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

Sirsi Taluk, Uttara Kannada District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

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भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास
एवं गंगा संरक्षण विभाग
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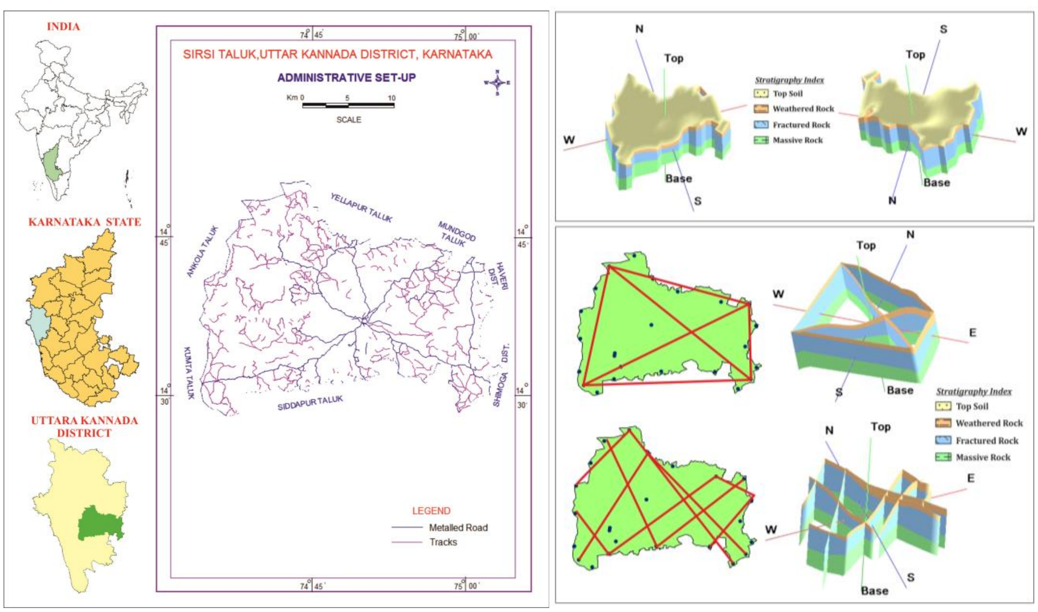
South Western Region,
Bengaluru

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

(AAP – 2022-2023)



By

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

<u>MAY 2023</u>

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

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

1.0 SALIENT INFORMATION

Name of the taluk: **SIRSI**

District: **UTTARA KANNADA**

State: Karnataka

Area: 1319 sq.km.

Population: 1,86,908

Annual Normal Rainfall: 2359.9 mm

1.1 Introduction to the study area

Aquifer mapping studies have been carried out in Sirsi taluk, Uttara Kannada district of Karnataka, covering an area of 1319 Sq. Kms under National Aquifer Mapping Project. The Sirsi taluk is located between North Latitudes 14° 27' 51" and 14° 51' 21" and East Longitudes between 74° 33' 48" to 75° 02' 41" and is falling in Survey of India Toposheets No forms parts of 48J/9, 48J/10, 48J/13, 48J/14. The study area is bounded on the East by Haveri & Shimoga Districts, on the North by Yellapur & Mundgod Taluk, on the South by Siddapur Taluk and on the West by Ankola & Kumta Taluks. Location map of Sirsi taluk of Uttara Kannada district is presented in Fig-1. Sirsi is taluk headquarter . There are 32 Gram-panchayats in this taluk.

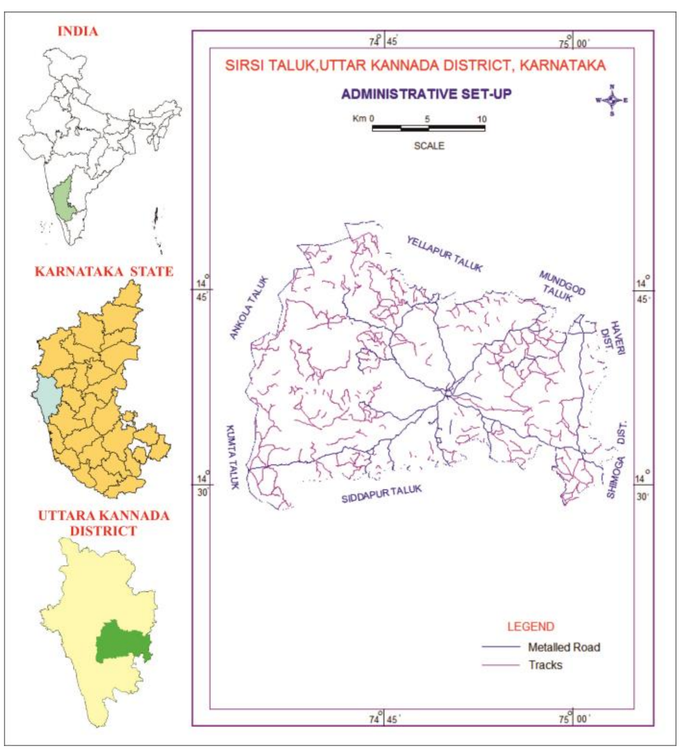


Fig-1: Location map of Sirsi taluk, Uttara Kannada District, Karnataka State

1.2 Population

According to 2011 census, the population in Sirsi taluk is 1,86,908. Out of which 93,902 are males while 93,006 are females. The average sex ratio of Sirsi taluk is 990. The Sirsi taluk has an overall population density of 142 persons per sq.km. The total decadal variation in population from 2001-2011 is 6.47% in Sirsi taluk.

Table 1: Population details of Sirsi Taluk

<table>
<tr><th colspan="4">Total Population: 186908</th></tr>
<tr><th>No. of Male</th><th>No. of Female</th><th>Total Rural Population</th><th>Total Urban Population</th></tr>
<tr><td>93902</td><td>93006</td><td>124026</td><td>62882</td></tr>
<tr><td colspan="4">Share of the District Population: 7.39%</td></tr>
<tr><td colspan="4">Decadal change in Population (2001-2011): 6.47</td></tr>
<tr><td colspan="2">Decadal change in Rural Population: 12.53%</td><td colspan="2">Decadal change in Urban Population: -3.75%</td></tr>
</table>

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

1.3 Rainfall

Sirsi taluk enjoys semi-arid climate. Dryness and hot weather prevail 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 2359.9 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 0.4 mm during February to 799.4 mm during July. The DEP% for pre-monsoon, SW monsoon and NE monsoon is 242, 35 & -28 % respectively. Annual average DEP% at this station works out to be 33 %. 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 Sirsi 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)	0.6	0.4	6.9	21.3	54	82	535.3	799.4	557.9	190.5	2083.1	144.7	42.4	7	193.8	2359.9
Actual Rainfall (mm)	0.1	0.0	13.1	40.2	227	280	342.3	1314.3	777.3	376.5	2810.4	127.7	3.6	8	139.0	3229.9
%DEP	-83	-100	90	89	322	242	-36	64	39	98	35	-12	-92	16	-28	33.0

Table 3: Annual Rainfall of Sirsi 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	0	0	0	16	0	16	301	641	842	299	2083	65	87	4	156	2255
2014	0	0	0	29	164	193	340	1170	777	274	2561	199	13	36	248	3002
2015	0	0	16	35	112	163	743	316	334	284	1677	112	128	0	240	2080
2016	0	0	0	0	44	44	448	590	549	175	1762	74	16	0	90	1896
2017	0	0	0	0	84	84	462	885	422	325	2094	269	15	0	284	2462
2018	0	0	65	12	152	229	642	932	738	129	2441	122	5	5	132	2802
2019	0	0	15.5	24.5	0	40	257.4	1130	1312	513	3212	310	48	1	359	3611
2020	4	2	3	31	66	106	576	672	1271	418	2937	207	3	2	212	3256
2021	62	12	14	29	219	336	663	1066	255	435	2419	208	199	32	439	3194
2022	0	0	13	40	227	280	342	1314	777	377	2810	128	4	8	140	3230

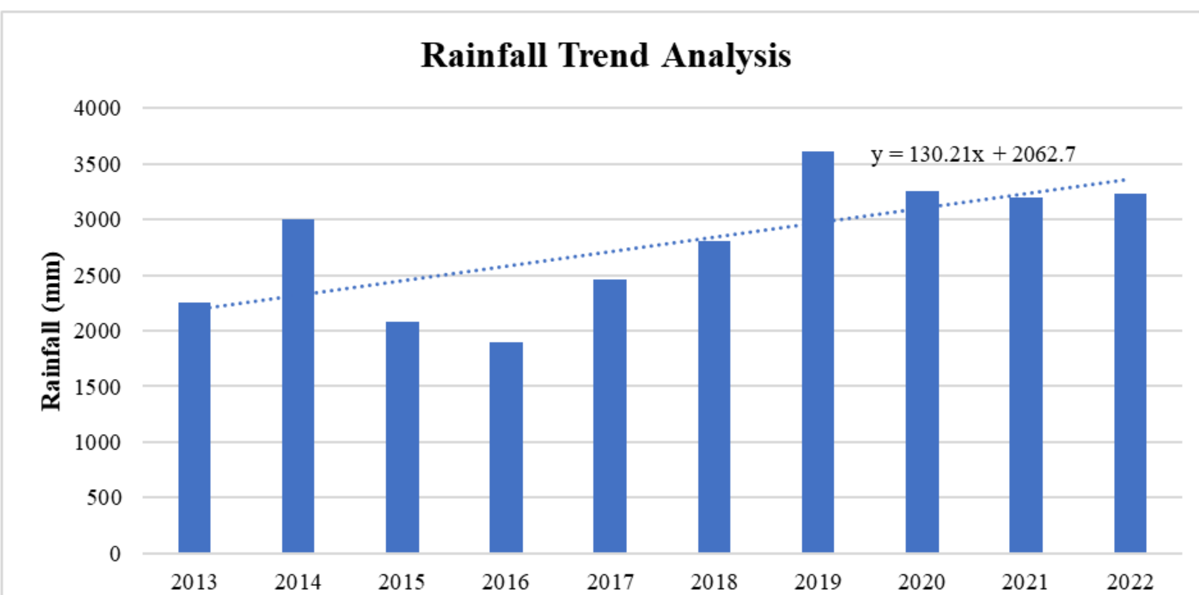


Fig-2: Long-term Rainfall Trend Analysis of Sirsi taluk of Uttara Kannada district

Assessment of Drought:

Rainfall data of Sirsi taluk has been analyzed for 108 (1901 – 2019) years using IMD method to assess the drought condition in Sirsi taluk. The results of the classification are listed in the Table 4. It is observed that the Sirsi taluk has experienced alternating no drought to moderate 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	Sirsi	9	92	7	0	0	Once in 15 years

The details of the drought assessment are discussed as herein under. Out of 108 years of analysis in Sirsi taluk, "No Drought" condition is experienced in 9 years, "Mild Drought" condition is experienced in 92 years and "Moderate Drought" condition experienced in 7 years in Sirsi 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 15 years** at Sirsi taluk.

1.4 Agriculture, Land use & Irrigation

Agriculture is the major occupation for the people in Sirsi taluk. Major Kharif crops are Paddy, Maize and Jowar. Main crops of Rabi season are Maize, and Jowar (Table-5). Water intensive crops like paddy & sugarcane is are grown in 34.23 % of total sown area. Maize is grown in 4.10 % total sown area of taluk. Important commercial crops like Sugarcane, Arecanuts, Coconuts are grown in 47.69 % of the total sown area.

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

Cereals (Area in Ha)			Pulses (Area in Ha)						
Paddy	Jowar	Maize	Ragi	Black Gram	Green Gram	Avare	Cow Pea	Bengal Gram	Other
8594	132	1039	1	8	1	2	5	3	6
9766			25						
Total area under Food Grains: 9791									

Oil Seeds (Area in Ha)			Commercial Crops (Area in Ha)			
Groundnuts	Other	Condiments & Spices	Arecanut	Coconut	Sugarcane	Other Comm. Crops
1	1	2530	8469	876	73	127
Total area under Oil Seeds: 2		**Total area under Commercial Crops: 12075**				

Fruits (Area in Ha)	Vegetables (Area in Ha)
3445.25	8.27

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

Majority of the geographical area of Sirsi is under forest cover which is 78.1 %. Out of which, it is observed that net sown area accounts for 15.72 % and area sown more than once covers 3.77 % of total geographical area (Table-6). Area not available for cultivation is 3.43 %. Whereas, area covered by fallow land is very less. Out of the total net irrigated area 42.75 % is irrigated by means of bore wells and 39.54 % is irrigated by tanks (Table-7).

