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

Sringeri Taluk, Chikmagalur District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

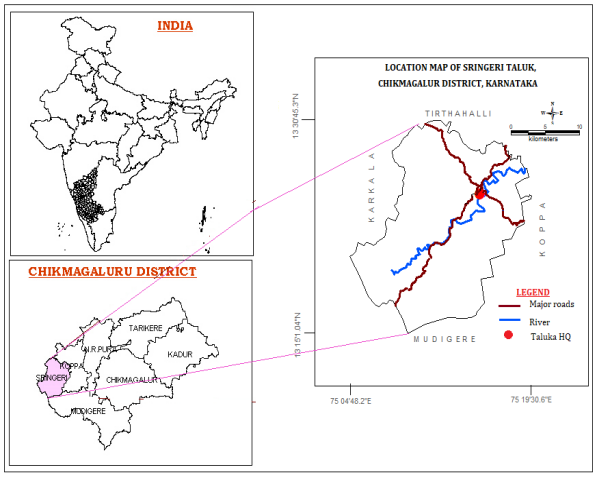
FOR OFFICIAL USE ONLY
No. SWR/RP/NQM/2023-24/14

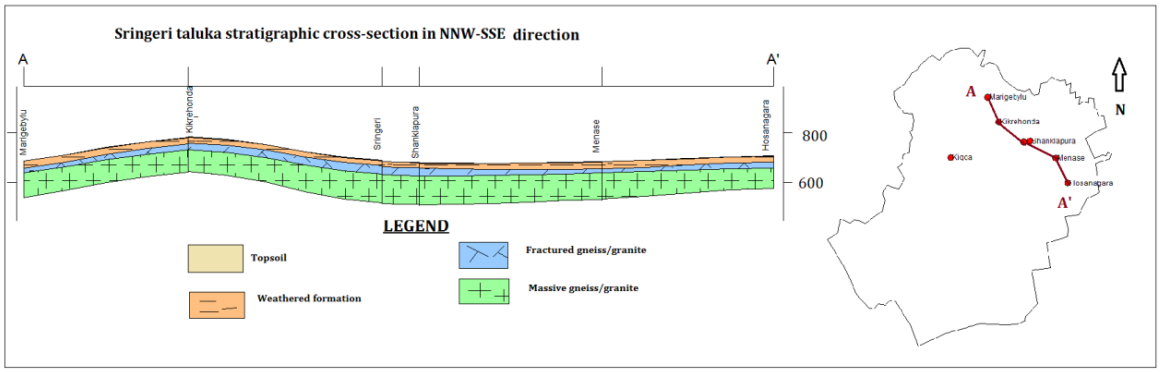
भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास
एवं गंगा संरक्षण विभाग
केन्द्रीय भूमिजल बोर्ड
दक्षिण पश्चिम क्षेत्र,
बेंगलुरु

Government of India
Ministry of Jal Shakti
Department of Water Resources,
River Development &
Ganga Rejuvenation
Central Ground Water Board
South Western Region,
Bengaluru

AQUIFER MAPS AND MANAGEMENT PLAN, SRINGERI TALUK, CHIKMAGALUR DISTRICT, KARNATAKA STATE

(AAP – 2022-2023)





By

Dr. Suchetana Biswas, Scientist 'C', CGWB, SWR, Bengaluru

MAY 2023

AQUIFER MAPS AND MANAGEMENT PLAN, SRINGERI TALUK, CHIKMAGALUR DISTRICT, KARNATAKA STATE

Contents

AQUIFER MAPS AND MANAGEMENT PLAN, SRINGERI TALUK, CHIKMAGALUR DISTRICT, KARNATAKA STATE

1.0 SALIENT INFORMATION

Name of the Taluk: **SRINGERI**

District: Chikmagalur

State: Karnataka

Area:444sq.km

Population:36539

Annual NormalRainfall:3887mm

1.1 Aquifer Management study area

Aquifer mapping studies were carried out in Sringeri taluk, Chikmagalur district of Karnataka, covering an area of 444sq.kmunder National Aquifer Mapping Project. Sringeri taluk of Chikmagalur district is located between North latitude 13°15'1.04" to 13°30'45.3"&East longitude 75°04'48.2" to 75°19'30.6"and is covered in parts of Survey of India Toposheet Nos. 48O/3 and 48O/7.Sringeritalukis bounded by Tirthahalli taluka of Shimoga district on North, Koppa taluk of Chikmagalur district on East, Karkala taluk of Udupi district on West and Mudigere taluk of Chikmagalur district on South side. Location map of Sringeri taluk of Chikmagalur district is presented in **Figure 1.**

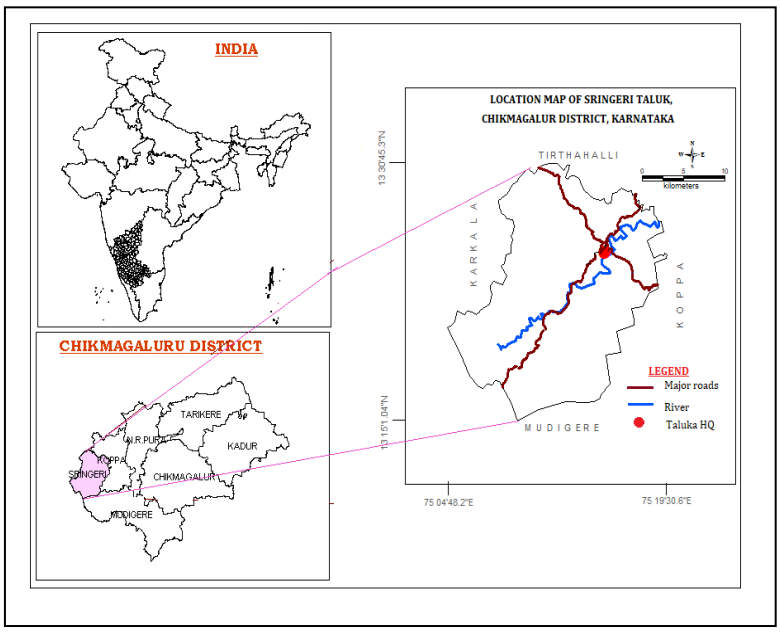


Figure 1: Location Map of Sringeri taluk, Chikmagalur district, Karnataka

Taluk administration of Sringeri is divided into 02Hoblies and 09 Gram Panchayats. There are 48 inhabited and 1 uninhabited villages in the Taluk.

1.2 Population

According to 2011census, the population in Sringeri taluk is 36539 ofwhich18030 male and 18509femalepopulation.

1.3 Rainfall

There are ten (10) rain gauge stations located in Sringeri taluk. Normal annual rainfall is 3887mm.The monthly rainfall data from 2001 to 2021 is given in Table 1. The rainfall data reveals that the annual rainfall ranges from 2703 to 4954 mm. The highest annual rainfall is observed in the year 2018 while it is low in the year 2017. The annual rainfall trend is flat as evident from Fig. 1A. Actual annual rainfall for 2021 was 3940.4mm.

Table 1: Monthly rainfall data of Sringeri taluk

YEAR	JAN	FEB	MAR	APR	MAY	PRE-MON	JUN	JUL	AUG	SEP	MON	OCT	NOV	DEC	POST-MON	ANN.
2001	0	0	0	324	73	397	902	990	900	147	2939	98	65	0	163	3499
2002	0	51	27	143	23	244	546	905	1002	196	2649	228	26	0	254	3147
2003	0	0	57	82	0	139	758	1112	1011	220	3101	182	0	0	182	3422
2004	0	0	27	29	193	249	1018	1089	1184	153	3444	68	42	0	110	3803
2005	0	0	0	121	38	159	635	1629	1220	395	3879	311	13	1	325	4363
2006	2	0	0	17	269	288	687	1505	1311	381	3884	39	230	1	270	4442
2007	0	4	0	80	69	153	980	1453	1113	658	4204	211	52	0	263	4620
2008	0	49	239	18	9	315	739	1002	1265	333	3339	80	11	3	94	3748
2009	0	0	166.1	27.1	83	276.2	270	1786	593	497	3146	340	174	16	530	3952.2
2010	7	0	2	100	73	182	434	1145.2	696.9	468	2744.1	218	250	5	473	3399.1
2011	0	0	10	110	48	168	994	1117	997	536	3644	236	81	0	317	4129
2012	0	0	0	141	23.4	164.4	486	879	1193	370	2928	37	145	0	182	3274.4
2013	1	4	16	13	0	34	486	879	1193	370	2928	37	145	0	182	3144
2014	0	13	15	57.6	148	233.6	457	1560	1056	425	3498	123	11	41	175	3906.6
2015	0	0	12	85	198	295	872	977	549	137	2535	180	151	20	351	3181
2016	0	0	3	47	103	153	837	1061	1181	441	2683	138	113	2	253	3089

2017	0	0	0	16	189	205	620	799	814	199	2432	66	0	0	66	2703
2018	0	0	41	101	227	369	1190	1716	1469	105	4480	72	26	7	105	4954
2019	0	0	0	0	18.6	18.6	379.6	1016	1539	755	3689.6	373	8	45	426	4134.2
2020	1	0	12	55	157	225	553	692	1289	758	3292	272	31	8	311	3828
2021	110.6	27.3	22.2	109.8	224.2	494.1	600.7	1167.6	659	473	2900.3	308	226	12	546	3940.4

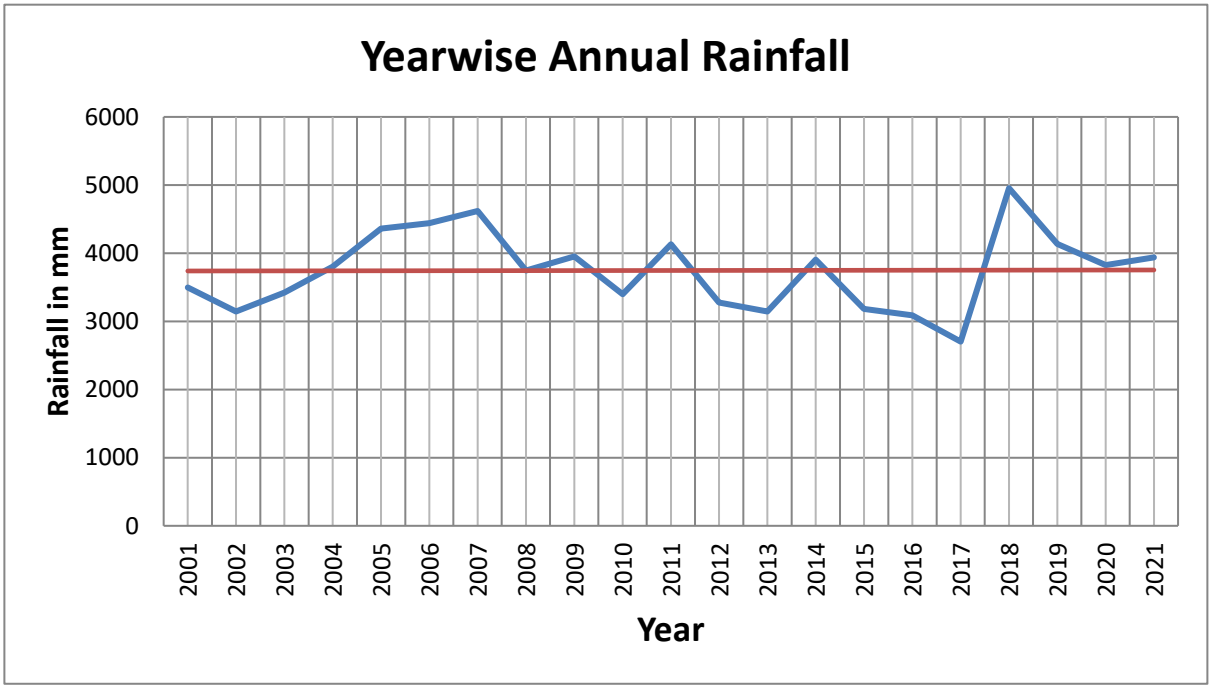


Figure 2: Year wise annual rainfall variation in Sringeri taluk

Sringeri taluk experiences semi-arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Hilly (Malnad) agro-climatic zone of Karnataka state. The taluk is landslide and flood prone. The wet season is warm and overcast and the dry season is hot, humid, and partly cloudy. The taluk receives heavy rainfall during monsoon.

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.

