-18: No. of Feasible wells per Sq.Km and Irrigation Potential of the area

Annual Available GW in Ham	Unit Draft in Ham	No. of Wells Feasible	No. of wells After considering 25%	Irrigation potential with 0.8 Ha
A	*B*	*A/B = C*	*C * 0.25 = D*	*D * 0.8 = E*
10806.88	1.1	9824	**2456**	**1965**

As the stage of extraction of groundwater is 20.65% ; rest of the 49.35% (upto 70%) is considered under groundwater development. For which, 7 borewells (as abstraction structures) per Sq.km are recommended for construction. Apart from the 72.34% area which is under Forest cover, the additional area which can be brought under assured ground water irrigation will be about 1965 hectares (Table-18). However, the figures given are tentative and pre-field studies/ DPR are recommended prior to implementation of these recharge structures.

Ground water resource enhancement by demand side interventions:

At present about 55.93% 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 crop like Paddy, Arecanut & Coconut which is grown in the cropped area largely and groundwater dependent. Implementation of efficient irrigation techniques will contribute in saving Groundwater.

Change in cropping pattern:

Farmers are merely facing inadequacy of groundwater for agriculture during summer. Water intensive crops like Paddy, Arecanut and Coconut which are grown in 6470 ha, 1512 ha and 69 ha respectively of net sown area of 14926 ha. However, oil seeds are grown during kharif and rabi. At present (GWRA'2022), the stage of ground water extraction is 20.65% and taluk has been categorised as Safe, thus change in cropping pattern has not been suggested. By adopting the supply side and demand side management plan itself, the stage of groundwater extraction decreases from 20.65% to 19.18 % and the taluk falls under safe category.

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Tentative Locations of Proposed AR Structures in Mundgod Taluk

Sl. No.	Latitude	Longitude	Name of the Village	Type of AR Structure
1	14.928873	75.028978	Ajjihalli	Checkdam
2	14.929311	75.051806	Ajjihalli	Checkdam
3	14.925978	75.046757	Ajjihalli	Checkdam
4	14.925673	75.047555	Ajjihalli	Checkdam
5	14.926328	75.052453	Ajjihalli	Checkdam
6	14.928436	75.057398	Ajjihalli	Checkdam
7	14.871041	75.070304	Alballi	Checkdam
8	14.867529	75.052744	Alballi	Checkdam
9	14.865812	75.052196	Alballi	Checkdam
10	14.864381	75.053620	Alballi	Checkdam
11	14.855839	75.062153	Alballi	Checkdam
12	14.855750	75.064269	Alballi	Checkdam
13	14.855933	75.069008	Alballi	Checkdam
14	14.853030	75.067353	Alballi	Checkdam
15	14.908608	74.985345	Andalgi	Checkdam
16	14.741463	74.938486	Balekoppa	Checkdam
17	14.765399	74.937281	Bedasgaon	Checkdam
18	14.753156	74.947902	Bedasgaon	Checkdam
19	14.757867	74.915050	Bedasgaon	Checkdam
20	14.759718	74.991528	Bekkodu	Checkdam
21	14.737686	74.970089	Bekkodu	Checkdam
22	14.738285	75.015086	Bekkodu	Checkdam
23	14.914481	75.052237	Chigalli	Checkdam
24	14.900919	75.060920	Chigalli	Checkdam
25	14.899961	75.063626	Chigalli	Checkdam
26	14.889543	75.042138	Hirehalli	Checkdam
27	14.890270	75.033515	Hirehalli	Checkdam
28	14.889807	75.025993	Hirehalli	Checkdam
29	14.732799	74.983831	Hosakoppa	Checkdam
30	14.732204	75.028283	Janageri	Checkdam
31	14.736261	74.993488	Janageri	Checkdam
32	14.800516	74.998601	Kadambi	Checkdam
33	14.788328	75.044984	Kalkoppa	Checkdam
34	14.809549	75.039992	Kalkoppa	Checkdam
35	14.901700	74.993726	Kallali	Checkdam
36	14.875294	75.043366	Katur	Checkdam
37	14.855560	75.040823	Katur	Checkdam
38	14.857031	75.032160	Katur	Checkdam
39	14.868295	75.039624	Katur	Checkdam
40	14.786067	75.046933	Kodabgeri	Checkdam
41	14.759025	74.964633	Kurli	Checkdam
42	14.754556	74.966973	Kurli	Checkdam
43	14.921263	75.011685	Lakkoli	Checkdam
44	14.920633	75.016573	Lakkoli	Checkdam
45	14.926307	75.024165	Lakkoli	Checkdam
46	14.914825	75.009744	Lakkoli	Checkdam
47	14.857228	75.056240	Margadi	Checkdam

Sl. No.	Latitude	Longitude	Name of the Village	Type of AR Structure
48	14.843034	75.051899	Margadi	Checkdam
49	14.839458	75.057141	Margadi	Checkdam
50	14.892893	75.061671	Mudsali	Checkdam
51	14.885829	75.054315	Mudsali	Checkdam
52	14.876960	75.044141	Mudsali	Checkdam
53	14.873846	75.017530	Nagnur	Checkdam
54	14.830197	75.069439	Onigeri	Checkdam
55	14.825818	75.060184	Onigeri	Checkdam
56	14.818692	75.061528	Onigeri	Checkdam
57	14.816659	75.066877	Onigeri	Checkdam
58	14.818343	75.062031	Onigeri	Checkdam
59	14.815640	75.069412	Onigeri	Checkdam
60	14.809865	75.078329	Onigeri	Checkdam
61	14.814799	75.091124	Onigeri	Checkdam
62	14.819165	75.089451	Onigeri	Checkdam
63	14.787514	75.056645	Pala	Checkdam
64	14.929021	75.031704	Salgaon	Checkdam
65	14.923859	75.026018	Salgaon	Checkdam
66	14.916443	75.027954	Salgaon	Checkdam
67	14.912155	75.022093	Salgaon	Checkdam
68	14.904700	75.025139	Salgaon	Checkdam
69	14.907984	75.003662	Salgaon	Checkdam
70	14.840933	75.045064	Singanhalli	Checkdam
71	14.847730	75.041201	Singanhalli	Checkdam
72	14.770051	74.947042	Togralli	Checkdam

Source: ARS Master Plan, Central Ground Water Board, 2020
Note: It is likely that the number of Artificial Recharge Structures proposed may vary depending upon the ground truthing & verification and feasibility criteria.

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