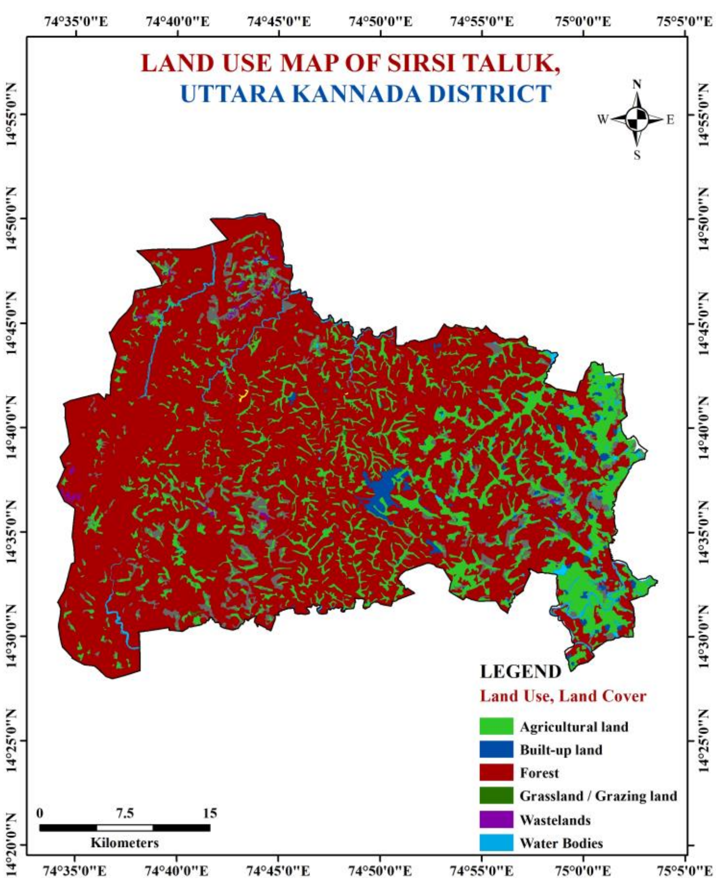


Fig-3: Land use Map

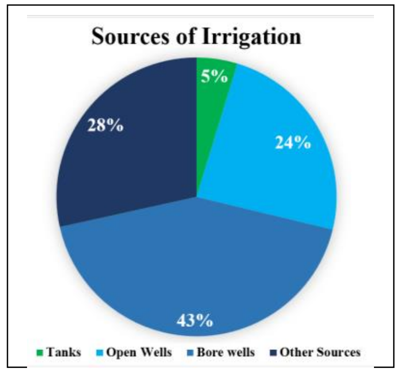
Total Geographical Area (Ha)	**132233**
Area under Forest	103270
Area not available for cultivation	4548
Fallow land	811
Net sown area	20790
Area sown more than once	4990

Table-6: Details of Land use in Sirsi taluk, 2021(Ha)

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

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

Source of Irrigation	Net Area Irrigated (Ha)
Tanks	265
Open Wells	1350
Bore wells	2400
Other Sources	1598
Total	5613



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

1.5 Geomorphology, Physiography & Drainage

Sirsi taluk is more or less a plateau region formed by dominant lithologies such as Granite gneisses of Banded Gneissic Complex with Metagreywackes and Argillites, which belong to "Dharwar Schists". Occurrence of Basalt is reported in patches in the western side. Whereas, Laterites are dominant in the eastern part of the taluk. Gradual change in the topography is prominent from West to East. Western part of the taluk is marked by Hilly terrain and turns into a piedmont zone where, average elevation is reduced but still topography is rugged and dissected. On the eastern parts the terrain becomes more low lying and peneplane.

The elevation in the plains varies from 633 m in the North western part to 201 m amsl in the Southern part of the taluk. The topographic variation is significant in the form of contrast in elevation amsl values. The differential altitude is significant as it is responsible to cause irregular ground water flow patterns on the micro scale (Fig.-4 and Fig.-4a). The topography is dominantly controlled by geological structures.

The entire Sirsi taluk is drained by tributaries of Bedthi river (Gangavali) and Aghanashini river 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-eastern area 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 south-eastern area of the taluk. (Fig.-5).

1.6 Soil

The soils in Sirsi taluk are derived from Schistose and argillite rocks, Granite gneisses and Laterites in semi-arid, sub-tropical climate and these vary in depth and texture, depending on the parent rock type, physiographic setting and climatic conditions. Clayey-skeletal soils and Clayey soils cover majority of the parts of the taluk, followed by the clayey loamy soils and loamy (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.

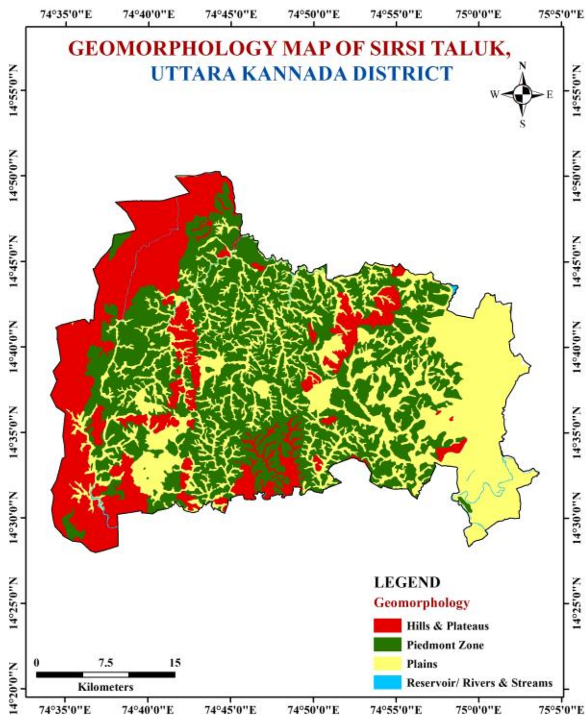


Fig-4: Geomorphology Map

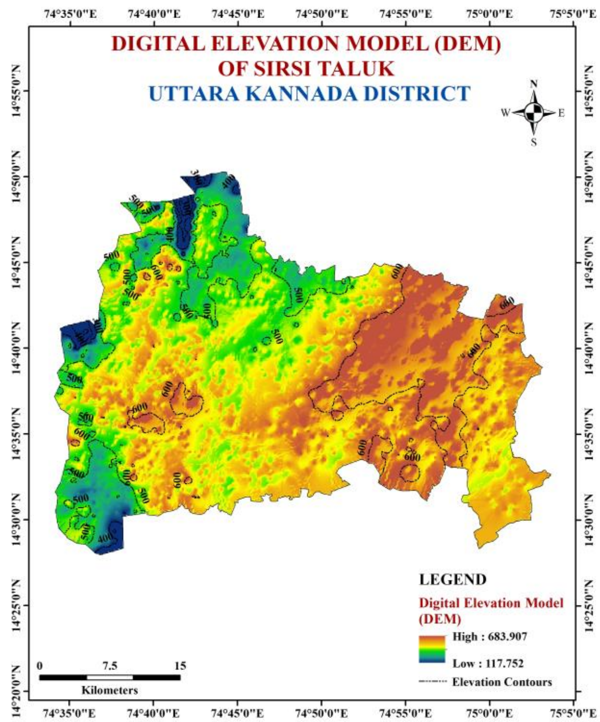


Fig-4a: Digital Elevation Model (DEM)

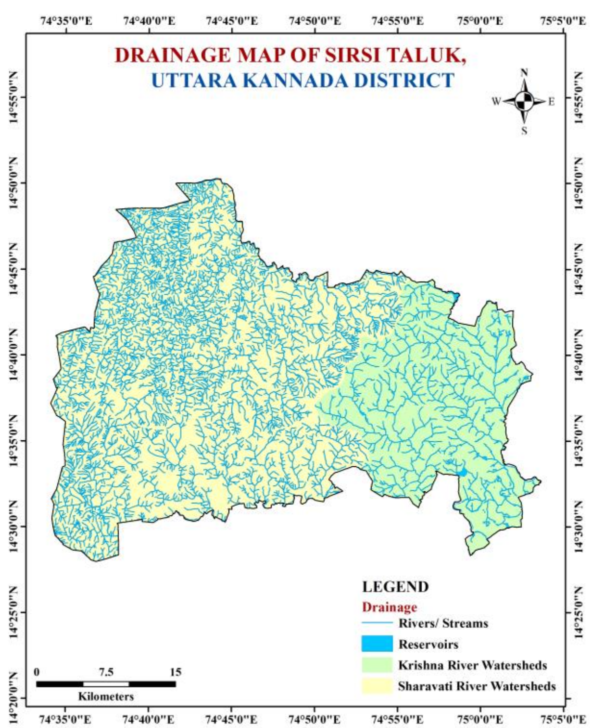


Fig-5: Drainage Map

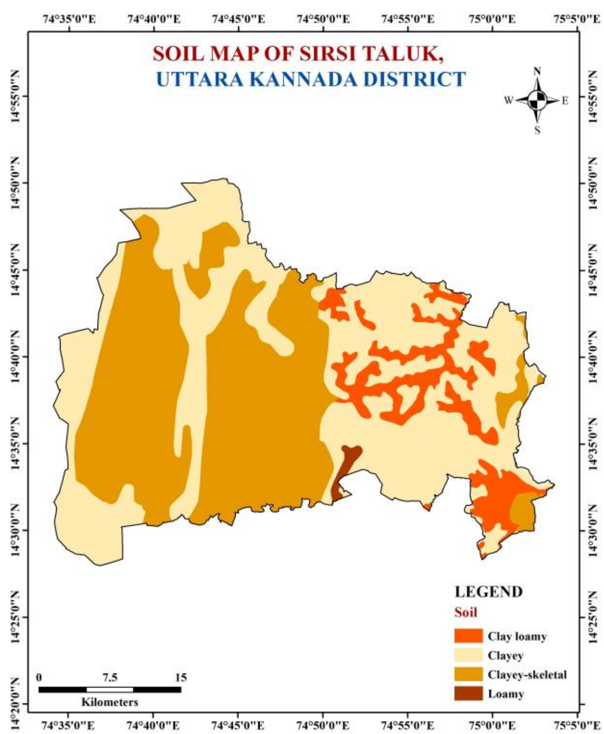


Fig-6: Soil Map

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
		Phreatic	Fractured (Down to 200m)	Dynamic + Phreatic in-storage + Fractured
Sirsi	11263.02	46272	5236	62771.02

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

- Net ground water availability for future use : 8173.66 Ham
- Allocation for Domestic use for projected year 2025 : 408.04 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: 2.75– 11.57 mbgl
- Post-monsoon: 2.85 – 15.68 mbgl

Aquifer-II

- Pre-monsoon: 6.16- 7.60 mbgl
- Post-monsoon: 5.37- 6.5 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	Amminalli	Unconfined	11	14.3875	74.8083	7.65	6.65
2	Banavasi	Unconfined	19	14.5342	75.0189	7.43	15.68
3	Bandal	Unconfined	11.1	14.5333	74.6667	5.78	6.37
4	Islur	Unconfined	12	14.6833	74.8833	6.02	4.54
5	Kolgibis	Unconfined	60	14.5333	74.8342	3.56	3.43
6	Kursi	Unconfined	16	14.5581	74.7625	11.57	10.25
7	Ragi hosalli	Unconfined	9.85	14.5403	74.6861	5.6	4.34
8	Sirsi	Unconfined	7.82	14.5236	74.6014	3.41	3.45
9	Unchalli	Unconfined	13.25	14.625	74.8736	8.51	7.9
10	Vandatte	Unconfined	9.95	14.5781	74.9061	7.38	5.93
11	Yekkambi	Unconfined	16	14.3667	74.725	9.21	9.22
12	Kansur	Semi-confined	11.8	14.6833	74.9333	6.16	5.37

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	Banavasi	Unconfined	12.18	14.541	75.014	4.85	6.08
2	Bisalkoppa	Unconfined	13.20	14.699	74.932	10.00	10.00
3	Ragihosalli (Hebre)	Unconfined	7.08	14.524	74.597	4.05	3.40
4	Ammenahali (Janmane)	Unconfined	12.80	14.548	74.737	9.15	7.35
5	Masigadde (Kanagod)	Unconfined	13.26	14.563	74.818	9.40	7.80
6	Navangeri	Unconfined	12.00	14.562	74.947	2.75	4.10
7	Hegadekatta (Shivalli)	Unconfined	6.25	14.607	74.717	3.10	2.85
8	Sirsi	Unconfined	16.30	14.615	74.835	11.45	10.90
9	Isloor	Semi-confined	60.00	14.681	74.887	7.55	6.30
10	Janmane	Semi-confined	82.00	14.543	74.727	7.00	6.50
11	Masigadde (Kanagod)	Semi-confined	46.00	14.564	74.818	7.60	5.95

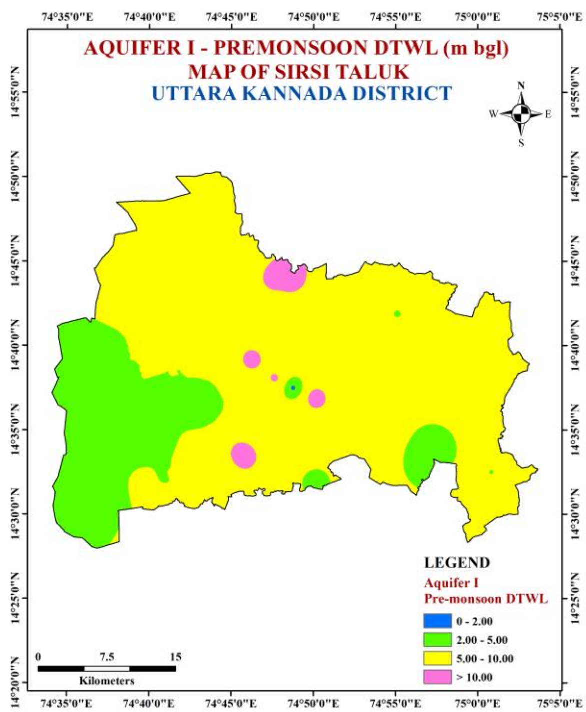


Fig-7: Aquifer I Pre-monsoon DTWL (May 2022)

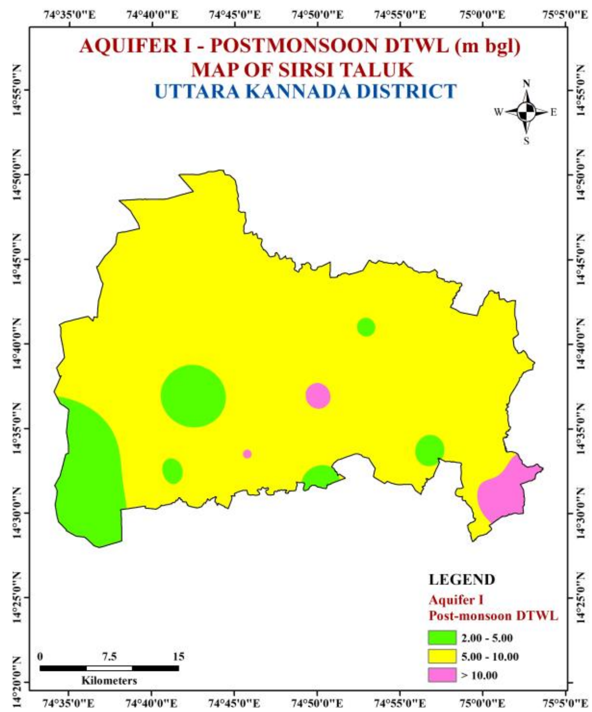


Fig-8: Aquifer I Post-monsoon DTWL (Nov 2022)