1.4 Agriculture and Irrigation

Agriculture is the main occupation in Sringeri taluk. Pulses and Paddy is the main foodcrop grown in the taluk in 1842 ha area. Area under total condiments and spices is 1051 ha. Arecanut and coconut are important cash crops grown in 3468 ha and 22ha area respectively. Area under total plantation crops is 1673ha (**Table 2**).

Table2: Cropping pattern in Sringeri taluk2018-2019(Ha)

Paddy	Pulses	Fruits	Vegetables	Oil seeds	Total condiment and snices	Arecanut	Coconut	Total plantation crops
1842	0	123	0	16	1051	3468	22	1673

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

It is observed that area under forest accounts for about 67.36% of total geographical area. It is observed that net sown area accounts for about 15.57% of total geographical area **(Table 3).** As per the data available, the taluk uses 77 tanks to irrigate 132ha area;61 dug wells to irrigate 14ha area and 308 borewells to irrigate 84ha area. Irrigation is mostly through other sources **(Table 4).** Landuse pattern of the taluk is represented in map as **Figure 3** and in pie diagram as **Figure 4**. As per figure 4, 16% of the total geographical area is net sown area,11% is permanent pastures and groves,1% is fallow land and 68% is area under forest. The net area irrigated by various sources is represented in the pie diagram in **figure 5**. From the pie diagram it is evident that 7% area is irrigated by surface water, 6% area is irrigated by groundwater and 87% is irrigated by other sources. The net irrigated area vs net sown area is represented in the pie diagram in **figure 6.**

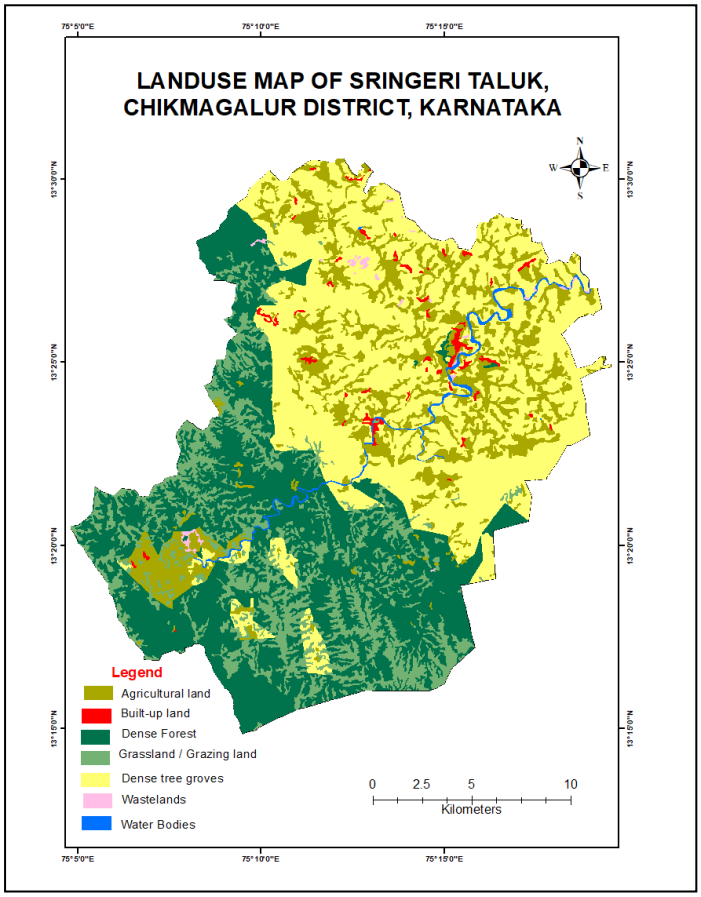


Figure 3: Landuse Map

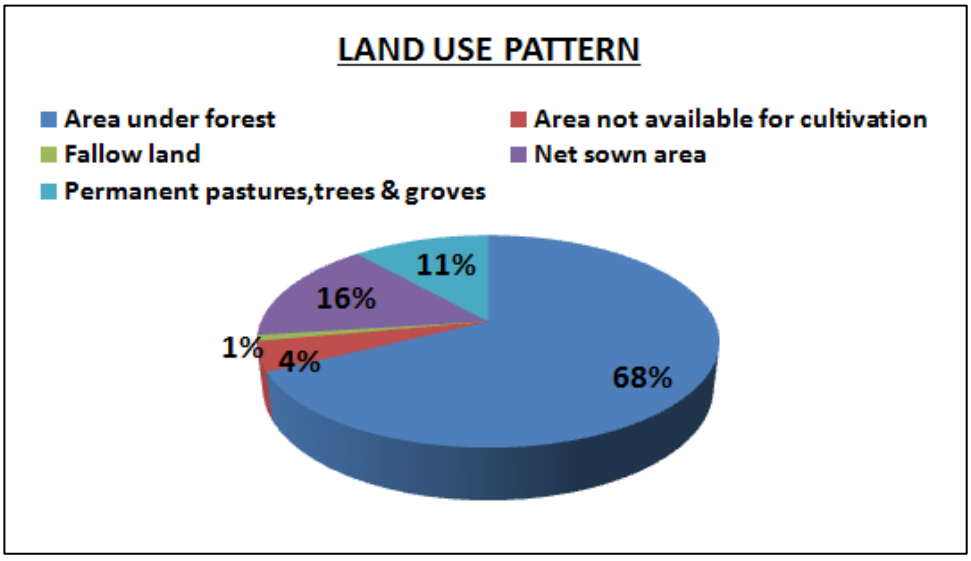
Table 3: Details of landuse in Sringeri taluk2018-2019(Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Other uncultivated land	Fallow land	Net sown area	Area sown more than once	Net area sown to geographical area
Sringeri	44400	29909	2001	5081	397	6896	1386	15.57%

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

Table 4: Irrigation details in Sringeri taluk(Ha)

Source of Irrigation	Nos./Length	Net area irrigated (Ha)	Gross area Irrigated (Ha)
Canals	0	0	0
Tanks	77	132	132
Total Surface water		**132**	**132**
Wells	61	14	14
Bore wells	308	84	84
Total ground water		**98**	**98**
Lift Irrigation	496	--	--
Other Sources		1502	1502
Total		**1502**	**1502**



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

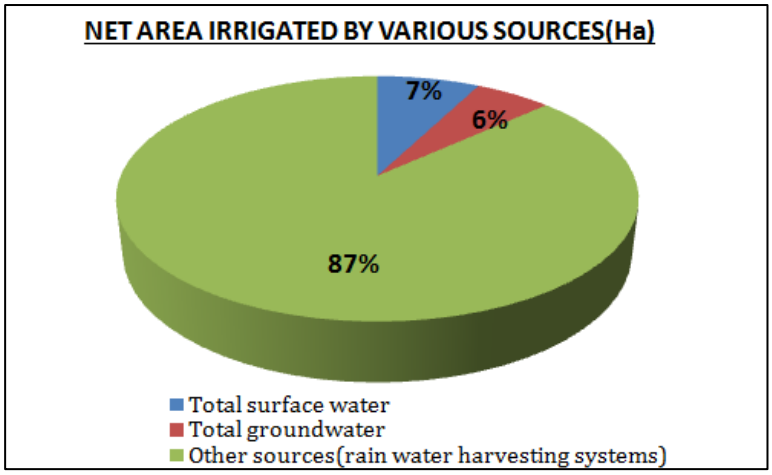


Figure 5: Pie diagram depicting net area irrigated by various sources in Sringeri taluk

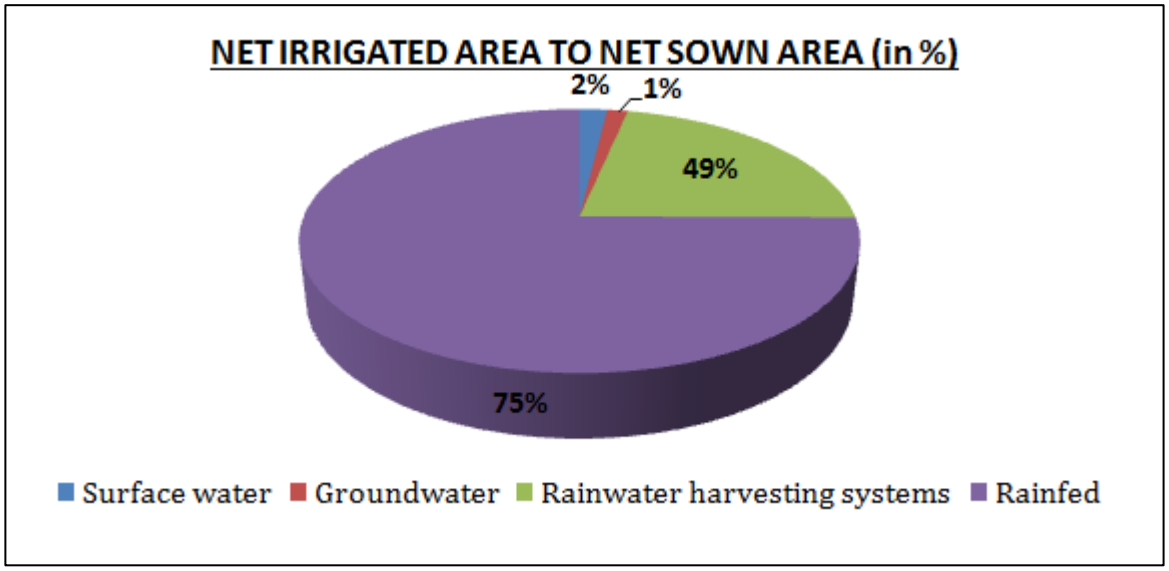


Figure 6: Pie diagram depicting net area irrigated to net area sown in Sringeri taluk

1.5 Geomorphology, Physiography and Drainage

The taluk is located in the Malnad region of the state. The surface topography is in the form of hills and undulating plain situated at an average elevation of 873m amsl. There are several hills and mountain ranges dotting the taluk and few fertile shallow valleys**(Figure 7)**. The general slope in the taluk is in south to north direction. There are 27 named mountains in Sringeri taluk. Sitabhumi is the highest point(1482 m asl). One of the prominent mountain range is NarasimhaParvata (1157 m asl). The southern part is mountainous and has dense dendritic drainage pattern. Due to steep slope of land, denser drainage pattern and high runoff water infiltration is low.The taluk is drained by Tunga river flowing towards North direction**(Figure 8).** Elevation >1000m amsl is seen in the Eastern,Western and Southern part of the taluk **(Figure 9)**. In hilly areas of the taluk, slope varies between 15° to 20° **(Figure 10)**.