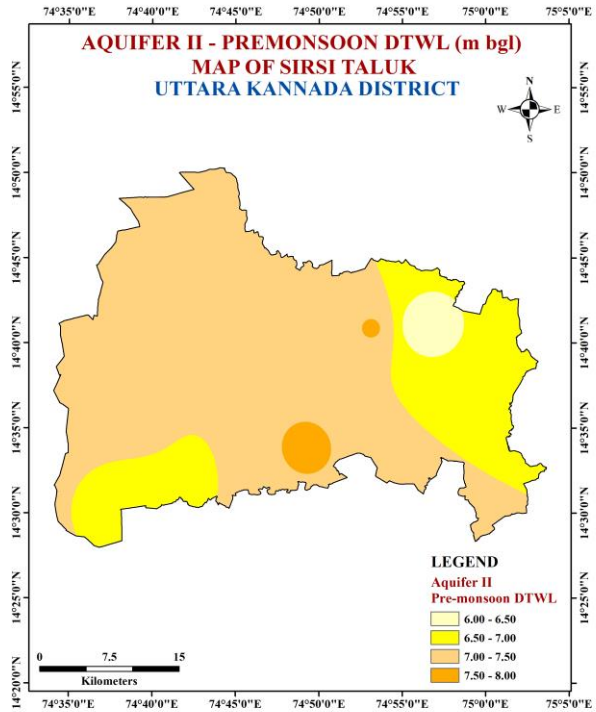


Fig-9: Aquifer II Pre-monsoon DTWL (May 2022)

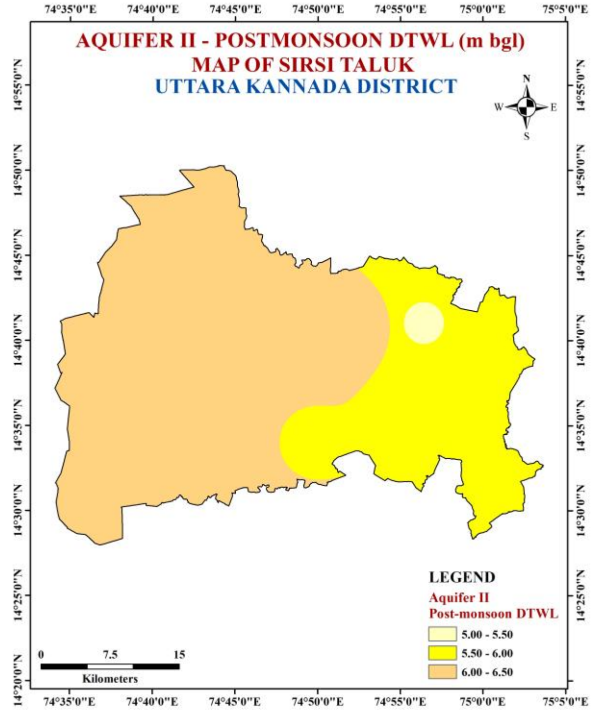


Fig-10: Aquifer II Post-monsoon DTWL (Nov 2022)

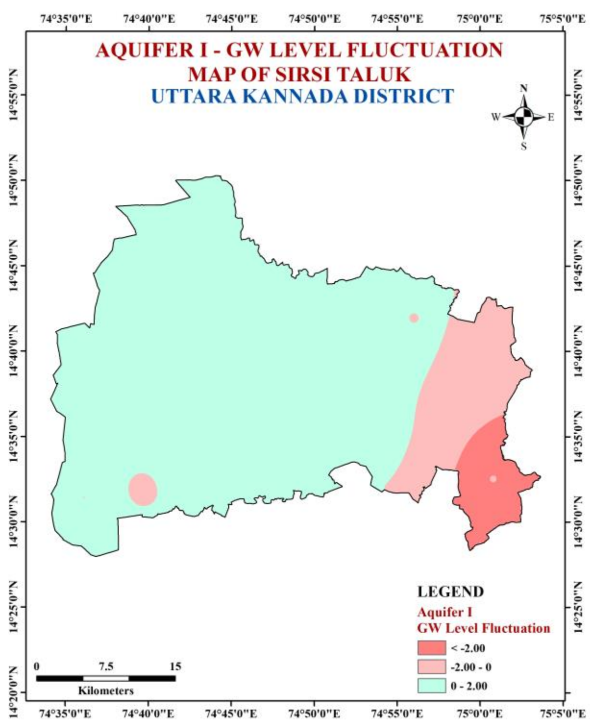


Fig-11: Aquifer I Groundwater level fluctuation map

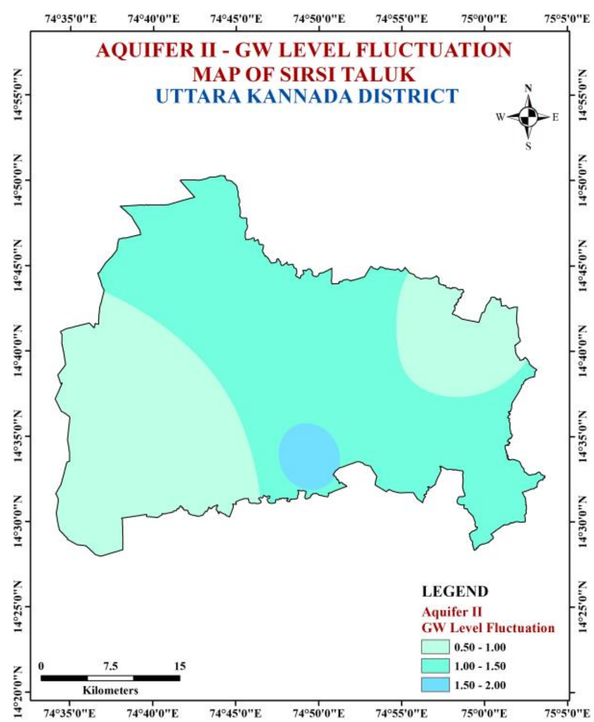


Fig-12: Aquifer II Groundwater level fluctuation map

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, Phreatic aquifer experience desaturation in few parts of the taluk as it presented by DTWL more than 10m and in case of fractured aquifer, the DTWL is observed to be in the range of 5 - 10m.

The seasonal fluctuation (Fig.-11,12) shows fall of more than 2.00m for phreatic aquifer in the south-eastern part and a small patch in the south-western part. Majority of the area experiences rise in the water level in the mean range of 0-2.00m. In case of fractured aquifer, the rise in the water level is reported throughout the area in the range of 0 – 2.00m.

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-22
Amminalli	DW	9.14	9.19	10.08	9.06	9.02	9.74	7.65
Banavasi	DW	16.18	15.48	16.21	16.95	17.31	17.45	7.43
Bandal	DW	8.4	8.45	8.91	6.25	8.52	10.08	5.78
Islur	DW	8.78	9.01	8.55	9.9	8.62	8.95	6.02
Kolgibis	DW	13.88	12.12	14.31	14.6	11.95	14.85	11.57
Kursi	DW	7.37	7.81	8.04	7.89	7.39	9.47	5.6
Ragi hosalli	DW	4.46	4.91	5.33	5.1	5.46	6.52	3.41
Sirsi1	DW	9.54	9.35	11.3	9.4	0	12.7	8.51
Unchalli	DW	9.04	7.92	8.88	8.98	8.62	9.83	7.38
Vandatte	DW	10.07	9.56	10.97	10.72	10.92	12.55	9.21
Yekkambi	DW	8.48	8.27	9.01	9.82	9.67	10.15	6.16
Kansur	BW	4.41	4.7	5.61	5.72	4.92	6.15	3.56

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
Amminalli	DW	6.1	7.1	6.9	3	6.3	5.58	5.5	6.65
Banavasi	DW	15.43	15.62	16.48	15.78	15.68	15.28	15.63	15.68
Bandal	DW	5.88	6.08	6	6.03	6.2	5.85	5.05	6.37
Islur	DW	4.09	5.1	6.2	8.65	4.5	2.9	2.37	4.54
Kolgibis	DW	12.39	12.7	12.8	12.52	12.4	12.25	12.2	10.25
Kursi	DW	3.75	4.29	3.74	3.96	2.24	3.64	3.04	4.34
Ragi hosalli	DW	3.39	3.53	3.65	3.49	3.5	3.3	2.77	3.45
Sirsi1	DW	7.97	8.64	11.55	0	0	7.35	7.4	7.9
Unchalli	DW	4.78	4.85	5.13	4.83	5.33	3.73	3.45	5.93
Vandatte	DW	8.78	8.81	9.97	8.27	6.97	6.3	8.7	9.22
Yekkambi	DW	4.52	6.12	6.37	6.02	6.07	3.55	3.17	5.37
Kansur	BW	2.94	3.6	3.56	3.42	3.2	2.77	1.8	3.43

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 Sirsi and Kolgibis are prepared (Fig.-13,14). These long-term trends show rising nature in both the Pre-monsoon & Post-monsoon periods.

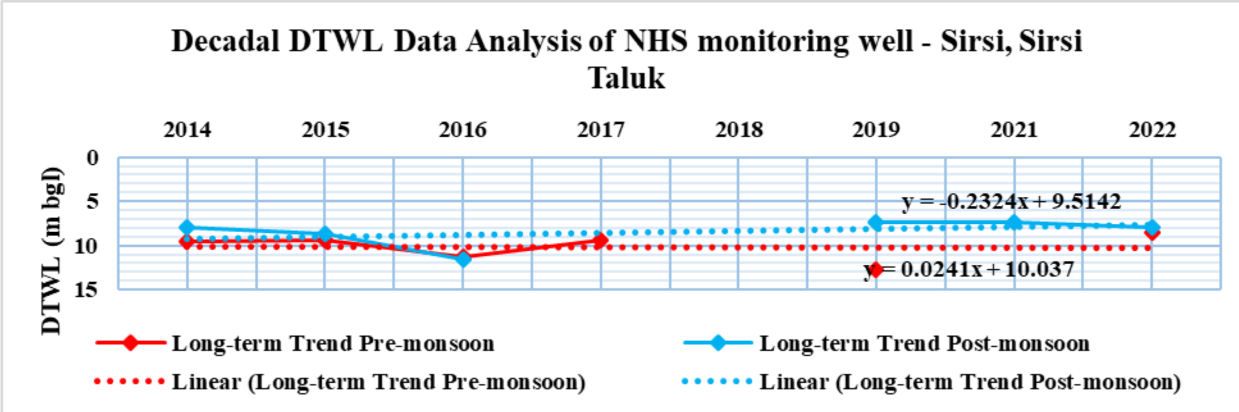


Fig-13: Hydrograph of Sirsi NHS well showing Decadal Long-term DTWL trends of Pre-monsoon & Post-monsoon Period

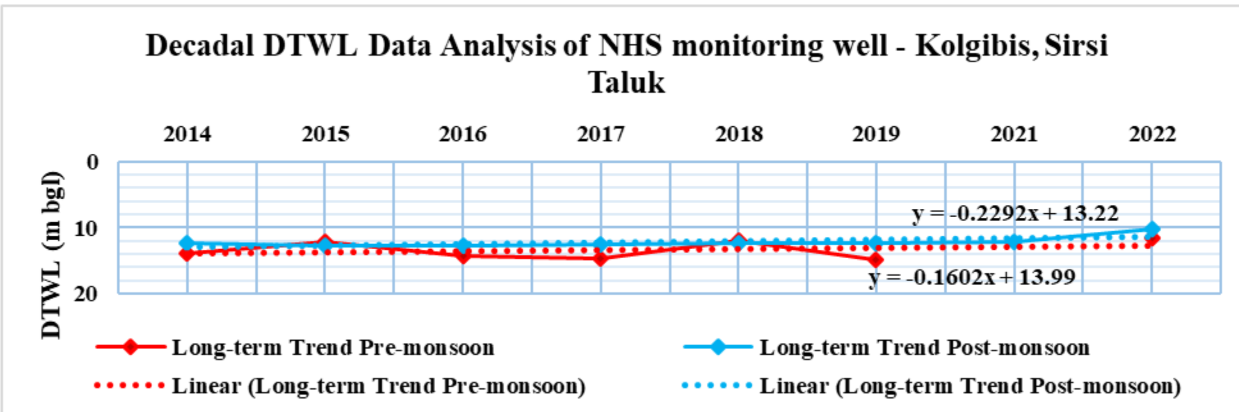


Fig-14: Hydrograph of Kolgibis NHS well showing Decadal Long-term DTWL trends of Pre-monsoon & Post-monsoon Period

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 2 – 10m, the area with shallower water level can be seen in the south-western and central part of the decadal postmonsoon map (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).

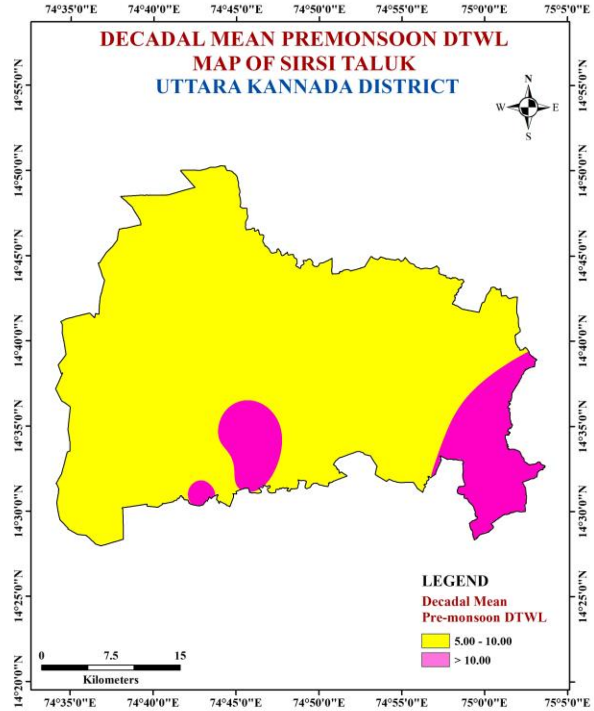


Fig-15: Decadal Mean Pre-monsoon DTWL map (2014-2022)

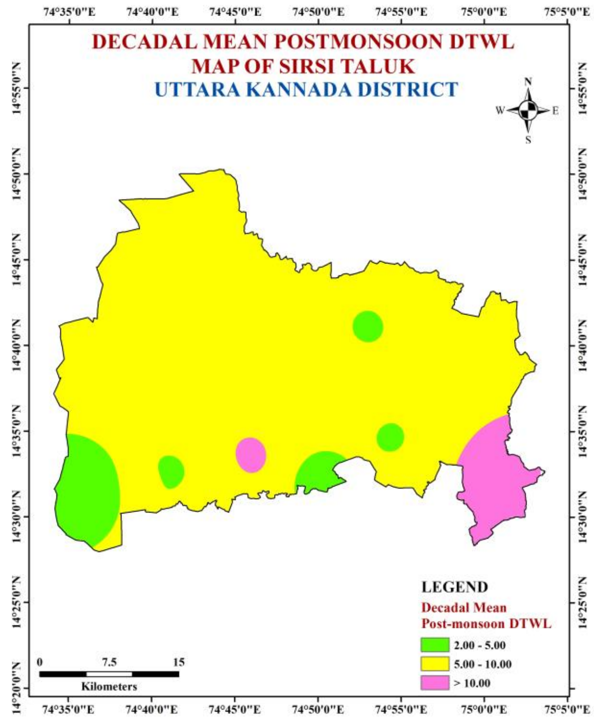


Fig-16: Decadal Mean Post-monsoon DTWL map (2014-2022)

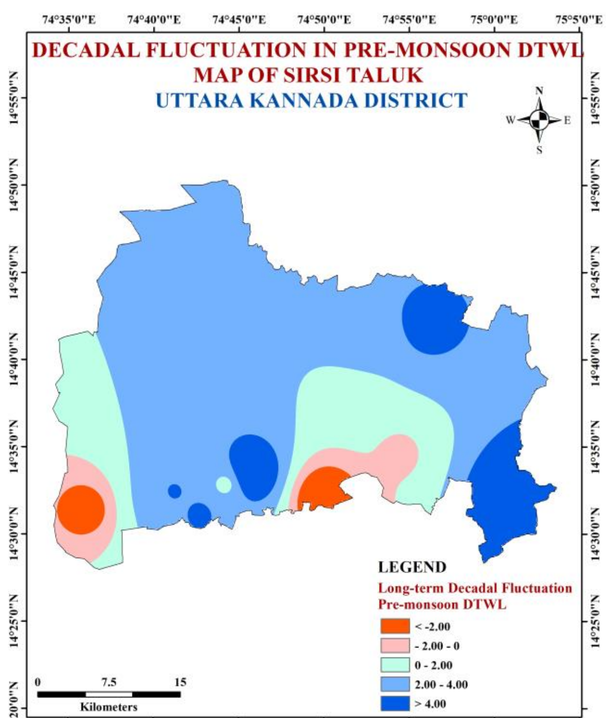


Fig-17: Decadal Fluctuation Pre-monsoon DTWL Map (2014-2022)

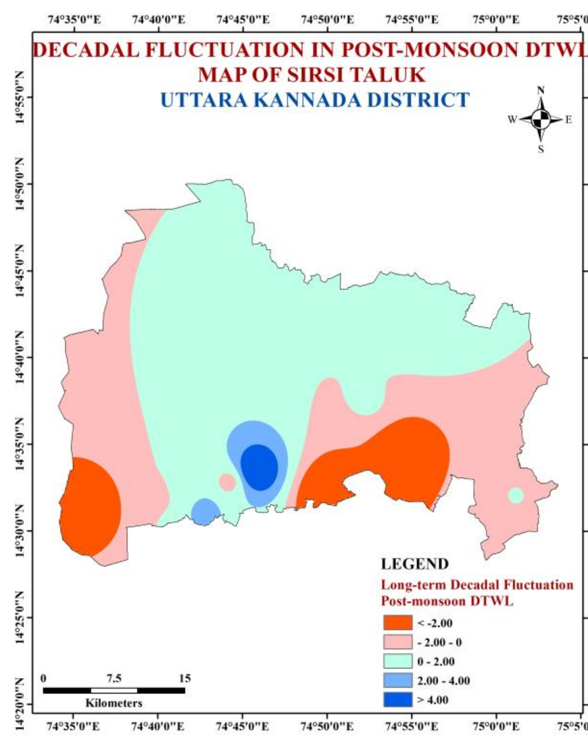
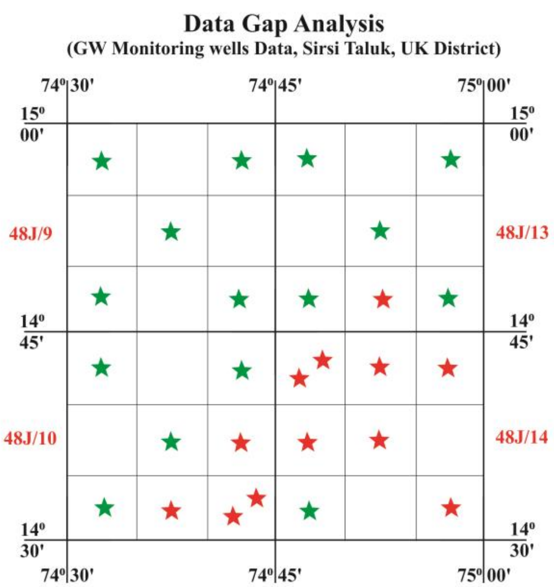


Fig-18: Decadal Fluctuation Post-monsoon DTWL Map (2014-2022)

2.0 DATA-GAP ANALYSIS

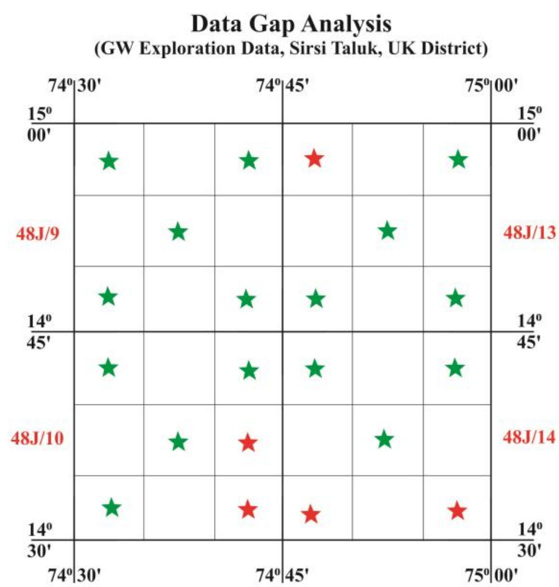
During the literature survey, previous available data has been considered for data-gap analysis. Using toposheets quadrants, the data adequacy is plotted along with the available data. The toposheet quadrants – 1A, 1C, 2B, 3A, 3C are preferred for data generation. If the data available lies in the quadrants 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
48J/9	5	0	5
48J/10	5	4	4
48J/13	5	1	5
48J/14	5	7	1

[Available Data-★ Data Gap-★]

Fig-19: Data Gap Analysis of GW Monitoring Data



Toposheet No.	Data Adequacy	Available Data	Data Gap
48J/9	5	1	4
48J/10	5	2	4
48J/13	5	1	4
48J/14	5	2	3

[Available Data-★ Data Gap-★]

Fig-20: Data Gap Analysis of GW Exploration Data

As per the data gap analysis of GW monitoring wells data for Sirsi Taluk, there is total data gap of 15 points (Fig.-19). And as per the data gap analysis of GW exploration data for Sirsi Taluk, there is total data gap of 15 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.

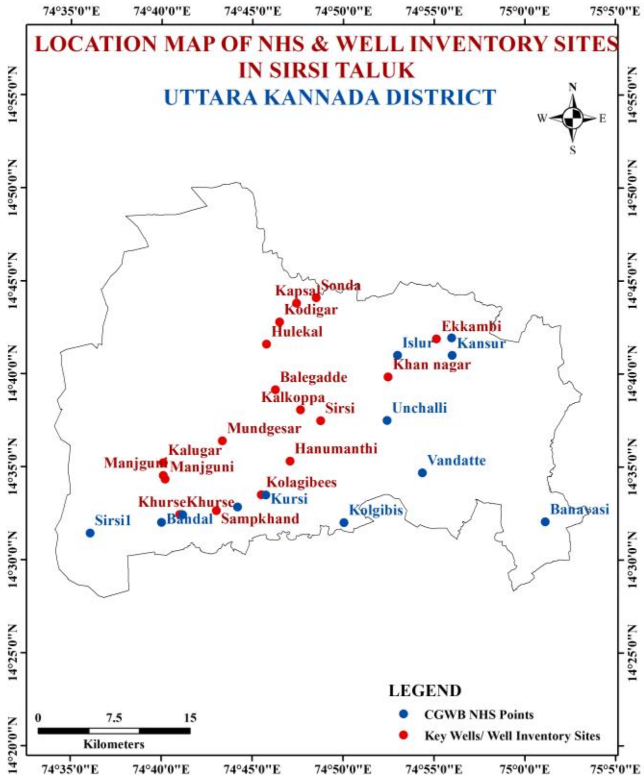


Fig-21: Location map of NHS wells & new GW Monitoring wells

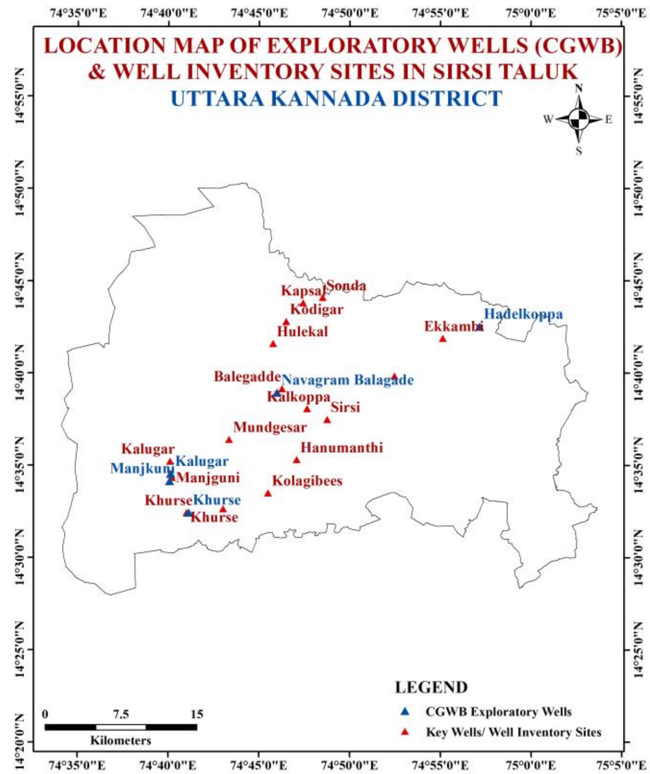


Fig-22: Location map of CGWB Exploratory Wells & Well inventory Key wells

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 Sirsi 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, Granite Gneiss)