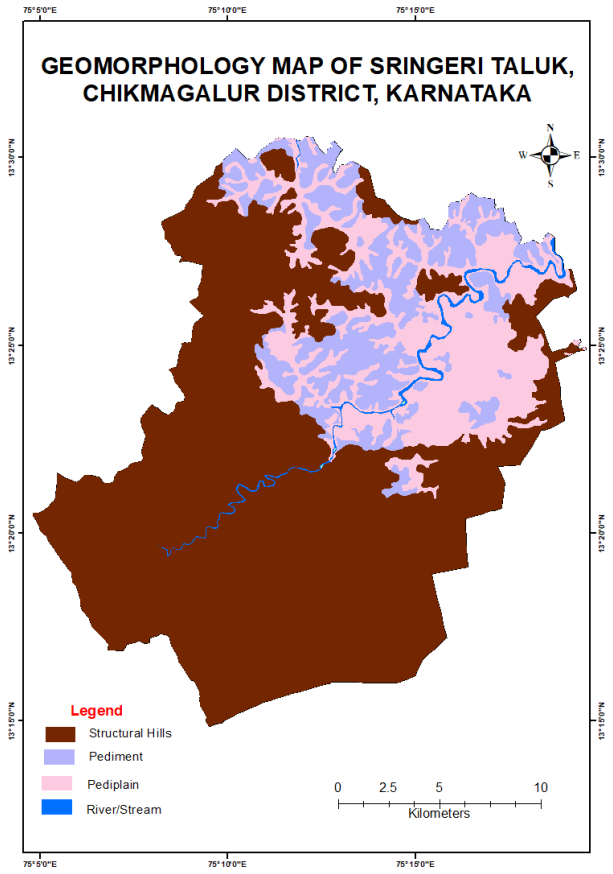


Figure 7: Geomorphology map

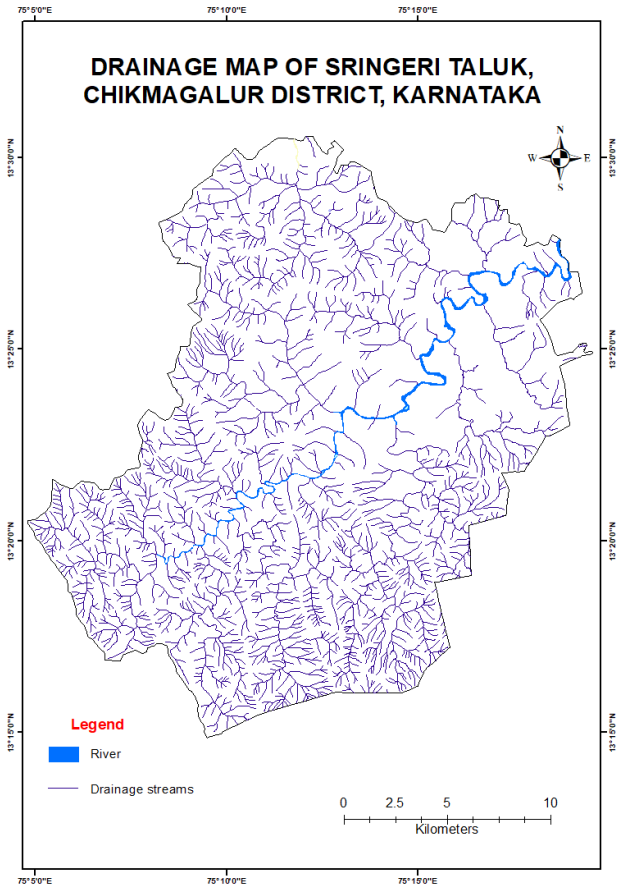


Figure 8: Drainage map

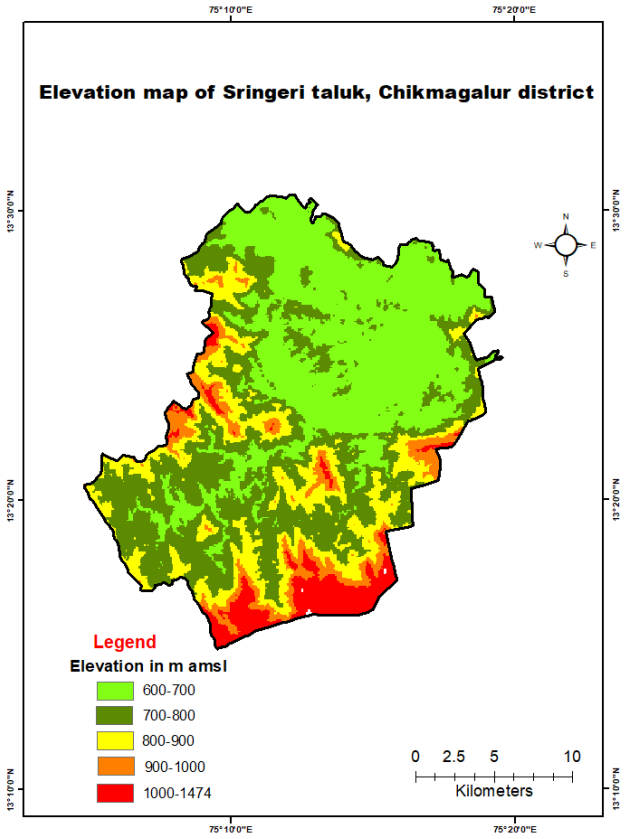


Figure 9: Elevation map of Sringeri taluk

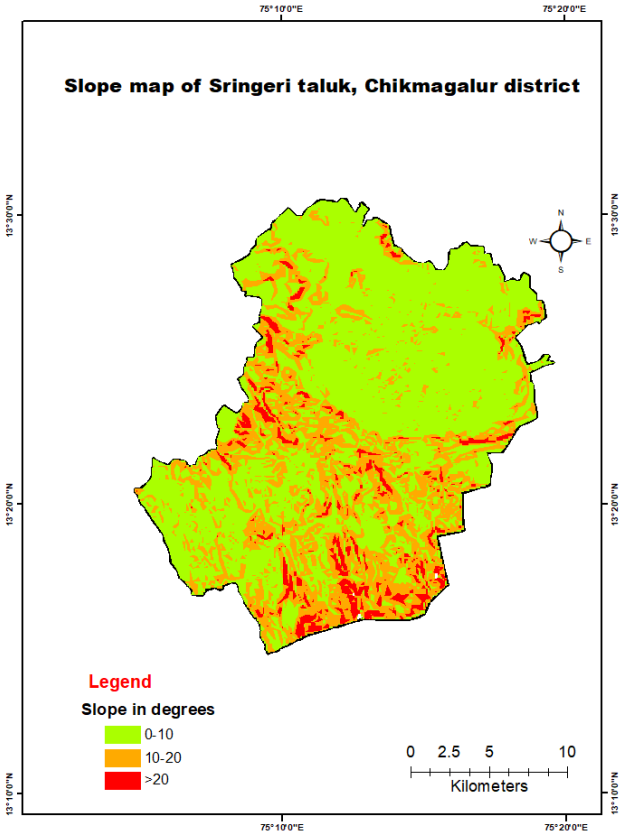


Figure 10: Slope map of Sringeri taluk

1.6 Soil

Ultisols, i.e, deep red clayey soils form 90% of the soils of thetaluk.Ultisols are reddish, clay-rich, acidic soils that support a mixed forest vegetation prior to cultivation. They are naturally suitable for forestry, can be made agriculturally productive with the application of lime and fertilizers, and are stable materials for construction projects. Alfisols form in semi-arid to humid areas, typically under a hardwood forest cover. They have a clay-enriched subsoil and relatively high native fertility. Lateritic soils, red gravelly and red clayey soils are also found in the taluk. Deep brown soils support plantation crops, while the red gravelly clayey and red soils are features of dryland agriculture. **(Figure 11).**

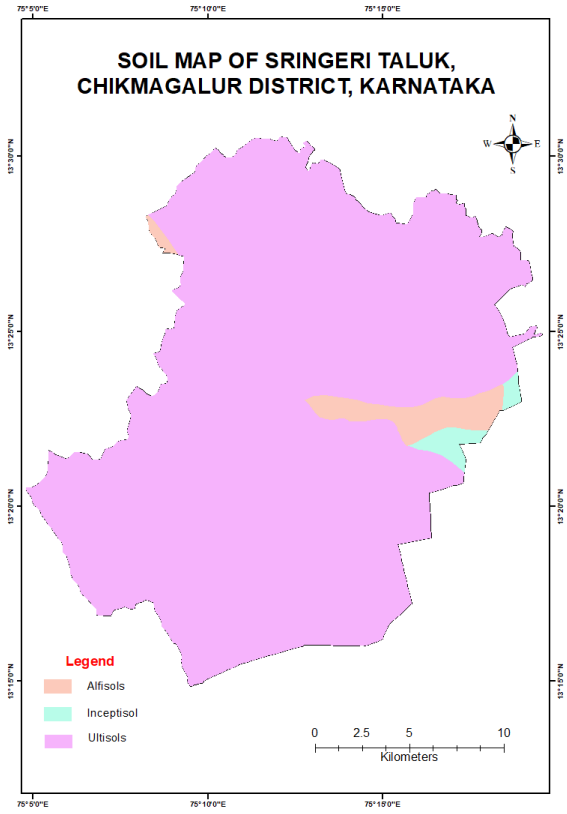


Figure 11: Soil map

1.7 Existing and future water demands (as per GWRA-2022) and Comparison with resource estimation of 2017 and 2020

The details of dynamic (Phreatic) ground water resources for Sringeri taluk as in 2022 is shown in **Table5a**. The annual extractable water resource is 2743.81 ham. Total groundwater extractions for irrigation and domestic use is 773.01 ham. Annual GW Allocation for domestic use as on 2025 is 69.29ham.Net Ground Water Availability for future use is 1970.27ham. The stage of extraction is 28.17% and taluka falls in Safe category. The details of dynamic (Phreatic) ground water resources for Sringeri taluk as in 2020is shown in **Table5b**.The annual extractable water resource is 6211.11 ham. Total groundwater extractions for irrigation and domestic use is 708.69 ham. Annual GW

Allocation for domestic use as on 2025 is 110.06ham.Net Ground Water Availability for future use is 5496.89ham. The stage of extraction is 11.41% and taluka falls in Safe category.

The details of dynamic (Phreatic) and phreatic in-storage and fractured aquifer ground water resources for Sringeri taluk as in 2017 is shown in **Table5c**.The stage of development of the taluk was 38%(safe).

Table.5a Detail of Dynamic Ground Water resource, Sringeri taluk (as on 2022)

Taluk	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Domestic and Industrial Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)
Sringeri	2743.81	704.25	68.76	773.01	69.29	1970.27	28.17(safe)

Table.5b Detail of Dynamic Ground Water resource, Sringeri taluk (as on March 2020)

Taluk	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Domestic and Industrial Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)
Sringeri	6211.11	604.17	104.53	708.69	110.06	5496.89	11.41(safe)

Table 5c: Total Ground Water Resources (2017) (Ham)

Taluk	**Annual Extractable Groundwater Resource**	**Fresh In-storage GW resources (2017)**		**Total availability of fresh GW resources**
Sringeri	8098	**Phreatic**	**Fractured (Down to 200m)**	**Dynamic + phreatic in-storage + fractured**
		71079	3078	82255

1.8 Data Availability, Data Adequacy and Data gap Analysis

The taluk has total geographical area of 444 sq.km, out of which 303.18 sq.km area is covered by hills and dense forest. Such areas are inaccessible or devoid of habitation. Since the taluk falls in hilly area, data gap analysis technique for "Hilly areas" was used along with study of actual satellite imagery on Google Earth to determine the feasibility of points for data gap and data generation required.

The hydrogeological data already available including number of monitoring wells, VES, exploratory wells, chemical parameters have been collected and analysed which shows that in the study area the required number of ground water monitoring stations is 7 against which 9 stations are available leading to no data gap. Similarly, the required number of ground water exploratory wells is 7 against which 8 stations are available. But 2 more exploration wells are necessary in two quadrants to obtain good idea. Likewise, the required number of ground water quality monitoring stations is 7 against which 7 stations are available, so no data gap exists. Lastly, the required number of VES is 10 against which no data are available leading to the data gap of 10.

On the basis of all data available in the study area, the data gap analysis has been prepared to ascertain the data gap in the study area which is presented in summary in Table 6 and 7. The maps are given in **Figure 12 and 13**.

Table.6 Data availability and gap analysis, Sringeri taluk

Activity		Required	Available	Gap
Exploration		7	8	2
Water level monitoring	Aquifer-I	5	5	nil
	Aquifer-II	0	3	0
Quality monitoring		7	7	nil
Geophysical studies		10	nil	10

Table 7:Details of data gap analysis in Sringeri taluk Sringeri taluk falls in Survey of India toposheet nos.48O/7 and 48O/3			
Toposheet no.	48O/7		
Quadrant	**Keywell**	**EW**	**Geophysical**
A1	**Aquifer-I** 1.Begaru DW 2.MenaseDW **Aquifer-II** 1.Begaru BW	Present 1. Sringeri 2. Sanklapura	Data gap Proposed village: 1.Addagadde 2.Menase
A2	**Aquifer-I** 1.Kunthanur/KunturDW **Aquifer-II** 1.Kunthanur/KunturBW	Present 1.Hosanagara	Data gap Proposed village:Kunthanur/Kuntur, Thekkur
Toposheet no.	48O/3		
Quadrant	**Keywell**	**EW**	**Geophysical**
C1	**Aquifer-I** 1.NallurDW 2.HolekoppaDW	1.Marigebylu 2.Kikrehonda	Data gap Proposed village:1.Nallur 2.Holekoppa 3.Kigga
C2	**Aquifer-II** 1.Kigga BW	Kigga	Data gap Proposed village:Huluguru,