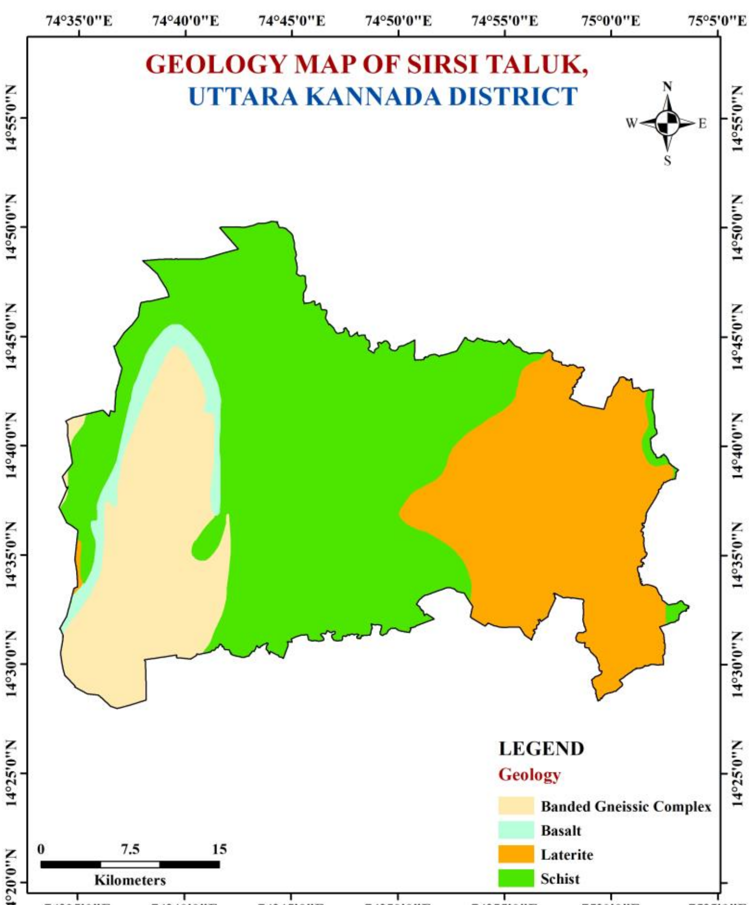


Fig-23: Geology Map

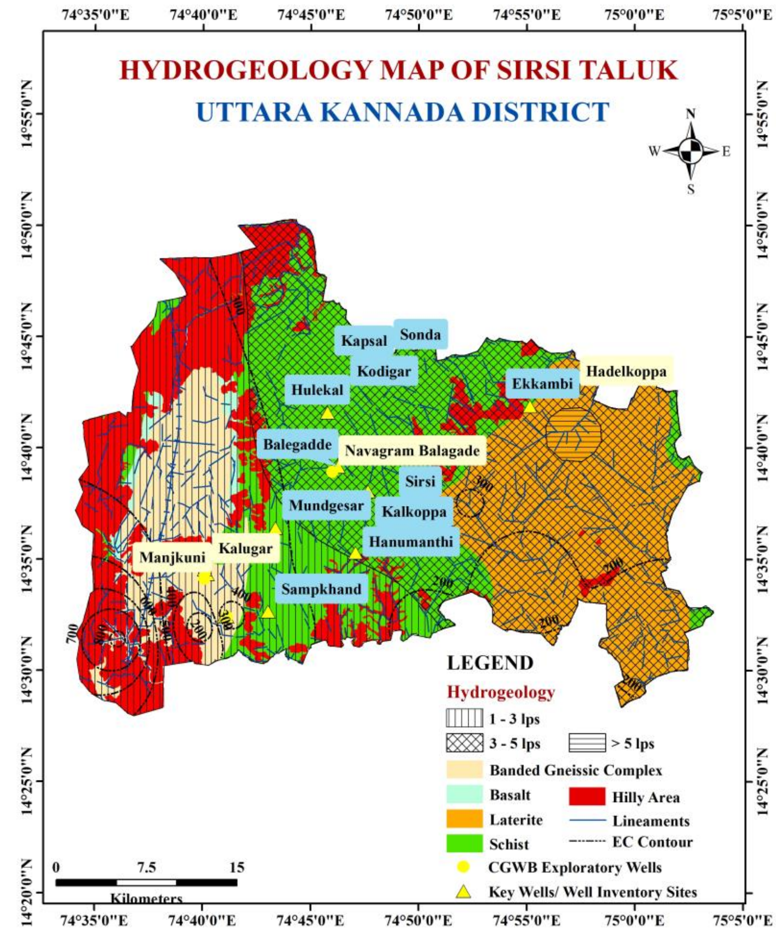


Fig-25: Hydrogeology Map

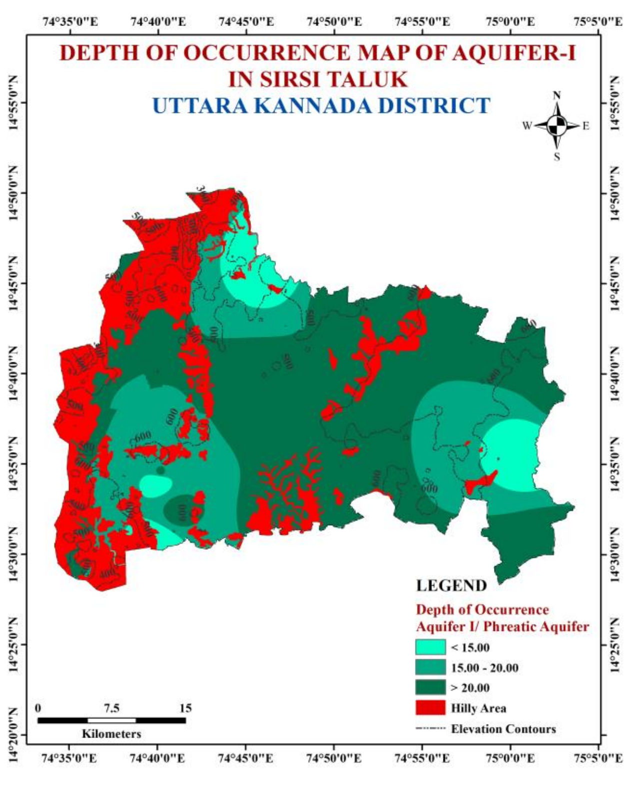


Fig-25a: Depth of Occurrence- Aquifer I

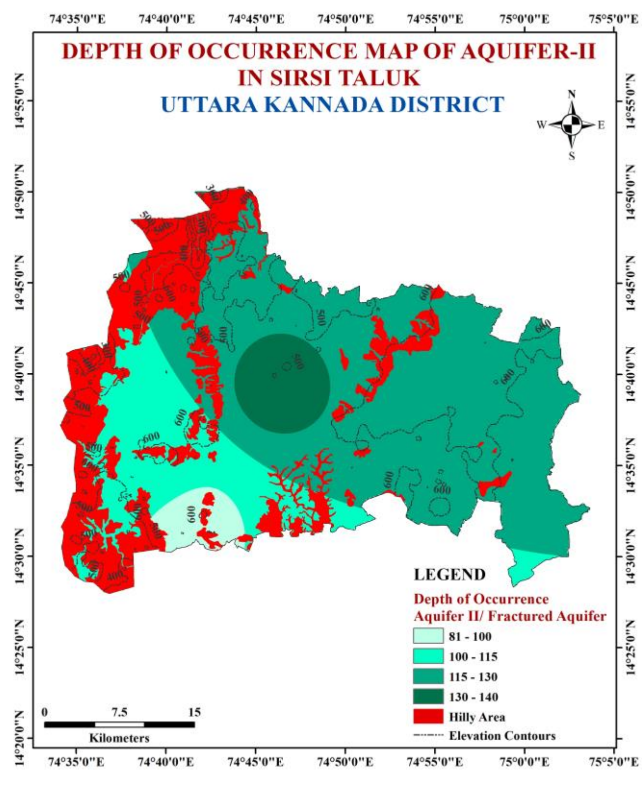


Fig-25b: Depth of Occurrence- Aquifer II

In Sirsi taluk, Schists and Banded Gneiss complex- Granite gneiss and laterites are the main water bearing formations (Fig-25).

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 less than 15m in Eastern, Northern and South-western parts to majority of the area covering the depth of occurrence of the maximum upto more than 20m. The depth to phreatic aquifer is maximum in the hilly terrain.

ii. Aquifer-II (Fractured aquifer) -

Aquifer II or Fractured/ Semi-confined Aquifer comprises lithology such as Granite Gneiss, 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 shallower depth of occurrence is observed to be in the South-western part of the Taluk in the range of 81-100m. Around 60% of the area is covered by fractures ranging from 115-130m. At one location in the Central part of the Taluk, deeper fractures are encountered upto the depth of 130-140m.

Ground water occurs within the weathered and fractured Schist unconfined condition and semi-confined condition. In Sirsi taluk bore wells were drilled from a minimum depth of 150.45 mbgl to a maximum of 199.25 mbgl. Depth of weathered zone ranges from 6 mbgl to 34 mbgl. Yield ranges from 1 to 11.67 lps. The basic characteristics of each aquifer are summarized in Table-14.

Table-12: Details of Ground Water Exploration, CGWB

S. No.	Location	Latitude	Longitude	Depth Drilled (mbgl) / Casing Depth in m	Lithology	APT Results				
						SWL in mbgl	Q in LPS	DD in m	T in m2/day	S in lpm/m/dd
1	Hudelkoppa Bisalkoppa EW	14.71222	74.952222	150.45 / 34	Granite Gneiss	6.79	2.7	12.03 8	-	13.64
2	Manjgun EW	14.56667	74.670833	199.25 / 6.60	Granite Gneiss	0.55	1	>32	3.67	-
3	Hudelkoppa EW	14.00833	74.952222	162.65	Metagrey wacke		5.89	9.5	40.55	-
4	Navagram-Balegadda EW	14.64861	74.766389	151.45 / 28.95	Metagrey wacke	10.35	11.6 7	11.69 5	26.73	59.85
5	Navagram-Balegadda OW	14.64861	74.766389	144.35 / 26	Metagrey wacke	7.1	4.3	12.18	34.41	21.18

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

Sl. No.	Location	Latitude	Longitude	Lithology	DW/ BW/ HP	Depth (m bgl)	Casing/ Parapet (m bgl)	Fracture (m bgl)	Yield (lps)	MP (m)	DTWL (m bgl)
1	Kalugar	14.586912	74.6683776	BGC Gneiss	HP	10.70	4.00	10.70	-	-	-
2	Balegadde	14.652526	74.771129	Schist/ Metagreywacke	DW	8.00	4.00	8.00	-	0.81	10.65
3	Ekkambi	14.698037	74.919125	Laterite/ Schists	DW	12.00	7.00	12.00	-	0.68	4.43
4	Hanumanthi	14.588346	74.784618	Schist/ Metagreywacke	DW	9.80	5.00	9.80	-	0.66	5.66
5	Hulekal	14.693268	74.763048	Schist/ Metagreywacke	DW	11.00	4.50	11.00	-	0.45	9.40
6	Kalkoppa	14.634356	74.79421	Schist/ Metagreywacke	DW	15.10	5.20	15.10	-	0.65	10.30
7	Kapsal	14.73001	74.790699	Schist/ Metagreywacke	DW	11.30	4.20	11.30	-	0.57	10.80
8	Khan nagar	14.663946	74.874731	Laterite/ Schists	DW	7.85	8.00	7.85	-	0.65	5.75
9	Khurse	14.54035	74.683611	BGC Gneiss	DW	7.60	4.50	7.60	-	0.78	3.95
10	Kodigar	14.713251	74.77493	Schist/ Metagreywacke	DW	14.20	3.50	14.20	-	0.66	6.00
11	Kolagibees	14.558336	74.758425	Schist/ Metagreywacke	DW	8.20	5.00	8.20	-	0.75	11.08
12	Manjguni	14.572088	74.670102	BGC Gneiss	DW	14.15	4.00	14.15	-	0.57	2.10
13	Mundgesar	14.606599	74.722705	Schist/ Metagreywacke	DW	12.40	4.20	12.40	-	0.40	2.60
14	Sampkhand	14.544052	74.717229	Schist/ Metagreywacke	DW	13.70	5.20	13.70	-	0.65	5.87
15	Sirsi	14.624727	74.812713	Schist/ Metagreywacke	DW	13.20	4.50	13.20	-	0.45	1.75
16	Sonda	14.734875	74.808593	Schist/ Metagreywacke	DW	12.60	4.00	12.60	-	0.65	11.00
17	Khurse	14.540474	74.685381	BGC Gneiss	BW	85.00	25.00	29, 81	2.00	0.53	6.80
18	Manjguni	14.575543	74.6683776	BGC Gneiss	BW	199.25	16.00	18, 114	1.50	0.52	7.10

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	Upto 34m	Low yield	-	Suitable
Fractured Zone (Aq.-II)	Fractured / Jointed Metagreywacke & Granite Gneiss	1-2	-	1.0 – 11.67	3.67 – 40.55	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 decrease in the Central Part, whereas it is observed to be more in the Northern and Southern parts. Similarly, it is observed in case of East-west section, the central part has less thickness of fractured aquifer and it increases towards East (Fig.-26).

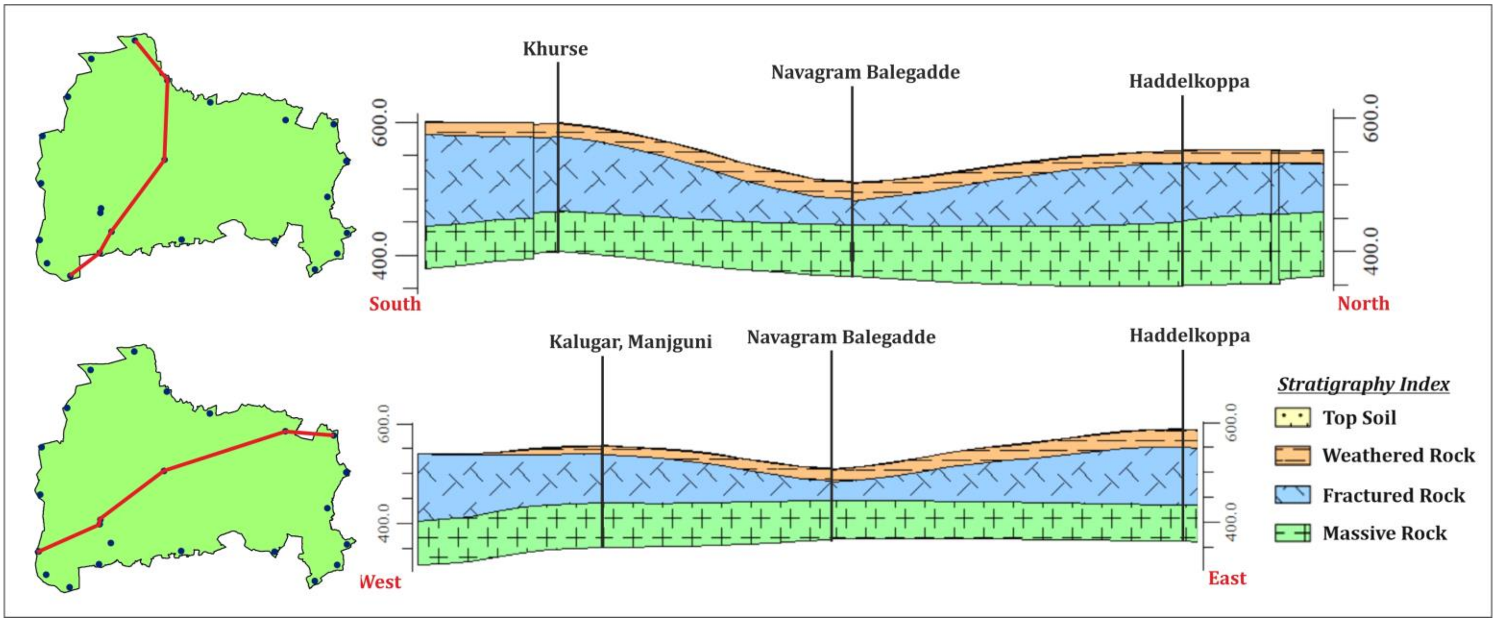


Fig-26: 2D Aquifer cross-section along North-South and East-West directions

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).