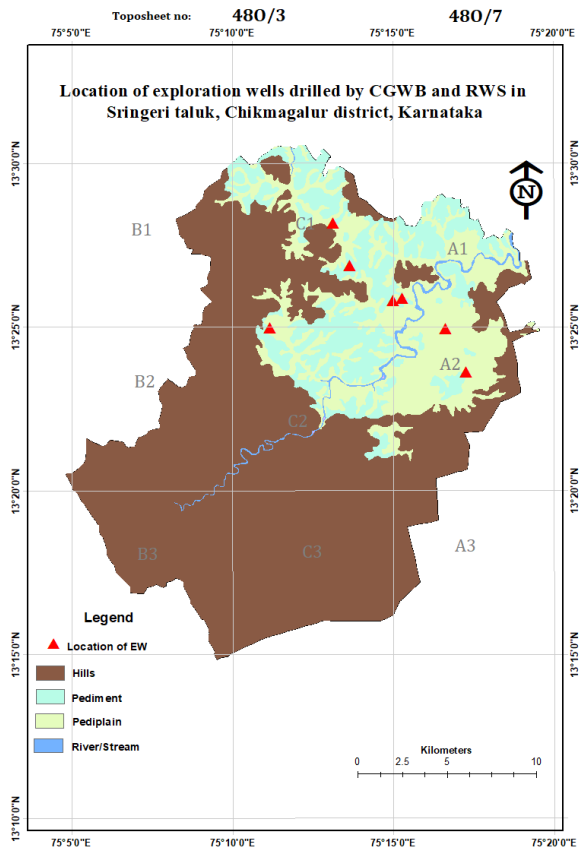


Figure 12: Location of exploration wells drilled by CGWB and RWS, Karnataka in Sringeri taluk

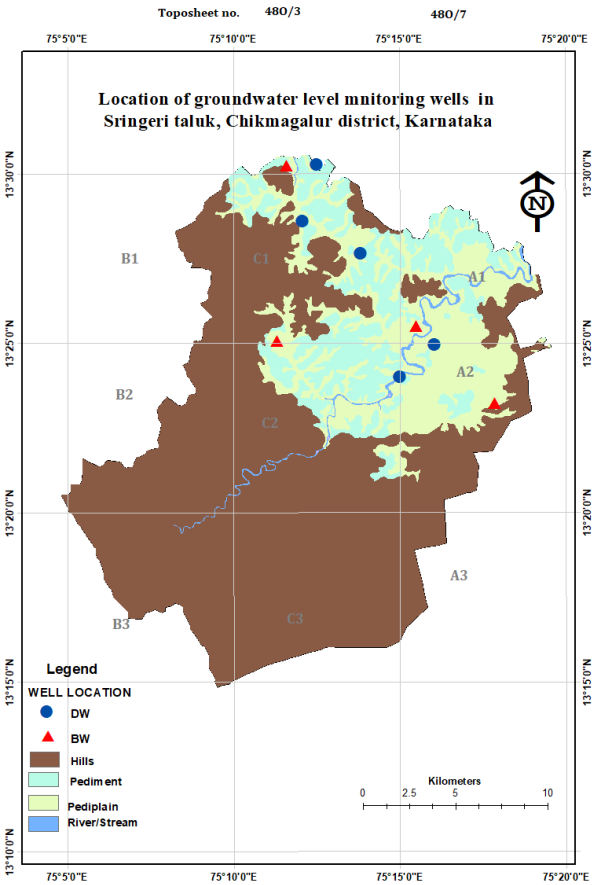


Figure 13: Location of water level monitoring wells of CGWB and GWD, Karnataka in Sringeri taluk

1.9 Water level behaviour

The water level data have been monitored from the representative dug wells for both pre and post-monsoon seasons (Table 8). During pre-monsoon season in i) aquifer-I (phreatic) water level ranges from 4.40 to 12.13mbgl **(Figure 14)**, ii) aquifer-II (fractured) water level ranges from 7.25 to 12.30mbgl , whereas in post-monsoon it varies from 2.20 to 9.55 m bgl in aquifer-I (phreatic) **(Figure 15)** and 6.35 to 10.25mbgl in aquifer-II (fractured) .The seasonal water level fluctuation in aquifer-I is rise in the range of 2.2 m to 3.0 m.The seasonal water level fluctuation in aquifer-II is rise in the range of 0.9m to 2.05m. The pre-monsoon decadal (2012-2021) average water level for aquifer-I varies from 6.27 to 12.06 mbgl**(Figure 16)**. The post-monsoon decadal average water level for aquifer-I varies from 2.45 to 9.63 mbgl**(Figure 17)**. The pre-monsoon decadal (2012-21)average water level vs May 2022 water level fluctuation map for phreatic aquifer indicates rise in water level in major parts of the taluk**(Figure 18)**.The post-monsoon decadal (2012-21) average water level vs November 2022 water level fluctuation map for phreatic aquifer indicates fall in water level in major parts of the taluk**(Figure 19)**.

Table.8Depth to water level monitoring stations in Sringeri taluk

Sl. No.	Well type	Village name	DTWL (m bgl) (Pre-monsoon 2022)	DTWL (m bgl) (Post-monsoon 2022)	Seasonal fluctuation (m)
1	Dugwell	Begaru	12.13	9.55	2.58
2	Dugwell	Holekoppa	9.90	7.20	2.70
3	Dugwell	Sringeri1	6.18	3.40	2.78
4	Dugwell	Menase	11.17	8.17	3.0
5	Dugwell	Nalluru	4.40	2.20	2.2
6	Borewell	Begar	8.35	6.80	1.55
7	Borewell	Kigga	7.25	6.35	0.9
8	Borewell	Kunthur	12.30	10.25	2.05

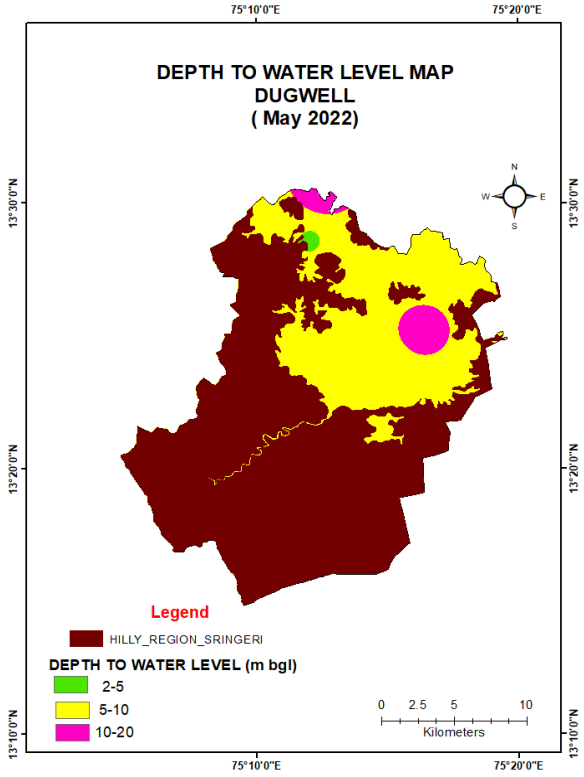


Figure 14: Pre-monsoon depth to water level map of Aquifer-I, Sringeri taluk

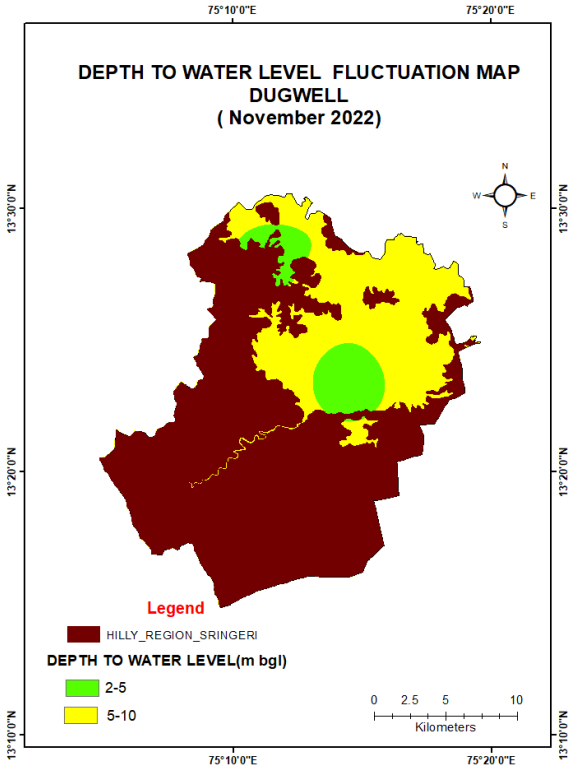


Figure 15: Post-monsoon depth to water level map of Aquifer-I, Sringeri taluk

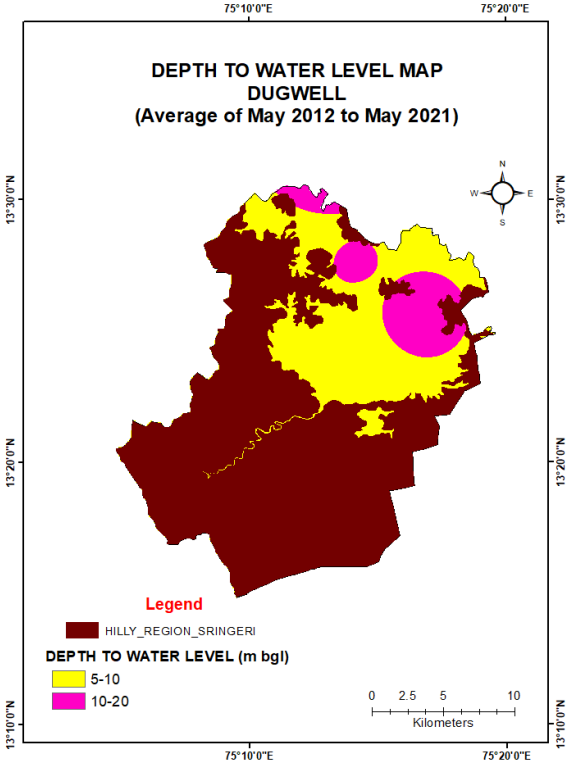


Figure 16: Pre-monsoon decadal average water level map, Sringeri taluk

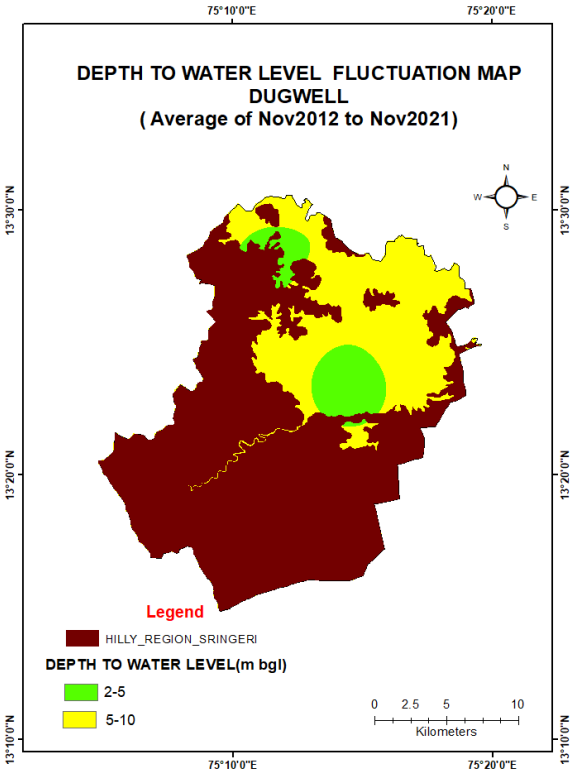


Figure 17: Post-monsoon decadal average water level map, Sringeri taluk

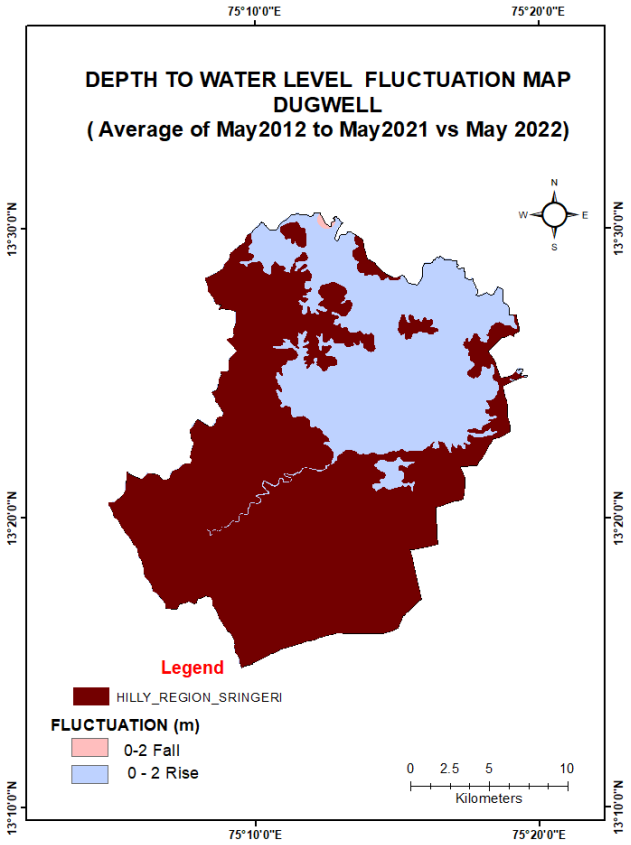


Figure 18: Pre-monsoon decadal average water level vs Pre-monsoon 2022 fluctuation