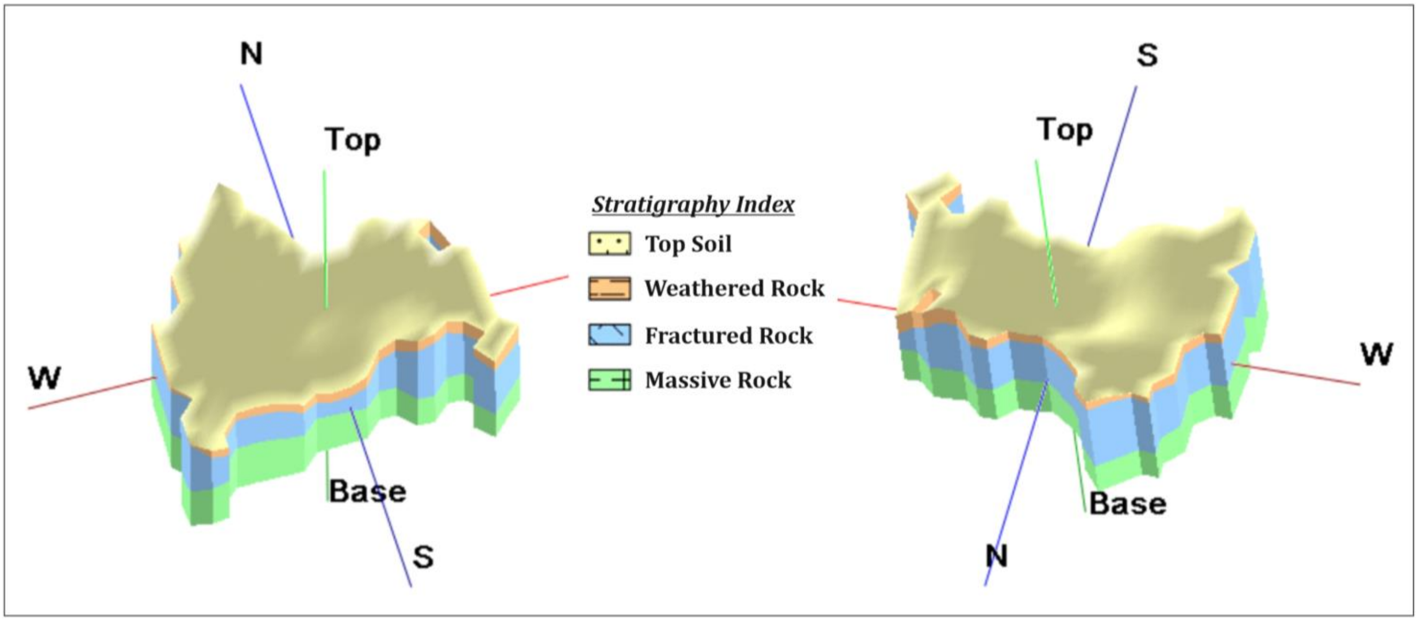


Fig-27: 3D Aquifer disposition model

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).

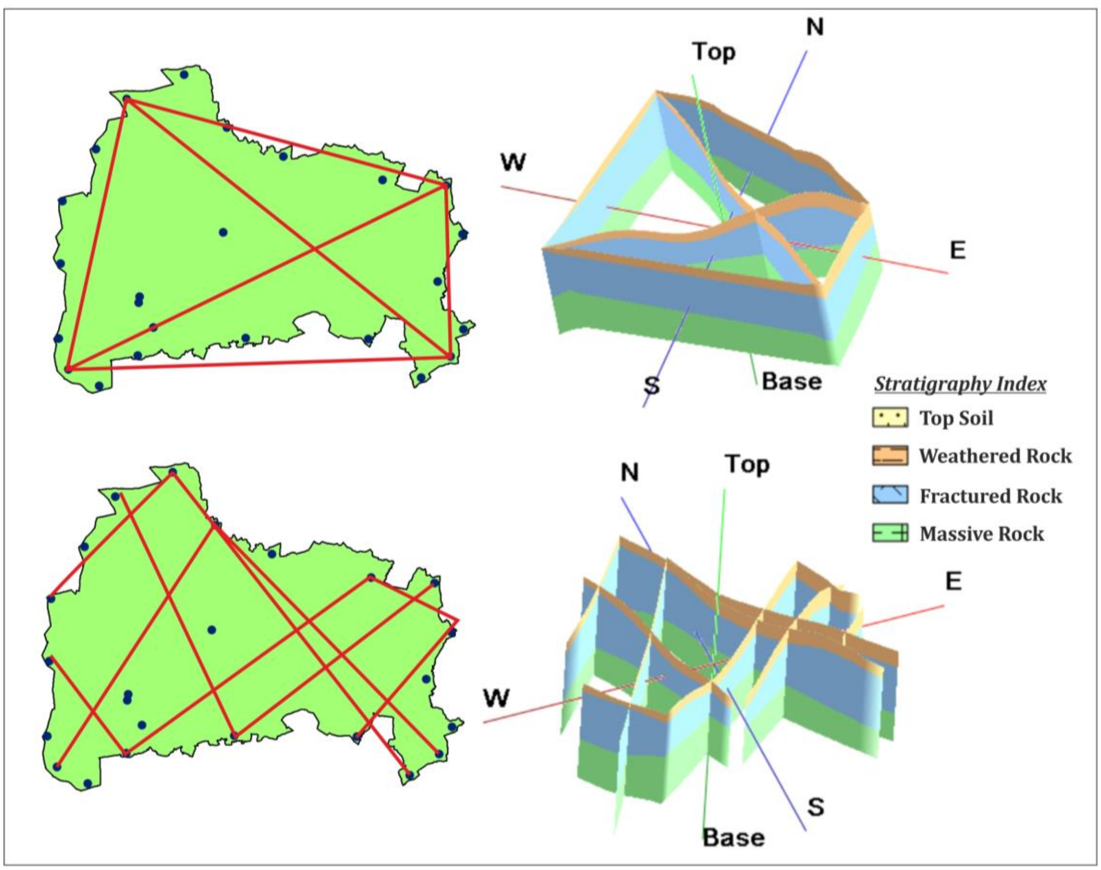


Fig-28: 3D Aquifer Fence diagrams

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 27.32% (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
Sirsi	11263.02	396.76	5.97	2675.35	3078.08	408.04	8173.66	27.32%	**Safe**

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

The phreatic and fractured In-storage component of groundwater along with the dynamic component is taken into account 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
Sirsi	11263.02	46272	5236	62771.02

(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 27.32% in 2022. As Sirsi 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		
Sirsi	7932	2641	33%	11780	2699	23%	11263.02	3078.08	27.32%

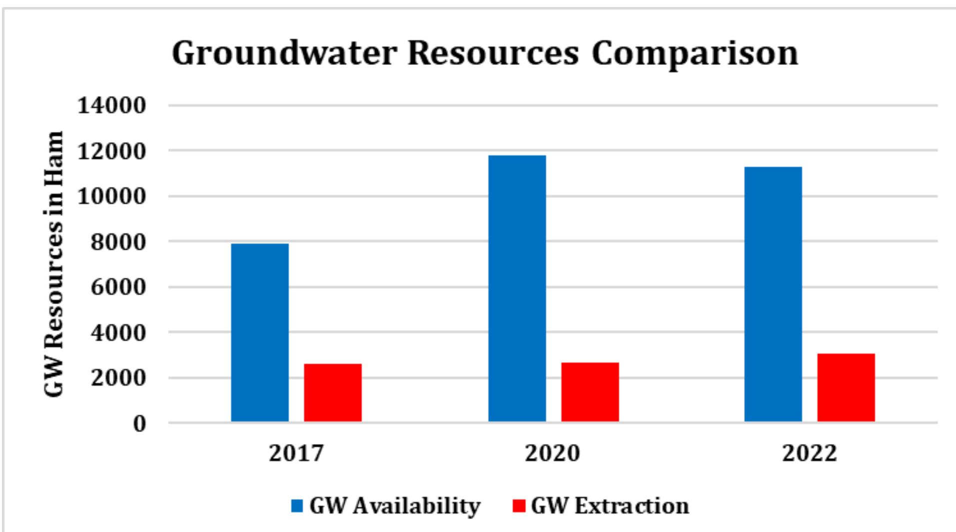


Fig-29: Groundwater resource comparison between 3 consecutive years of assessment

4.2 Chemical Quality of Ground Water and Contamination

The groundwater samples were collected from dugwells and borewells of various parts of Sirsi Taluk and were analyzed in the Chemical laboratory of CGWB, SWR, Bengaluru. Interpretation from Chemical Analysis results (Table-14) in Sirsi taluk is mentioned as below:

- **ELECTRICAL CONDUCTIVITY:** In general, EC values range from 130 to 810 µS/cm at 25°C (Fig-30).
- **CHLORIDE**: Chloride concentration in ground water ranges between 14 and 106 mg/l (Fig-31).
- **NITRATE:** Nitrate concentration in ground water ranges from 0.42 and 15.06 mg/l (Fig-32).
- **FLUORIDE:** Fluoride concentration in ground water ranges between 0.10 and 0.52 mg/l (Fig-33).

Table-14: GW Quality of ground water in Sirsi taluk of Uttara Kannada district (May 2022)

Sl. No.	Location	DW/BW	Latitude	Longitude	PH	EC	Cl	NO3	F
1	Amminalli	DW	14.3875	74.8083	6.54	340	43	15.4	ND
2	Banavasi	DW	14.5342	75.0189	6.73	170	14	0.42	ND
3	Bandal	DW	14.5333	74.6667	6.88	130	18	1.86	ND
4	Islur	DW	14.6833	74.8833	6.79	260	28	11.52	ND
5	Kolgibis	DW	14.5333	74.8342	7.68	160	18	14.21	ND
6	Kursi	DW	14.5581	74.7625	8.23	240	14	0	ND
7	Ragi hosalli	DW	14.5403	74.6861	8.59	450	32	15.06	0.51
8	Sirsi	DW	14.5236	74.6014	8.06	810	106	11.66	0.52
9	Unchalli	DW	14.625	74.8736	8.25	310	28	1.48	ND
10	Vandatte	DW	14.5781	74.9061	8.51	140	21	3.39	ND
11	Yekkambi	DW	14.3667	74.725	8.19	280	32	0	ND
12	Kansur	BW	14.6833	74.9333	7.86	200	28	2.75	0.1

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 amount of nitrate (10-20 mg/l) in the samples from Sirsi, Ragi Hosalli, Bandal, Aminahalli, Kolgibis. Sample collected from Sirsi shows amount of Fluoride more than 0.45 mg/l 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.

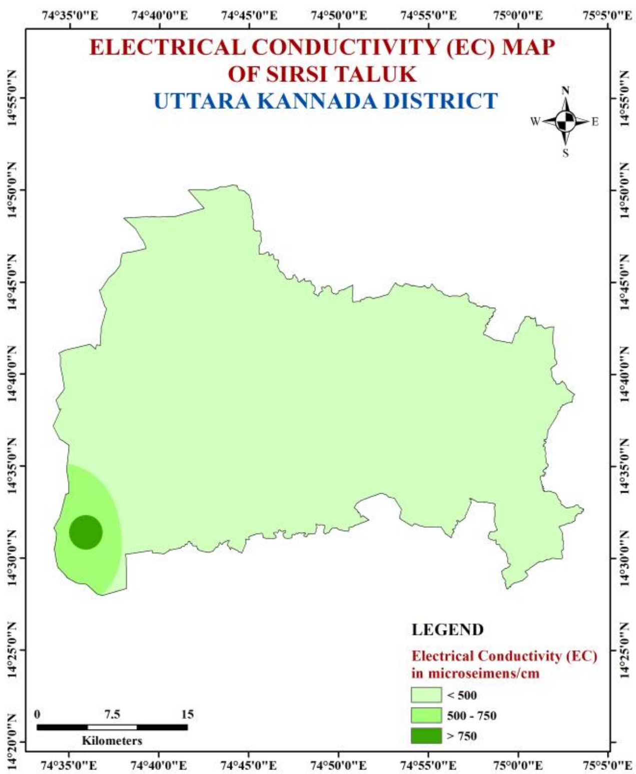


Fig-30: Distribution of Electrical Conductivity

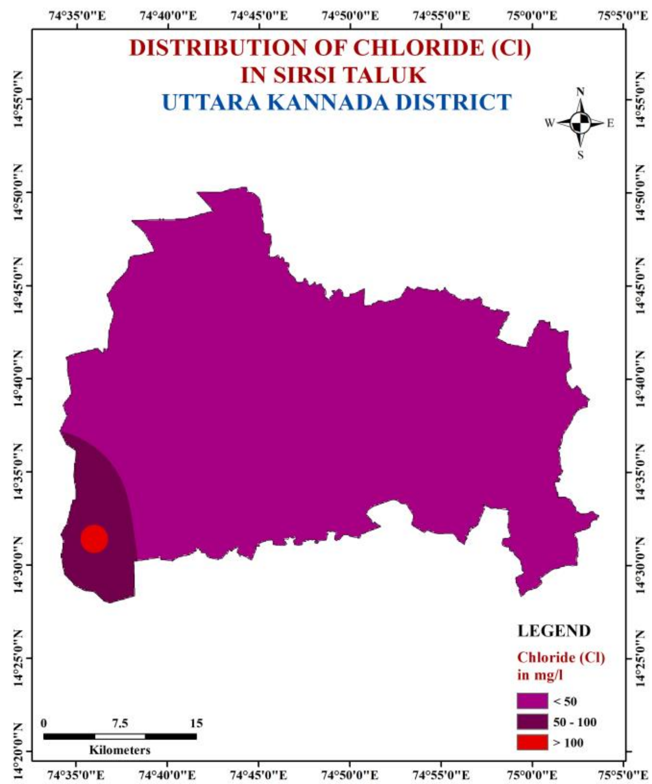
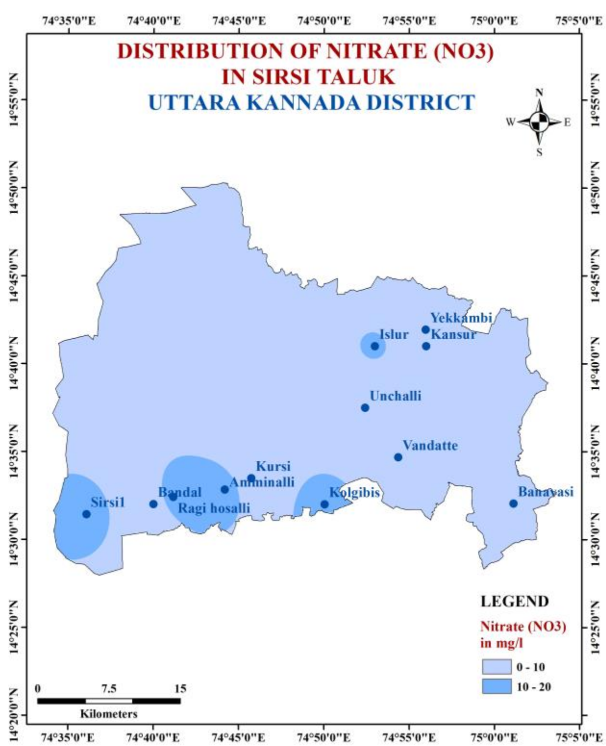