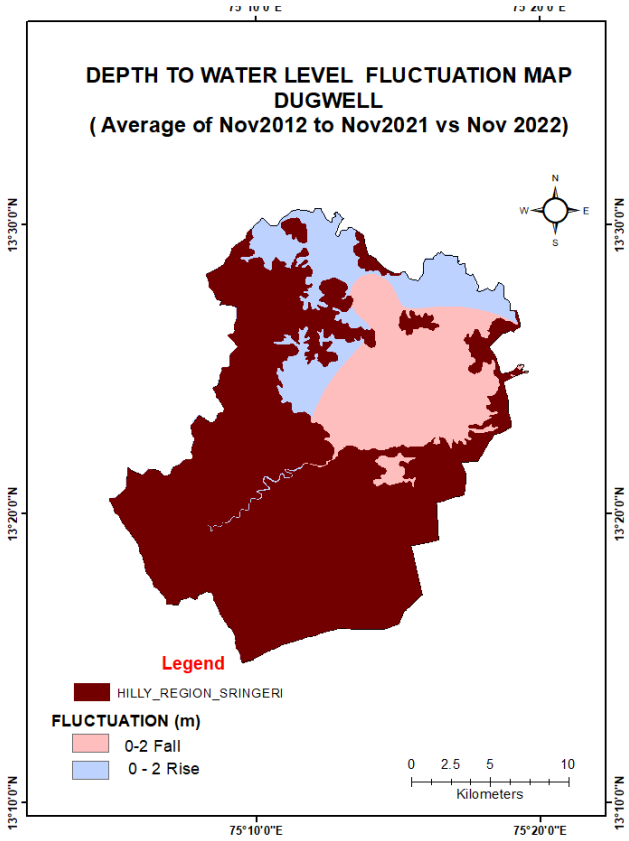


Figure 19: Post-monsoon decadal average water level vs Pre-monsoon 2022 fluctuation

The long term groundwater trend (2010-2019) for pre-monsoon period shows a fall in the range 0.05m/year to 0.12m/year and rise of 0.02m/year (Table 9).The long term groundwater trend (2010-2019) for post-monsoon period shows a fall of 0.069m/year and rise in the range of 0.0094m/year to 0.128m/year (Table 10). During pre-monsoon period monitoring stations are mostly showing falling trend and during post-monsoon period monitoring stations are mostly showing rising trend. **Figure 20** is the hydrograph of Begaru village for pre and post-monsoon period showing no rise or fall. **Figure 21** is the hydrograph of Sringeri town for pre and post-monsoon period showing slightly rising trend.

Table 9: Pre-monsoon Trend Of Groundwater monitoring stations (2010 to 2019)

SL_No	LOCATION	RISE (M/YEAR)	FALL (MYEAR)	AQUIFER_TYPE
1	Menase		0.0828	Unconfined
2	Nalluru		0.1284	Unconfined
3	Begaru		0.1272	Unconfined
4	Holekoppa		0.0514	Unconfined
5	Sringeri	0.0253		Unconfined
6	Sringeri1		0.1253	Semi-Confined

Table 10: Post-monsoon Trend Of Groundwater monitoring stations (2010 to 2019)

SL_No	LOCATION	RISE (M/YEAR)	FALL (MYEAR)	AQUIFER_TYPE
1	Menase	0.1203		Unconfined
2	Nalluru	0.1284		Unconfined
3	Begaru	0.0094		Unconfined
4	Holekoppa	0.0675		Unconfined
5	Sringeri		0.0699	Unconfined
6	Sringeri1	0.0555		Semi-Confined

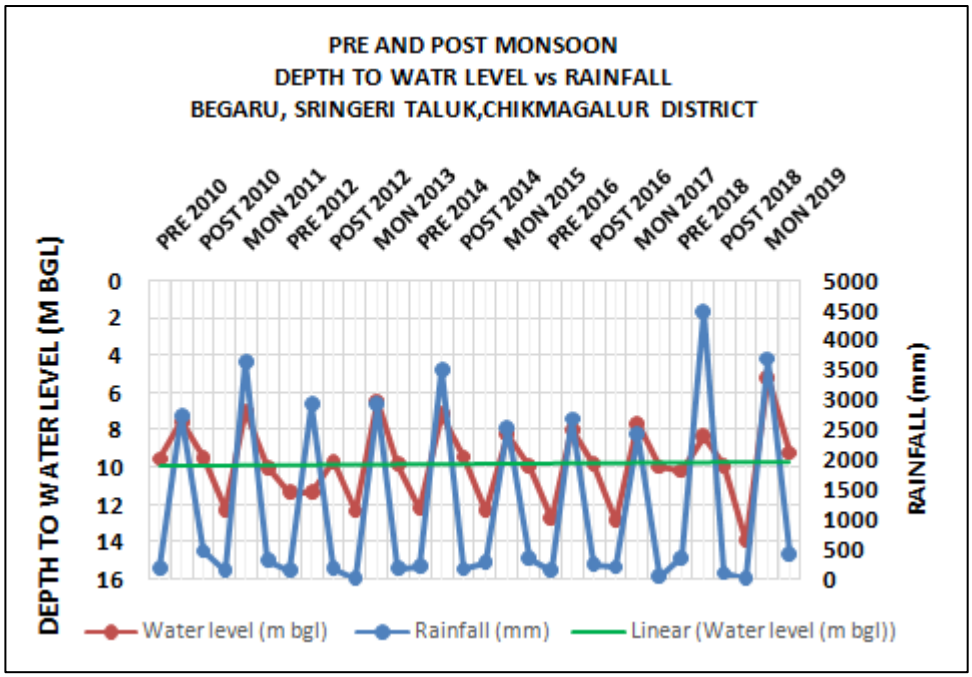


Figure 20: Pre & post-monsoon rainfall vs depth to water level graph of Begaru village, Sringeri taluk

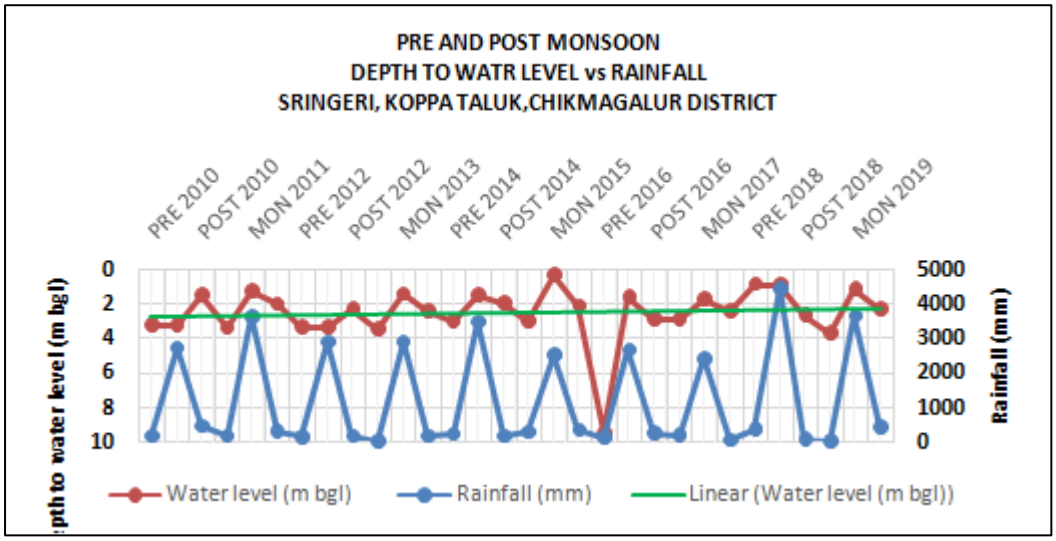


Figure 21: Pre & Post-monsoon rainfall vs depth to water level graph of Sringeri town, Sringeri taluk

2. AQUIFER DISPOSITION

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

i) Aquifer-I (Phreatic aquifer) comprising of weathered banded gneissic complex and schist

ii) Aquifer-II (Fractured aquifer) comprising fractured banded gneissic complex and schist

In Sringeri taluk, fractured gneiss and schist are the major water bearing formation. (**Figure 22**). Groundwater occurs within the jointed and fractured granitic gneiss and schist under semi-confined to confined conditions. In Sringeri taluk borewells were drilled from a minimum depth of 120 mbgl to a maximum of 200.0 mbgl (Table 11). Depth of weathered zone (Aquifer-I) ranges from 18mbgl to 32.6mbgl.Major part of the taluk has weathered thickness between 25-30m bgl (**Figure 23**). Aquifer-II fractured formation is generally encountered between the depth of 25 to 65m bgl. **From figure 24,** it is evident that most of the fractures are shallow and lie between 40 to 50m bgl depth. Yield is generally < 1lps to 1.5. **Figure 25a** represents the stratigraphic cross-section of exploration wells drilled in Sringeri taluk in NNW-SSE direction considering the wells of Marigebylu, Kikrehonda, Shanklapura and Hosanagara. The fracture thickness is more at Shanklapura. **Figure 25b** represents stratigraphic cross-section of exploration wells drilled in Sringeri taluk in W-E direction considering the wells of Kigga, Sringeri and Shanklapura. **Figure 26a,b** represent the 3D aquifer disposition.

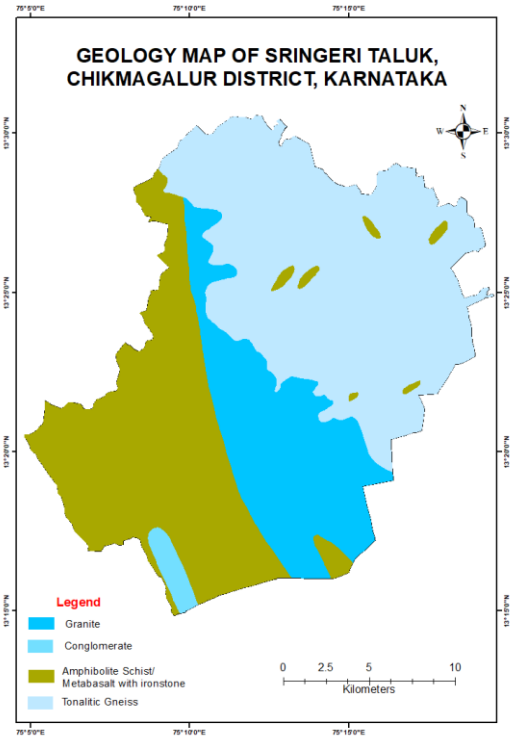


Figure 22: Geology Map, Sringeri taluk

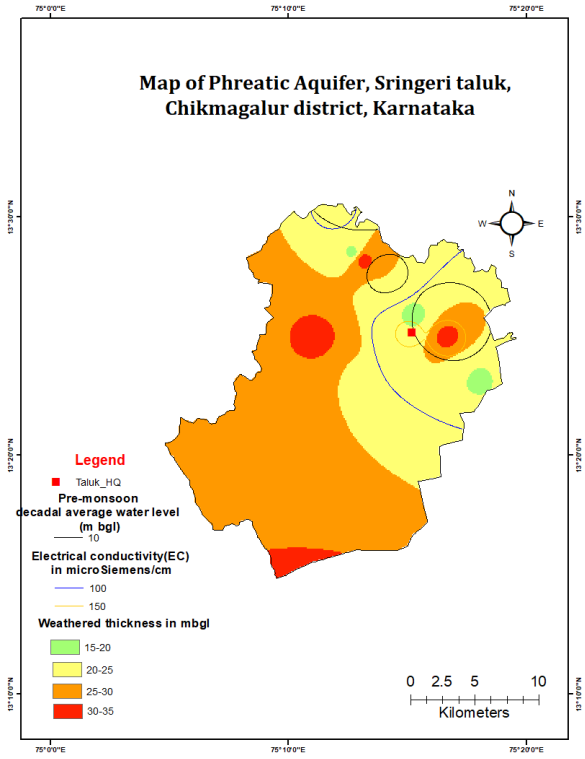


Figure 23: Map of phreatic aquifer, Sringeri taluk

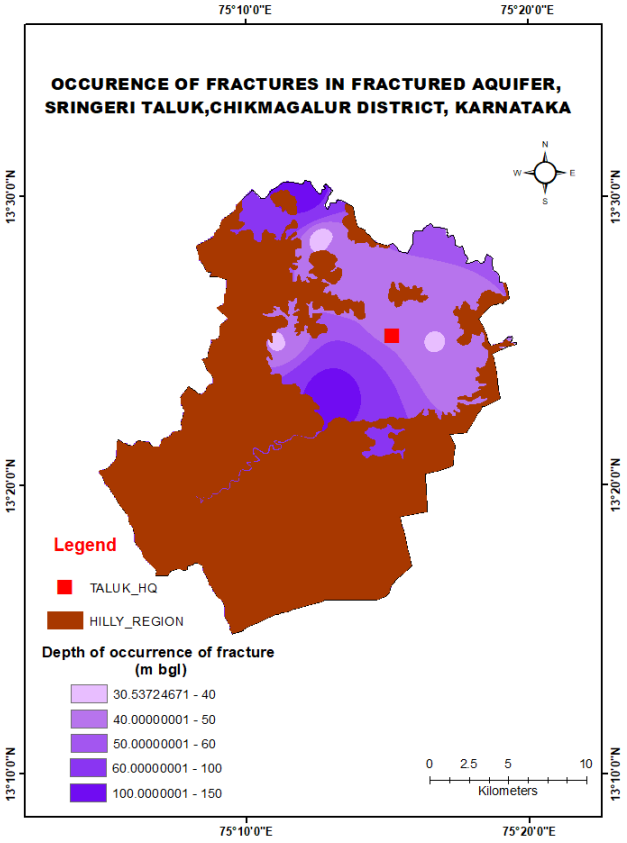


Figure 24: Depth of occurrence of fractures in aquifer-II (fractured aquifer) map

Table 11: Details of Ground water Exploration

Sl. No.	Location	Latitude(N)	Longitude (E)	Depth Drilled (m bgl)	Casing Depth (m bgl)	Fracture Zone (mbgl)	Q (lps)
1.	Hosanagara	75.2881	13.3939	120	23	23-50	0.33
2.	Kikrehonda	75.2278	13.4478	120	24	24-50	0.5
3.	Marigebylu	75.2189	13.4694	150	33	33-45	0.64
4.	Kigga	75.1864	13.4164	150	33	33-55	0.36
5.	Menase	75.2775	13.4158	150	33	33-40	0.36
6.	Shanklapura	75.2550	13.4311	150	18	18-50	0.2
7.	Sringeri	75.2500	13.4300	200.55	20	20-60	negligible

Source:(CGWB and Rural Water Supply Dept., Chikmagalur district, Karnataka)

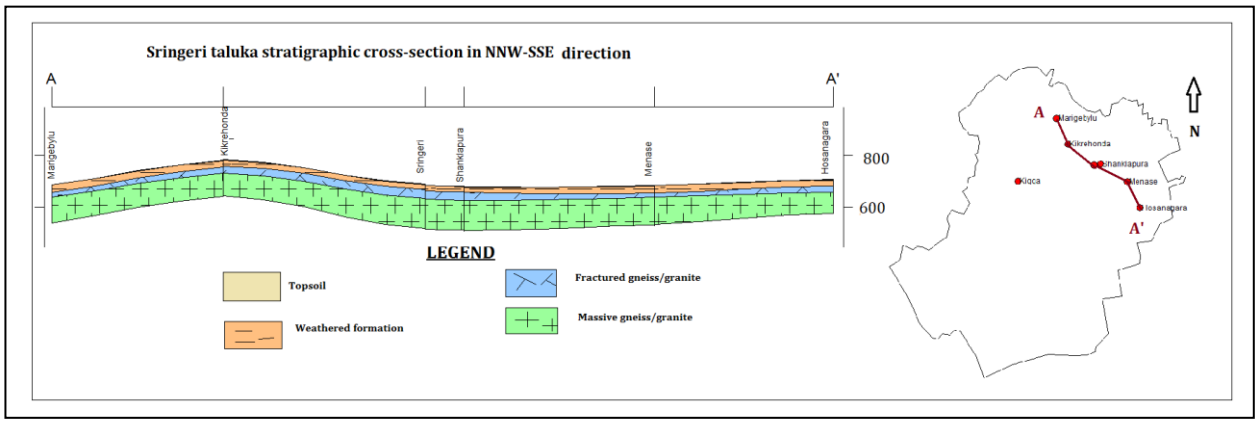


Figure 25a: NNW-SSE direction stratigraphic cross-section of exploration wells drilled in Sringeri taluk

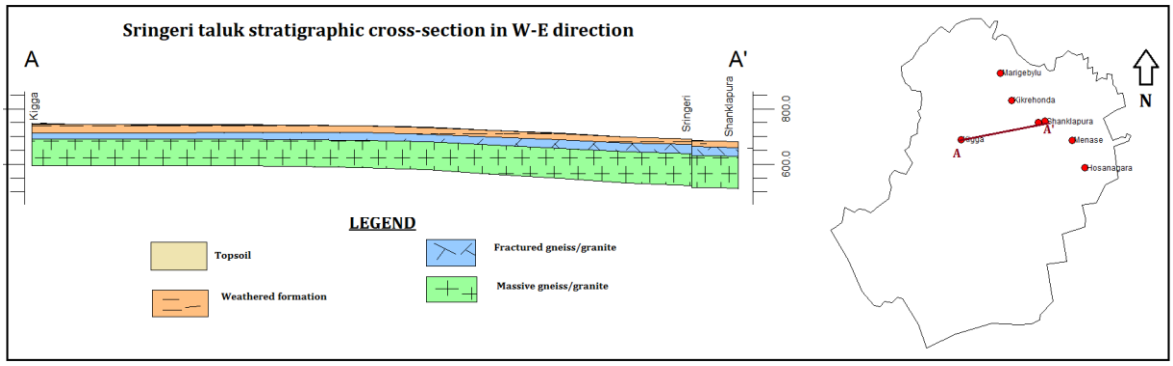


Figure 25b: W-E direction stratigraphic cross-section of exploration wells drilled in Sringeri taluk

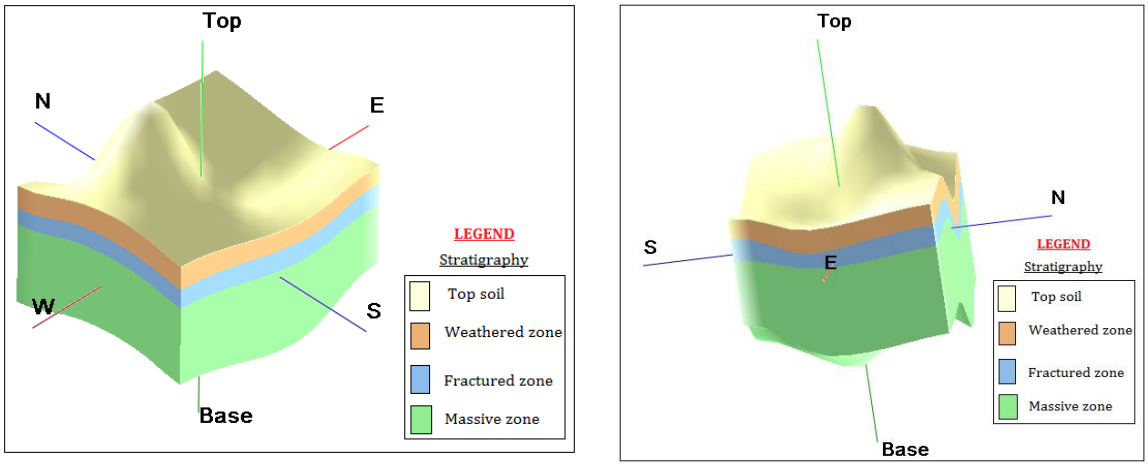


Figure 26(a,b):3D aquifer disposition

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

3.1. Aquifer wise resource availability and extraction

The comparison of the resource as on 2011,2013, 2017 and 2020 are summarised below in Table 12. It is observed that the draft has reduced during the year 2020 as compared to previous years. It is attributable to heavy rains, the improvement in irrigation practice, and also due to the water conservation / recharge activities carried out in the taluk by various state govt. and other agencies.

Table 12: Comparison of Ground Water Availability and Draft Scenario in Sringeri taluk

Taluk	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development (%)	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development (%)	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development (%)	Annual extractable GW resource (Ham)	Total GW Extraction (Ham)	Stage of GW Extraction (%)
	2011			2013			2017			2020		
Sringeri	7959	2585	32	7744	2813	36	8098	3045	38	6211.11	708.69	11.41

3.2 Water Quality

Interpretation from Chemical Analysis of Aquifer - I results in Sringeri taluk **(Table 13)** shows that the pH varies from 5.2 to 7.61, Electrical Conductivity ranges from 40 to 160 µ/mhos/cm in the aquifer-Iat 25^{o}C, while Total Hardness concentration ranges from 10to 61 mg/L. The Nitrate value ranges from 0 to 12.4 mg/l and Fluoride concentration in groundwater ranges between 0.024 – 0.12 mg/l.

Interpretation from Chemical Analysis of Aquifer - II results in Sringeri taluk **(Table 13)** shows that the pH varies from 5.93 to 6.85, Electrical Conductivity ranges from 60 to 250 µ/mhos/cm in the aquifer-Iat 25^{o}C, while Total Hardness concentration ranges from 20 to 95 mg/L. The Nitrate value ranges from 0 to 3.3 mg/l and Fluoride concentration in groundwater ranges between 0.081 – 0.18 mg/l.

Table 13: Hydro-chemical data of water samples analysed 2022

Sl.no.	Location	Source	pH	EC in mS/cm	TH (600)	Ca (200)	Mg (100)	Na	K	HCO_3	Cl (1000)	SO_4 (400)	NO_3 (45)	F (1.5)	TDS (2000)
1	NemmaruBW	BW	6.36	90	20	6.012	1.215	11.5	1	42.7	7.09	2	0	0.091	93
2	NalluruBW	BW	6.77	190	65	20.04	3.645	15.6	2.6	85.4	14.18	3	3.3	0.13	207
3	Begaru	BW	6.85	250	95	26.052	7.29	12.9	6.1	115.9	17.725	6	0	0.18	202
4	Menase	DW	7.34	160	61	14	6	8.52	1.05	55	14	16	1.71	0.066	86.52
5	Sringeri	DW	7.61	160	61	18	4	5.03	1.3	55	11	14	2.22	0.12	80.28
6	NemmaruDW	DW	5.23	40	10	2.004	1.215	4.1	0.3	12.2	7.09	2	0.1	0.083	37
7	Gulaganjemane	DW	5.55	40	15	4.008	1.215	3	0.9	6.1	7.09	2	7.5	0.085	41
8	Kerekatte	DW	5.35	40	15	4.008	1.215	2.8	0.7	6.1	3.545	2	12.4	0.08	41
9	Adikirurugrama	DW	5.31	40	15	4.008	1.215	2.91	0.69	12.2	3.545	2	4.5	0.083	45
10	Holekoppa	DW	5.2	50	15	4.008	1.215	4.8	0.6	18.3	7.09	1	0	0.08	46
11	NalluruDW	DW	5.5	70	25	6.012	2.43	5.1	0.3	30.5	3.545	5	0	0.089	49
12	Kunchebylu	HP	6.3	100	30	8.016	2.43	11.9	1.2	42.7	10.635	4	0	0.1	99
13	Kigga	HP	5.93	60	20	6.012	1.215	4.6	1.3	12.2	10.635	5	0	0.081	52
14	Mathuvalli	HP	6.03	60	20	4.008	2.43	4.6	4.5	12.2	10.635	8	0.6	0.089	54

The water quality of both phreatic and fractured aquifer is good and suitable for drinking and irrigation purposes. The EC, nitrate and fluoride concentration maps for both phreatic and fractured aquifer are given in Figure 27 to 32.