Fig-31: Distribution of Chloride



g-32: Distribution of Nitrate

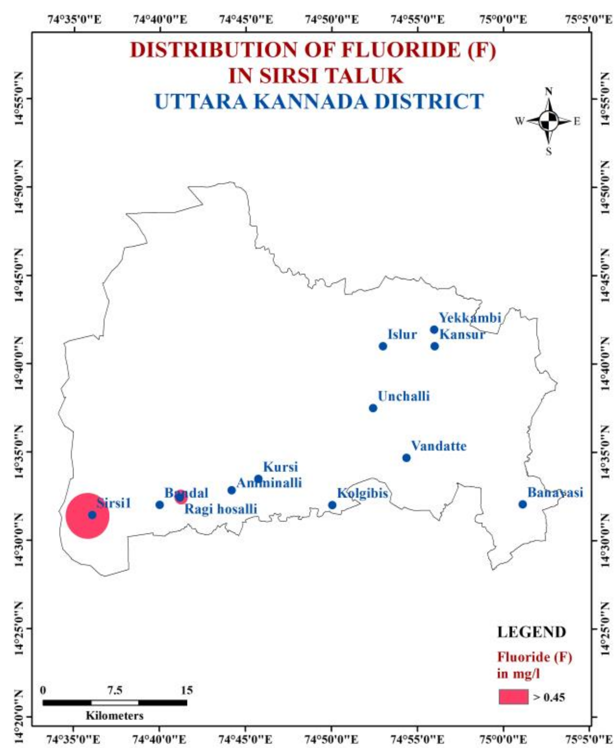


Fig-33: Distribution of Fluoride

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	Sirsi taluk
Non committed monsoon runoff available (MCM)	64.827
Total no. of Existing Artificial Recharge Structures	169
Number of Proposed Check Dams	337
Number of Proposed Percolation Tanks	0
Number of Proposed Sub surface dyke	2
Tentative total cost of the project (Rs. in lakhs)	3402.024
Excepted recharge (MCM)	48.620

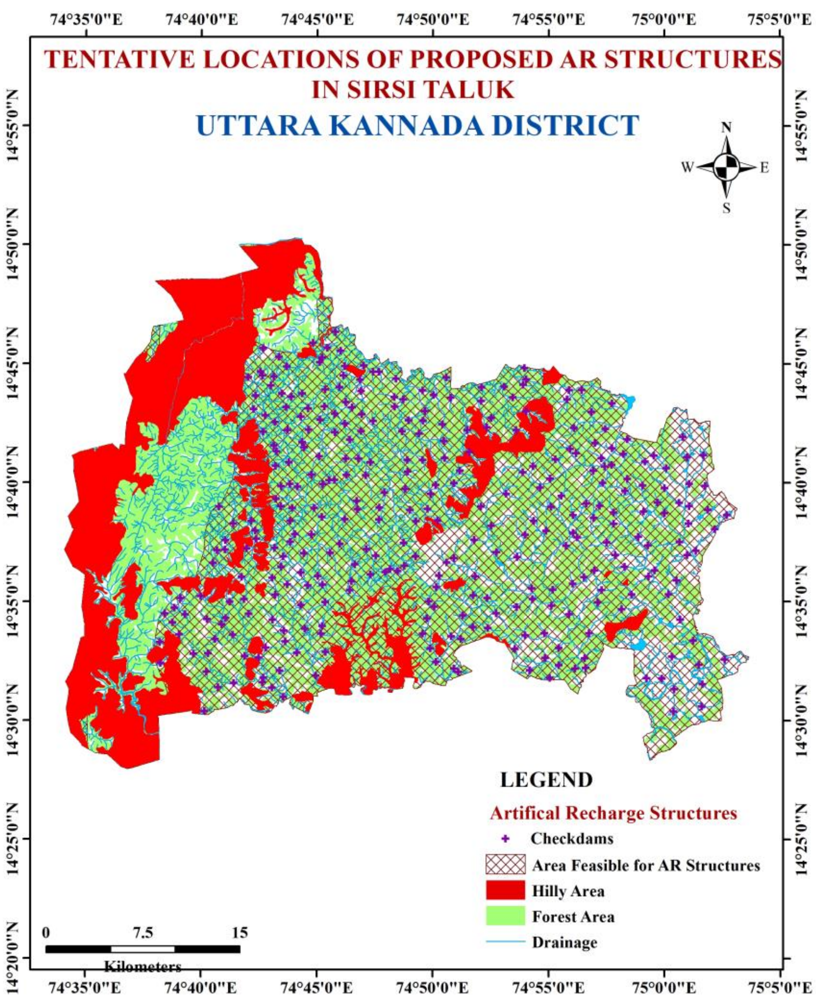


Fig-34: Tentative Locations of Proposed AR Structures

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

Sirsi 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 3750 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 8594 ha, 8469 ha and 876 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	11263.02
2	Existing Stage of Groundwater extraction in %	27.32
3	Existing Gross Groundwater Draft for all uses in Ham	3078.08
4	Expected Recharge from Artifical recharge structures in Ham	4862
5	Expected improvement in stage of ground water extraction after implementation of AR structures in %	19.08
6	Expected improvement in overall stage of groundwater extraction in %	8.24

5.2.3 Change in Cropping Pattern

Agriculture is the main occupation in Sirsi taluk. Water intensive crops like Paddy, Arecanut and Coconut which are grown in 8594 ha, 8469 ha and 876 ha respectively of net sown area of 20790 ha. However, oil seeds are grown during kharif and rabi. At present (2022), the stage of ground water extraction is 27.32% and taluk has been categorised as Safe, thus change in cropping pattern has not been suggested.

5.3 Regulation and Control

Sirsi taluk has been categorized as **Safe**, since the stage of ground water extraction has reached 27.32% (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 Sirsi taluk is given below. As per the Ground Water Resource Assessment' 2022, Sirsi taluk falls under Safe category with the stage of groundwater extraction is 27.32%. 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 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 6482.7 Ham. This can be used to recharge the aquifer mainly through check dams (337) and subsurface dykes (2). The volume of water expected to be conserved/recharged is 4862 Ham through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 3402.024 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*
11263.02	1.1	10239	**2560**	**2048**

As the stage of extraction of groundwater is 27.32% ; rest of the 42.68% (upto 70%) is considered under groundwater development. For which, 3 borewells (as abstraction structures) per Sq.km are recommended for construction. Apart from the 78.1% area which is under Forest cover, the additional area which can be brought under assured ground water irrigation will be about 2048 hectares. 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 66.81% 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 8594 ha, 8469 ha and 876 ha respectively of net sown area of 20790 ha. However, oil seeds are grown during kharif and rabi. At present (GWRA'2022), the stage of ground water extraction is 27.32% 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 27.32% to 19.08 % and the taluk falls under safe category.

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Appendix-I

Tentative Locations of Proposed AR Structures in Sirsi Taluk

Sl. No.	Latitude	Longitude	Name of the Village	Type of AR Structure
1	14.649723	74.918510	Achanalli	Checkdam
2	14.657333	74.925930	Achanalli	Checkdam
3	14.682551	74.815078	Agasala	Checkdam
4	14.702601	74.811198	Agasala	Checkdam
5	14.544789	75.005370	Ajarni	Checkdam
6	14.731513	74.940542	Anagodkoppa	Checkdam
7	14.615932	75.016484	Andgi	Checkdam
8	14.728052	74.833885	Arasapur	Checkdam
9	14.726652	74.731384	Audhal	Checkdam
10	14.729080	74.724588	Audhal	Checkdam
11	14.732024	74.755734	Audhal	Checkdam
12	14.729175	74.739252	Audhal	Checkdam
13	14.733451	74.766076	Audhal	Checkdam
14	14.600844	74.863917	Bachagaon	Checkdam
15	14.698805	75.013428	Badangod	Checkdam
16	14.523206	74.678788	Badgi	Checkdam
17	14.506646	74.669158	Badgi	Checkdam
18	14.526115	74.690167	Badgi	Checkdam
19	14.710620	74.752275	Bakkal	Checkdam
20	14.703739	74.743811	Bakkal	Checkdam
21	14.718607	74.743537	Bakkal	Checkdam
22	14.720119	74.755217	Bakkal	Checkdam
23	14.712858	74.738193	Bakkal	Checkdam
24	14.719573	74.727817	Bakkal	Checkdam
25	14.522842	74.717726	Balvalli	Checkdam
26	14.526623	74.710774	Balvalli	Checkdam
27	14.516341	74.725812	Balvalli	Checkdam
28	14.566172	74.753679	Bammanalli	Checkdam
29	14.560721	74.752851	Bammanalli	Checkdam
30	14.538925	75.024839	Banavasi	Checkdam
31	14.546695	74.661231	Bandal	Checkdam
32	14.660812	74.971639	Bankanal	Checkdam
33	14.669294	74.973221	Bankanal	Checkdam
34	14.746913	74.899313	Bedasgaon	Checkdam
35	14.558868	74.846632	Belakhand	Checkdam
36	14.726264	74.846157	Belale	Checkdam
37	14.665924	75.017854	Bellankeri	Checkdam
38	14.704362	74.957456	Benagi	Checkdam
39	14.588380	74.976534	Bengale	Checkdam
40	14.577995	74.969187	Bengale	Checkdam
41	14.571485	74.829103	Bettekoppa	Checkdam
42	14.701000	74.823332	Bhairumbe	Checkdam

Sl. No.	Latitude	Longitude	Name of the Village	Type of AR Structure
43	14.521872	75.007199	Bhashi	Checkdam
44	14.506314	75.006523	Bhashi	Checkdam
45	14.574381	74.931353	Bidralli	Checkdam
46	14.580391	74.918835	Bidralli	Checkdam
47	14.675206	74.948798	Biluru	Checkdam
48	14.677882	74.957037	Biluru	Checkdam
49	14.666528	74.955683	Biluru	Checkdam
50	14.650336	74.953369	Biluru	Checkdam
51	14.704930	74.934894	Bisalakoppa	Checkdam
52	14.541097	74.835602	Bisalakoppa	Checkdam
53	14.534083	74.851796	Bisalakoppa	Checkdam
54	14.536374	74.848557	Bisalakoppa	Checkdam
55	14.662238	74.813584	Bommanalli	Checkdam
56	14.703617	74.858043	Boppanalli	Checkdam
57	14.632904	74.914943	Byagadde	Checkdam
58	14.744365	74.794563	Dasanagadde	Checkdam
59	14.739362	74.806874	Dasanagadde	Checkdam
60	14.730706	74.781555	Dasanagadde	Checkdam
61	14.744222	74.790270	Dasanagadde	Checkdam
62	14.738643	74.780831	Dasanagadde	Checkdam
63	14.748627	74.783612	Dasanagadde	Checkdam
64	14.685750	74.992422	Dhanaganahalli	Checkdam
65	14.681346	74.986121	Dhanaganahalli	Checkdam
66	14.676765	75.001314	Dhanaganahalli	Checkdam
67	14.684441	75.016515	Dhanaganahalli	Checkdam
68	14.583431	74.830417	Edalli	Checkdam
69	14.579780	74.834398	Edalli	Checkdam
70	14.690322	74.932079	Ekkambi	Checkdam
71	14.591393	74.954976	Gadageri	Checkdam
72	14.649932	74.867880	Gaudalli	Checkdam
73	14.707581	74.840269	Golikoppa	Checkdam
74	14.643901	74.934187	Gonagatta	Checkdam
75	14.652069	74.943790	Gonagatta	Checkdam
76	14.642078	74.949118	Gonuru	Checkdam
77	14.628359	74.937303	Gonuru	Checkdam
78	14.631520	74.934326	Gonuru	Checkdam
79	14.702187	74.711166	Gurvalli	Checkdam
80	14.718037	74.704344	Gurvalli	Checkdam
81	14.713640	74.712572	Gurvalli	Checkdam
82	14.709125	74.719489	Gurvalli	Checkdam
83	14.727773	74.705755	Gurvalli	Checkdam
84	14.570653	75.011288	Hadlagi	Checkdam
85	14.600456	74.695783	Hakkigadde	Checkdam
86	14.573707	74.855146	Halasinakaj	Checkdam
87	14.697137	74.973299	Hallikoppa	Checkdam
88	14.582803	74.755972	Halsargi	Checkdam

Sl. No.	Latitude	Longitude	Name of the Village	Type of AR Structure
89	14.701760	74.762811	Hare Hulekal	Checkdam
90	14.626231	74.684061	Hasanagi	Checkdam
91	14.637863	74.689730	Hasanagi	Checkdam
92	14.649694	74.679366	Hasanagi	Checkdam
93	14.683012	74.921596	Hebballi	Checkdam
94	14.618943	75.022624	Hebbatti	Checkdam
95	14.634076	75.036381	Hebbatti	Checkdam
96	14.639976	74.906006	Hebbatti	Checkdam
97	14.554826	74.637019	Hebre	Checkdam
98	14.603549	74.738320	Heggar	Checkdam
99	14.594588	74.743332	Heggar	Checkdam
100	14.606057	74.802628	Hipanali	Checkdam
101	14.604734	74.808083	Hipanali	Checkdam
102	14.639551	74.821107	Hirepal	Checkdam
103	14.647629	74.817007	Hirepal	Checkdam
104	14.678085	74.905476	Holebail	Checkdam
105	14.570587	74.718020	Hosatota	Checkdam
106	14.562742	74.726289	Hosatota	Checkdam
107	14.716178	74.947317	Hudelkoppa	Checkdam
108	14.658873	74.886102	Huladevanasara	Checkdam
109	14.731367	74.825922	Hulgol	Checkdam
110	14.716869	74.827525	Hulgol	Checkdam
111	14.724936	74.812053	Hulgol	Checkdam
112	14.710239	74.816008	Hulgol	Checkdam
113	14.709989	74.826083	Hulgol	Checkdam
114	14.591346	74.773709	Hunasekoppa	Checkdam
115	14.597611	74.774893	Hunasekoppa	Checkdam
116	14.630044	74.899775	Husari	Checkdam
117	14.614475	74.894047	Husari	Checkdam
118	14.617913	74.879157	Husari	Checkdam
119	14.607859	74.971323	Husari	Checkdam
120	14.605183	74.993070	Husari	Checkdam
121	14.588392	75.003058	Husari	Checkdam
122	14.600898	74.988548	Husari	Checkdam
123	14.622665	74.988127	Husari	Checkdam
124	14.624368	74.812428	Huttagar	Checkdam
125	14.640746	74.794615	Itguli	Checkdam
126	14.649160	74.794834	Itguli	Checkdam
127	14.604014	74.799175	Janmane	Checkdam
128	14.547399	74.735487	Janmane	Checkdam
129	14.534759	74.723130	Janmane	Checkdam
130	14.592543	74.904688	Kabbe	Checkdam
131	14.555979	75.020760	Kadagodu	Checkdam
132	14.647928	74.779031	Kadakod	Checkdam
133	14.640909	74.770028	Kadakod	Checkdam
134	14.653898	74.778631	Kadakod	Checkdam

Sl. No.	Latitude	Longitude	Name of the Village	Type of AR Structure
135	14.639808	74.730770	Kadbal	Checkdam
136	14.648982	74.732217	Kadbal	Checkdam
137	14.529793	74.917557	Kagodu	Checkdam
138	14.685861	75.028272	Kalangi	Checkdam
139	14.617312	74.759508	Kalave	Checkdam
140	14.623753	74.766457	Kalave	Checkdam
141	14.624788	74.958445	Kalave	Checkdam
142	14.582809	74.952120	Kalgundikoppa	Checkdam
143	14.598225	75.008744	Kalkardi	Checkdam
144	14.615297	74.792331	Kallagara	Checkdam
145	14.619925	74.785615	Kallagara	Checkdam
146	14.627226	74.706300	Kallagara	Checkdam
147	14.639753	74.702565	Kallagara	Checkdam
148	14.574206	74.655108	Kallalli	Checkdam
149	14.585585	74.651749	Kallalli	Checkdam
150	14.578760	74.647315	Kallalli	Checkdam
151	14.587013	74.666305	Kallalli	Checkdam
152	14.585673	74.872530	Kallalli	Checkdam
153	14.543716	74.914305	Kalli	Checkdam
154	14.538644	74.924036	Kalli	Checkdam
155	14.588079	74.719897	Kambigar	Checkdam
156	14.599957	74.717777	Kambigar	Checkdam
157	14.595223	74.728558	Kambigar	Checkdam
158	14.645808	74.963399	Kandraji	Checkdam
159	14.637764	74.963394	Kandraji	Checkdam
160	14.560874	74.826020	Kangodu	Checkdam
161	14.550556	74.831621	Kangodu	Checkdam
162	14.529690	74.987148	Kantraji	Checkdam
163	14.529437	74.998116	Kantraji	Checkdam
164	14.648999	74.747888	Karigundi	Checkdam
165	14.579577	74.893812	Kerekoppa	Checkdam
166	14.650275	75.017763	Kiryatti	Checkdam
167	14.638081	75.017385	Kiryatti	Checkdam
168	14.647527	75.031203	Kiryatti	Checkdam
169	14.580696	74.738348	Kodagibail	Checkdam
170	14.564303	74.741298	Kodagibail	Checkdam
171	14.555373	74.727196	Kodagibail	Checkdam
172	14.764464	74.747002	Kodanagadde	Checkdam
173	14.719420	74.775270	Kodigar	Checkdam
174	14.708015	74.769992	Kodigar	Checkdam
175	14.723133	74.770490	Kodigar	Checkdam
176	14.715004	74.762796	Kodigar	Checkdam
177	14.692680	74.718976	Kolgar	Checkdam
178	14.535279	74.903218	Koppa	Checkdam
179	14.659680	74.798349	Koppa	Checkdam
180	14.671734	74.785034	Koppa	Checkdam

Sl. No.	Latitude	Longitude	Name of the Village	Type of AR Structure
181	14.680795	74.788374	Koppa	Checkdam
182	14.731495	74.931370	Koppa	Checkdam
183	14.615890	74.964822	Koralakatta	Checkdam
184	14.686879	74.970536	Kotekoppa	Checkdam
185	14.683343	74.779855	Kotgemane	Checkdam
186	14.672005	74.771022	Kotgemane	Checkdam
187	14.683402	74.770660	Kotgemane	Checkdam
188	14.696649	74.773470	Kotgemane	Checkdam
189	14.632934	74.705435	Kotigehalli	Checkdam
190	14.703492	74.893385	Kudremane	Checkdam
191	14.716597	74.900422	Kudremane	Checkdam
192	14.705310	74.872098	Kudremane	Checkdam
193	14.711862	74.875381	Kudremane	Checkdam
194	14.530008	74.711465	Kugtemane	Checkdam
195	14.543944	74.707973	Kugtemane	Checkdam
196	14.531438	74.749145	Kukri	Checkdam
197	14.564751	74.872997	Kulave	Checkdam
198	14.557165	74.853547	Kulave	Checkdam
199	14.565551	74.862333	Kulave	Checkdam
200	14.663698	74.735887	Kuppagaud	Checkdam
201	14.672092	74.745885	Kuppagaud	Checkdam
202	14.652622	75.010619	Kuppagaud	Checkdam
203	14.662862	75.000216	Kuppagaud	Checkdam
204	14.652781	74.995198	Kuppagaud	Checkdam
205	14.645274	75.000209	Kuppagaud	Checkdam
206	14.556819	74.676773	Kursi	Checkdam
207	14.533993	74.670548	Kursi	Checkdam
208	14.545004	74.698069	Kursi	Checkdam
209	14.559928	74.689384	Kursi	Checkdam
210	14.546848	74.671559	Kursi	Checkdam
211	14.624975	75.010833	Kyadikoppa	Checkdam
212	14.690677	74.962224	Malalgaon	Checkdam
213	14.683717	74.954719	Malalgaon	Checkdam
214	14.694502	74.950189	Malalgaon	Checkdam
215	14.687208	74.936502	Malalgaon	Checkdam
216	14.682512	74.826042	Malalgaon	Checkdam
217	14.674474	74.815228	Malalgaon	Checkdam
218	14.646432	74.985102	Malanji	Checkdam
219	14.740307	74.843005	Malenalli	Checkdam
220	14.614816	74.820998	Manjavalli	Checkdam
221	14.608302	74.812859	Manjavalli	Checkdam
222	14.570786	74.670996	Manjguni	Checkdam
223	14.628669	74.981262	Margundi	Checkdam
224	14.622430	74.929324	Marigudde	Checkdam
225	14.548025	74.756114	Mattigar	Checkdam
226	14.664641	74.984386	Mattihalli	Checkdam

Sl. No.	Latitude	Longitude	Name of the Village	Type of AR Structure
227	14.758933	74.766857	Mogadde	Checkdam
228	14.748331	74.769772	Mogadde	Checkdam
229	14.754340	74.753559	Mogadde	Checkdam
230	14.772173	74.763026	Mogadde	Checkdam
231	14.761012	74.757373	Mogadde	Checkdam
232	14.751133	74.751981	Mogadde	Checkdam
233	14.741795	74.768828	Mogadde	Checkdam
234	14.620395	74.699445	Mundgar	Checkdam
235	14.543581	74.942704	Mundgehalli	Checkdam
236	14.536864	74.943451	Mundgehalli	Checkdam
237	14.691232	74.740626	Nakshe	Checkdam
238	14.695113	74.739200	Nakshe	Checkdam
239	14.703337	74.728791	Nakshe	Checkdam
240	14.678200	74.720197	Nakshe	Checkdam
241	14.680911	74.729698	Nakshe	Checkdam
242	14.688490	74.720727	Nakshe	Checkdam
243	14.509810	75.027039	Narur	Checkdam
244	14.560987	74.945702	Navanageri	Checkdam
245	14.574660	74.700823	Navilgar	Checkdam
246	14.610278	74.675103	Onigadde	Checkdam
247	14.619138	74.677932	Onigadde	Checkdam
248	14.619589	74.683730	Onigadde	Checkdam
249	14.665417	74.754039	Onikeri	Checkdam
250	14.668598	74.762530	Onikeri	Checkdam
251	14.668367	74.758574	Onikeri	Checkdam
252	14.663175	74.910523	Pura	Checkdam
253	14.695849	74.841300	Sadashivalli	Checkdam
254	14.684007	74.841764	Sadashivalli	Checkdam
255	14.675159	74.852742	Sadashivalli	Checkdam
256	14.666143	74.848422	Sadashivalli	Checkdam
257	14.665020	74.835263	Sadashivalli	Checkdam
258	14.658750	74.831825	Sadashivalli	Checkdam
259	14.688276	74.859593	Sadashivalli	Checkdam
260	14.650126	74.724051	Salkani	Checkdam
261	14.655250	74.720358	Salkani	Checkdam
262	14.550989	74.713105	Sampkhand	Checkdam
263	14.525460	75.027470	Sampkhand	Checkdam
264	14.602341	74.788439	Sannali	Checkdam
265	14.609223	74.777205	Sannali	Checkdam
266	14.643826	75.045017	Santavalli	Checkdam
267	14.536375	74.935814	Shastralli	Checkdam
268	14.685014	74.751573	Shinganhalli	Checkdam
269	14.614715	74.725687	Shivalli	Checkdam
270	14.607518	74.724332	Shivalli	Checkdam
271	14.625127	74.730790	Shivalli	Checkdam
272	14.620838	74.719464	Shivalli	Checkdam

Sl. No.	Latitude	Longitude	Name of the Village	Type of AR Structure
273	14.617168	74.740577	Sigehalli	Checkdam
274	14.630126	74.746019	Sigehalli	Checkdam
275	14.642481	74.753496	Sigehalli	Checkdam
276	14.630391	74.734154	Sigehalli	Checkdam
277	14.593398	74.835752	Sirsi	Checkdam
278	14.610647	74.843313	Sirsi	Checkdam
279	14.613705	74.848592	Sirsi	Checkdam
280	14.626598	74.863169	Sirsi	Checkdam
281	14.636330	74.875241	Sirsi	Checkdam
282	14.648377	74.829535	Sirsi	Checkdam
283	14.640045	74.836852	Sirsi	Checkdam
284	14.601315	74.837714	Sirsi	Checkdam
285	14.726495	74.890870	Sivalli	Checkdam
286	14.735334	74.898222	Sivalli	Checkdam
287	14.738992	74.900412	Sivalli	Checkdam
288	14.733957	74.884761	Sivalli	Checkdam
289	14.723894	74.868174	Sivalli	Checkdam
290	14.733300	74.868266	Sivalli	Checkdam
291	14.560986	74.913638	Somanolli	Checkdam
292	14.719865	74.805746	Sonda	Checkdam
293	14.726549	74.805597	Sonda	Checkdam
294	14.709825	74.790160	Sonda	Checkdam
295	14.714552	74.782143	Sonda	Checkdam
296	14.702779	74.781678	Sonda	Checkdam
297	14.600444	74.942185	Sugavi	Checkdam
298	14.595767	74.933987	Sugavi	Checkdam
299	14.591544	74.919595	Sugavi	Checkdam
300	14.605107	74.949524	Sugavi	Checkdam
301	14.587660	74.862412	Tarkanalli	Checkdam
302	14.664101	74.724297	Tattisar	Checkdam
303	14.665731	74.730299	Tattisar	Checkdam
304	14.560091	74.650838	Teppar	Checkdam
305	14.568445	74.645997	Teppar	Checkdam
306	14.574745	74.640542	Teppar	Checkdam
307	14.539999	74.637488	Teppar	Checkdam
308	14.571628	74.684342	Teppar	Checkdam
309	14.567276	74.681407	Teppar	Checkdam
310	14.542769	75.043400	Tigni	Checkdam
311	14.725062	74.929878	Ullal	Checkdam
312	14.550817	74.923937	Umbalekoppa	Checkdam
313	14.679141	74.962046	Ummudi	Checkdam
314	14.673956	74.898128	Ummudi	Checkdam
315	14.669556	74.917669	Ummudi	Checkdam
316	14.585215	74.905084	Unchalli	Checkdam
317	14.575160	74.878901	Unchalli	Checkdam
318	14.559740	74.899916	Upplekoppa	Checkdam

Sl. No.	Latitude	Longitude	Name of the Village	Type of AR Structure
319	14.550132	74.892341	Upplekoppa	Checkdam
320	14.722238	74.962200	Vadageri	Checkdam
321	14.664341	75.029305	Vaddal	Checkdam
322	14.583099	74.687122	Vadgere	Checkdam
323	14.585039	74.697406	Vadgere	Checkdam
324	14.595038	74.753934	Yachadi	Checkdam
325	14.601182	74.750712	Yachadi	Checkdam
326	14.760880	74.711057	Yadalli	Checkdam
327	14.744493	74.709259	Yadalli	Checkdam
328	14.741617	74.710741	Yadalli	Checkdam
329	14.740497	74.700278	Yadalli	Checkdam
330	14.741074	74.718932	Yadalli	Checkdam
331	14.734761	74.716665	Yadalli	Checkdam
332	14.754805	74.722441	Yadalli	Checkdam
333	14.747948	74.728251	Yadalli	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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