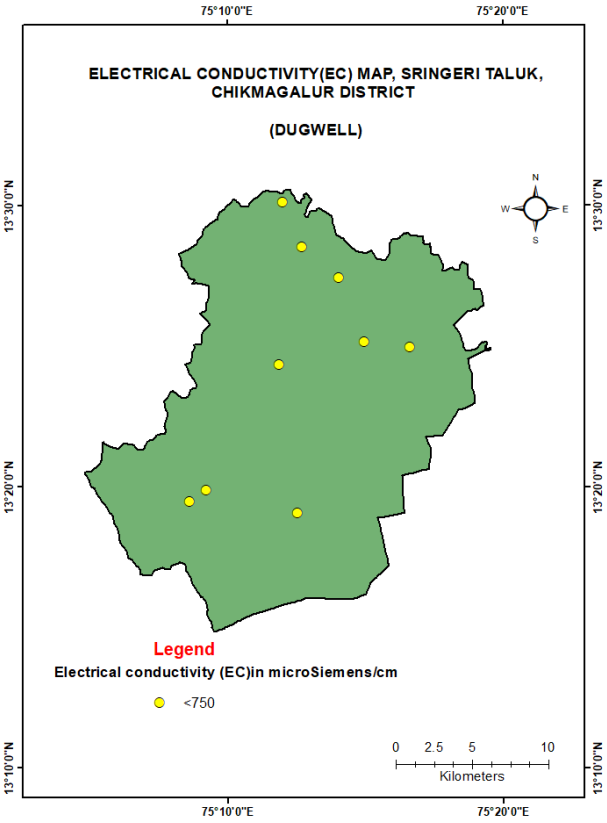


Figure 27: EC map of phreatic aquifer, Sringeri taluk

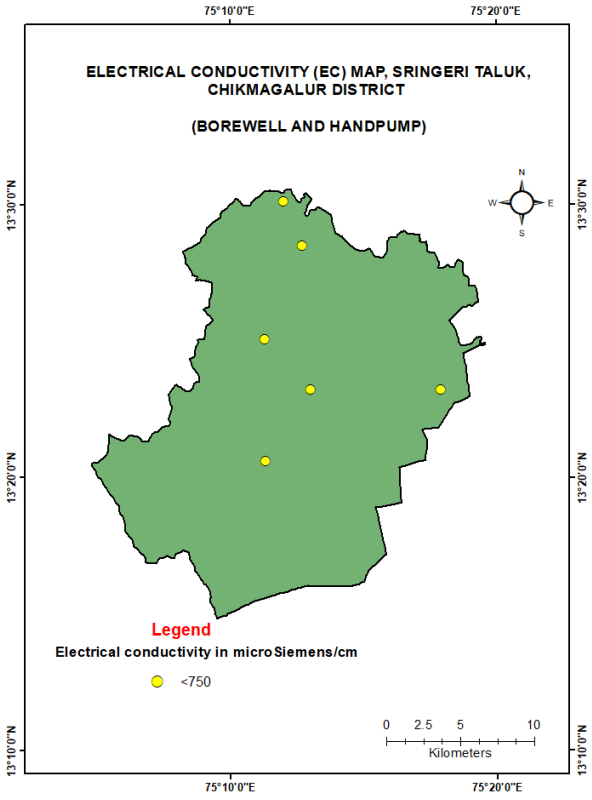


Figure 28: EC map of fractured aquifer, Koppa taluk

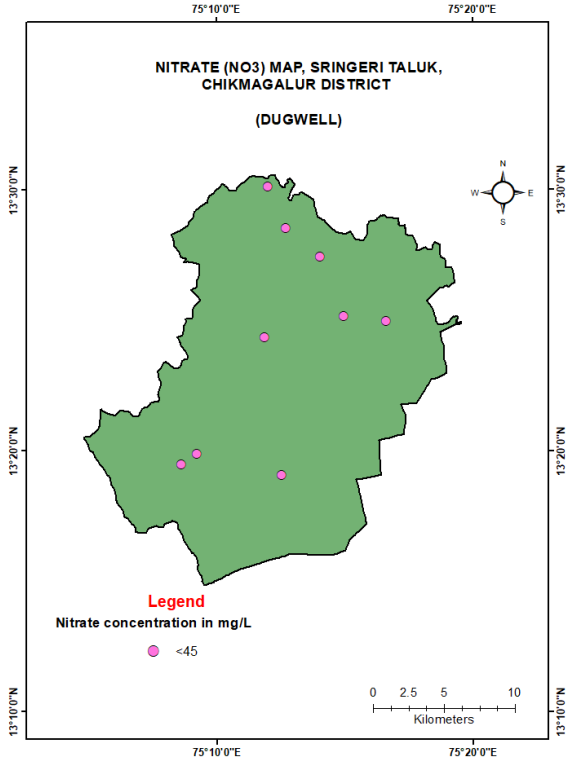


Figure 29: Nitrate map of phreatic aquifer, Koppa taluk

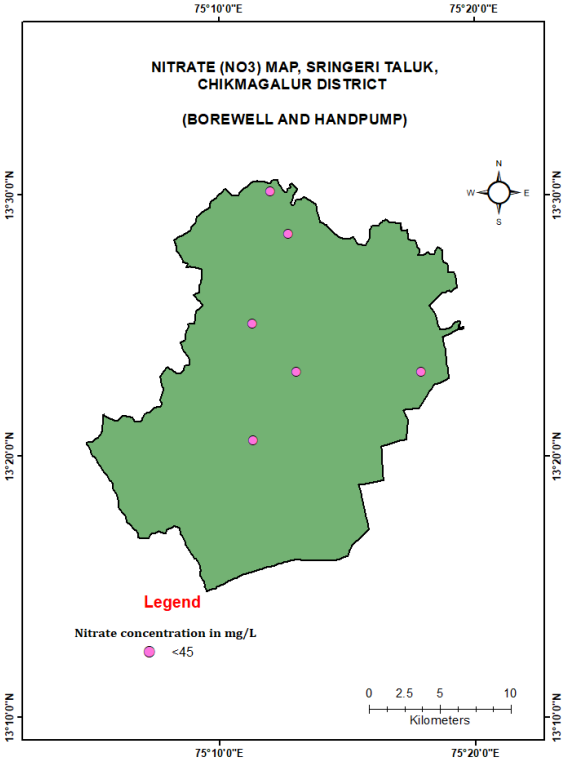


Figure 30: Nitrate map of fractured aquifer, Koppa taluk

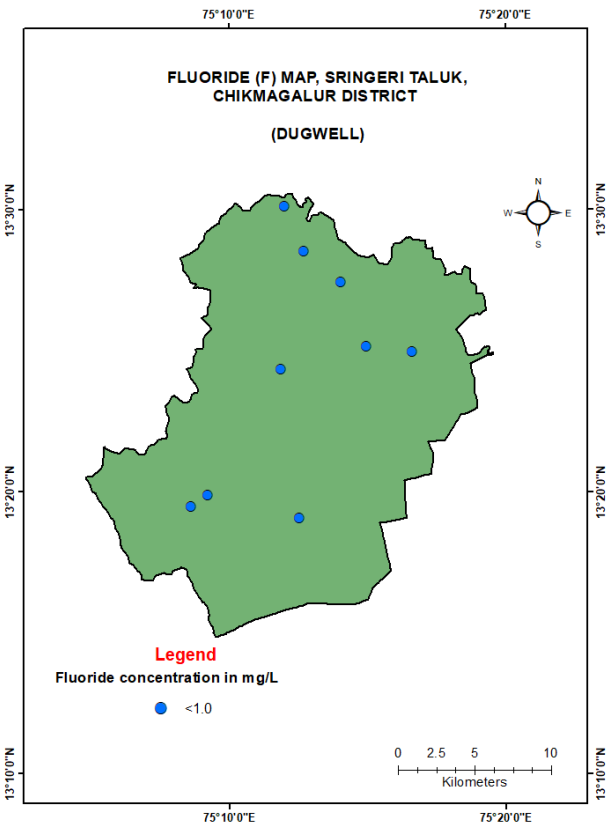


Figure 31: Fluoride map of phreatic aquifer, Koppa taluk

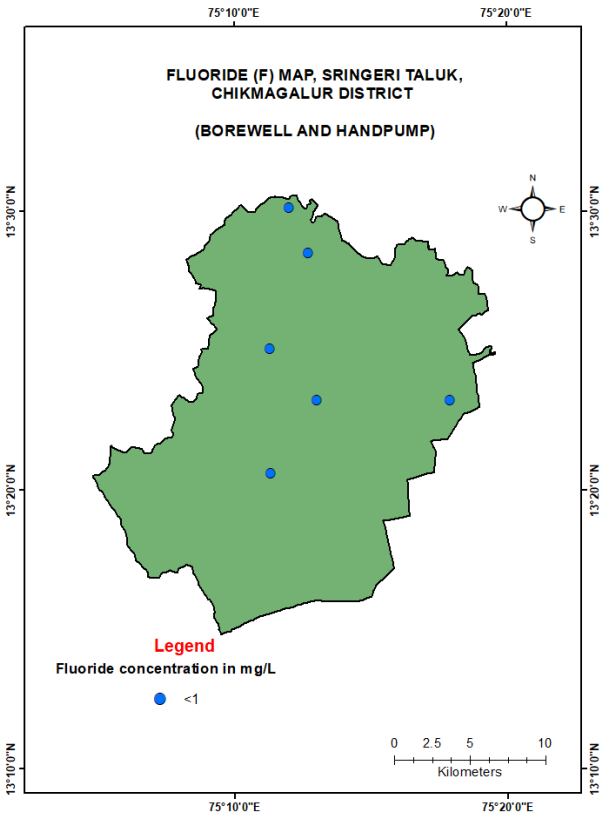


Figure 32: Fluoride map of fractured aquifer, Koppa taluk

3.3Groundwater Issues:

- Low stage of groundwater extraction (28.17%).
- All most all areas in Sringeri, are hilly and therain fall is also high (1911to 4046 mm).This rainfall leads to an excessively fast recharge of local groundwater levels, causing the water table to rise above the land surface. Groundwater flooding occurs as a result of heavy rainfall.
- Intense rainfall up to 3000 mm in this terrain in a short spell poses challenges to harvest water for both agricultural purposes and in the long duration interest of forest rejuvenation and conservation of ecology.
- Peak summer period scarcity of water in the hilly areas.

3.4 Status of Ground Water Development:

Groundwater development in the taluk is very low (28.17%) due to the following reasons:

(i) Hilly and undulating terrain condition

(ii) Uneven distribution of aquifers

(iii) Gram panchayats provide spring water flowing out of surrounding hills through pipeline distribution to the villages for domestic use. Farmers also use this water through diversion channels for agricultural activities.

(iv) The hilly terrain limits the availability of cultivable land.

(v) The farmers with small land holding depend mainly on the rainwater and water available in the shallow wells.

(vi) The abstraction structures, dug-wells and bore wells constructed/existing are mainly tapping the aquifers within depth range 3.9 to 9.2mbgl and 75 to 120mbgl respectively.

(vii) The major ground water developmental activities are concentrated in the valley regions, along the banks of rivers/streams and a moderate development found in the undulating land/plateau. The ground water extraction for irrigation is practiced through shallow abstraction structures in the taluk.

4.0 GROUND WATER RESOURCE ENHANCEMENT, DEVELOPMENT AND MANAGEMENT PLAN

4.1 Resource Enhancement by Supply Side Interventions

The overall stage of ground water development is 28.17% as per GEC 2022. The area feasible for recharge in the taluk is 326 sq.km as per Master Plan for artificial recharge, Karnataka and Goa,2020 (Figure 27). However, out of 326 sq.km area,303.18 sq.km area is hilly area. Considering the copious volume of non-committed monsoon runoff available, it is proposed to construct water harvesting structures in hilly areas as well as artificial recharge (AR) structures in undulating terrain as to enhance the ground water resources. The surface surplus non-committed runoff availability is 2973.9 ham, which is considered for planning of structures. For this, a one (1) sub surface dyke, 27 percolation tanks,4 filter beds and 154 check dams /vented dams are proposed. The volume of water expected to be conserved/recharged @75% efficiency is 2230.4ham through these AR structures. The approximate cost estimate for construction of these structures is Rs. 2093.414 Lakhs. However, the figures given are tentative and pre-field studies / DPR are recommended prior to implementation of these recharge structures.

The details pertaining to proposed recharge structures, cost estimates and likely Recharge benefits for Sringeri taluk, Chikmagalur district have been carried out and given in below Tables 14a.

Table14a: Quantity of non-committed surface runoff and expected recharge through AR and water conservation structures (As per Master Plan for artificial recharge, Karnataka and Goa,2020)

Artificial Recharge Structures	**Sringeri taluk**
Area Feasible for Artificial Recharge	326sq km
Non-committed monsoon runoff available (Ham)	2973.9
Number of Check Dams/Vented dams	154
Number of Percolation Tanks	27
No. of filter beds	4
Number of subsurface dykes	1
Tentative total cost of the project (Rs.In lakhs)	2093.414
Expected recharge (Ham)	2230.4
Additional irrigation potential (lakh hectares)	0.027

As per NAQUIM study, the area feasible for artificial recharge is about 141 sq.km excluding the hilly area with slope >20° and high drainage density which causes intense runoff. 77 numbers of check dams/vented dams and 14 numbers of percolation tanks are proposed to be constructed in the piedmont areas and valley areas. In the hilly parts, contour trenches, vegetative checks, boulder checks may be constructed to arrest soil erosion and rain water harvesting. **Figure 33** shows the area feasible for artificial recharge in Sringeri taluk as per NAQUIM study. The tentative locations of proposed artificial recharge structures is given in Annexure-I and Annexure-II. The details pertaining to proposed recharge structures, cost estimates and likely recharge benefits for Koppa taluk, Chikmagalur district have given in below Table 14b.

Table 14b: Expected recharge through AR and water conservation structures (As per NAQUIM study)

Artificial Recharge Structures	**Sringeri taluk**
Area Feasible for Artificial Recharge	141 sq km
Number of Check Dams/Vented dams	77
Number of Percolation Tanks	14
Expected recharge	11.43 mcm/1143 ham
Tentative total cost of the project (Rs.In lakhs)	1050

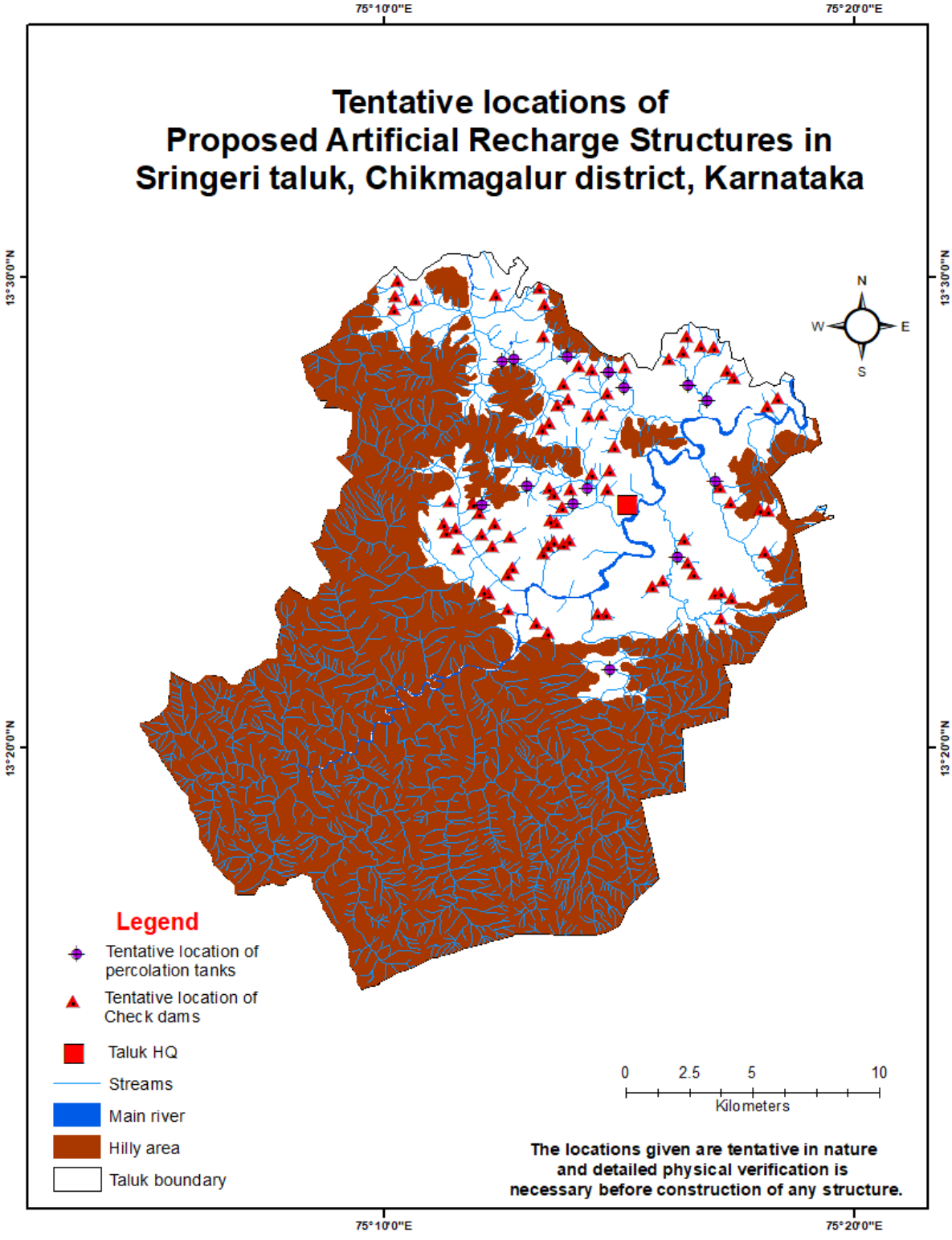


Figure 33: Area feasible for artificial recharge in Sringeri taluk as per NAQUIM study.

4.2 Ground Water Development Plan

In Sringeri taluka, the present stage of ground water extraction (2022) is 28.17 % with annual extractable resource of 2743.81 ham and total extraction of 773.01 ham. The ground water draft for irrigation purpose is 704.25 ham, thus indicating that ground water irrigation needs to be encouraged in the area. Also, the less ground water development is most probably linked to the mountainous and hilly terrain, extensive availability of base flow water for irrigation and limited area for agriculture. To overcome these, it is imperative to have a robust ground water resource development plan for the area, which can be implemented in scientific manner. The implementation of the plan needs to based on site specific detailed hydrogeological, geophysical and scientific surveys for pinpointing the sites for construction of dugwells and borewells.

In view of above, the focus of proposed ground water development plan is to up the ante of ground water development from the present 28.17% to 60% in a systematic way by adopting scientific approach. About 1143dugwells (15-30 m depth; 3 to 5 m diameter at Rs. 3.00 lakh/dugwell) are recommended to be constructed in feasible areas due to shallow groundwater table. The total expenditure proposed to be incurred will Rs. 34 Cr for dugwells. Drilling of borewell should be only in exigency, for use during the lean summer period. The detailed ground water development strategy to uplift the ground water use in the feasible areas is presented in **Table15**.

Table – 15: Feasibility of additional GW abstraction structures based on GWRA 2020 availability

Balance GWR available to make SOE 60%	DW unit draft	BW unit draft	No. of DW feasible @ 25% with unit draft of 0.6 ham	No. of BWs feasible @ 10% with unit draft of 0.9 ham	Cost of Proposed DW's/year @ unit cost of Rs. 3 lakhs	Cost of Proposed BW's @ unit cost of Rs. 2 lakhs
873.276	0.6	0.9	1143	335.3306667	342,900,000	67066133.33

Lot of base flow is available in the streams and rivers of the taluk during non-monsoon period (December to April), this base flow can be harvested by construction of vented dams at suitable places. The water retained in these vented dams can be utilised for domestic water supply to villages and towns located in the area as the villages and towns located in the area face shortage of drinking water during peak summer. The water retained in vented dams can also be utilised for lift irrigation.

- **Additional area of irrigation**

After adopting various water harvesting and recharge measures and its resultant savings, an additional area of 0.027 lakh hectare additional area may be brought under irrigation.

4.3Ground water resource enhancement by demand side interventions: At present maximum irrigation is by rain water. The micro irrigation practices like drip and sprinkler irrigation is practiced mostly by big plantation owners only. However, in long run the practice of efficient irrigation techniques will add to the ground water resource in large extent.

4.4 Other interventions proposed:

- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Mandatory roof top rain water harvesting in urban and semi-urban areas.
- Build up awareness among local village/urban community about proper use of groundwater resource.

5.0 SUMMARY AND RECOMMENDATIONS

The main ground water issues are low stage of extraction, groundwater flooding and high runoff. The summary of ground water management plan of Koppa taluk is given in table-16.

Table 16: Summary of Management plan of Koppa taluk

Stage of GW Extraction and Category (2020)	28.17 %, Safe
Annual Extractable GW Resource (Ham)	2743.81
Total Extraction (Ham)	773.01
Ground Water Draft for Irrigation (Ham)	704.25
Ground Water Resource Enhancement by Supply side Interventions as per Master Plan Artificial Recharge in Karnataka and Goa,2020	
No of Proposed AR structures SSD PT CD/VD FB	 1 27 154 4

Expected Additional Recharge to GW due to AR (Ham)	2230.4
Additional Irrigation Potential that can be created (lakh Ha)	0.027
Total Estimated Expenditure (Rs. in lakhs)	2093.414
Ground Water Resource Enhancement as per NAQUIM study	
Number of Check Dams/Vented dams	77
Number of Percolation Tanks	14
Expected recharge	11.43 mcm/1143 ham
Tentative total cost of the project (Rs.In lakhs)	1050
Ground Water Resource Development Plan	
Balance GWR available to enhance SOE 60% (Ham)	873.276
No. of wells proposed **DW** – Depth: 15 to 30 m, Dia: 3 to 5 m, Unit Cost –Rs. 3.00 lakh, Av. Annual Gross draft – 0.6 ham **BW** – Depth: 40 to 100 m, Dia: 150 mm, Unit Cost – Rs. 2.00 lakh, Av. Annual Gross draft – 1.50 ham	 1143 335
Total Estimated Expenditure (Rs. in Cr.)	40.99
Increase in Stage of GW Extraction (%)	28.17 to 60

As per the resource estimation – 2022, Sringeri taluk falls under safe category with the stage of ground water extraction is 28.17 %. But there is need to formulate management strategy to tackle the water scarcity related issues in the taluk in the summer days to avoid water crisis in the future. It is suggested to adopt a scientific and multi-pronged ground water management strategy covering supply side interventions, demand side interventions, ground water development interventions and ground water quality protection aspects as mentioned in the management plan suggested above.

Ground water resource development: In Sringeri taluka, the present stage of ground water extraction (2022) is 28.17 % with annual extractable resource of 2743.81 ham and total extraction of 773.01 ham. The ground water draft for irrigation purpose is 704.25 ham, thus indicating that ground water irrigation needs to be encouraged in the area. In view of above, the focus of proposed ground water development plan is to up the ante of ground water development from the present 28.17% to 60% in a systematic way by adopting scientific approach. About 1143dugwells (15-30 m depth; 3 to 5 m diameter @ Rs. 3.00 lakh/dugwell)

are recommended to be constructed in feasible areas due to shallow groundwater table. The total expenditure proposed to be incurred will Rs. 34 Cr for dugwells.

Ground water resource enhancement by demand side interventions: At present maximum irrigation is by rain water. The micro irrigation practices like drip and sprinkler irrigation is practiced mostly by big plantation owners only. However, in long run the practice of efficient irrigation techniques will add to the ground water resource in large extent.

Finally, Roof top rain water harvesting, mass awareness programmes and participatory groundwater management are suggested for better management of groundwater resources.

ANNEXURE-I

Tentative locations of proposed Check Dams/ Vented dams in Sringeri taluk

Sl.no.	Longitude	Latitude	Village
1	75.2252	13.3740	NEMMAR
2	75.2208	13.3774	NEMMAR
3	75.2864	13.3790	HERUR
4	75.2458	13.3805	KOCHAVALLI
5	75.2427	13.3807	KOCHAVALLI
6	75.2109	13.3823	YEDAHALLI
7	75.2904	13.3860	HERUR
8	75.2845	13.3877	VAIKUNTAPUR
9	75.2042	13.3880	YEDAHALLI
10	75.2866	13.3882	HERUR
11	75.2022	13.3889	YEDAHALLI
12	75.2620	13.3903	BETTGERI
13	75.2657	13.3924	BETTGERI
14	75.2106	13.3948	YADADAL
15	75.2767	13.3951	VAIKUNTAPUR
16	75.2124	13.3972	YADADAL
17	75.2748	13.3987	VAIKUNTAPUR
18	75.2234	13.4024	YADADAL
19	75.3018	13.4026	KIKARI
20	75.1933	13.4040	YEDAHALLI
21	75.2250	13.4045	YADADAL
22	75.2052	13.4047	GANDAGHATTA
23	75.2306	13.4057	ULUVALLI
24	75.2271	13.4063	YADADAL
25	75.2328	13.4069	ULUVALLI
26	75.2734	13.4072	MENASE
27	75.2117	13.4081	GANDAGHATTA
28	75.2015	13.4089	GANDAGHATTA
29	75.1889	13.4097	YEDAHALLI
30	75.1922	13.4109	YEDAHALLI
31	75.1880	13.4127	RUSHYASHRINGAPURA
32	75.2061	13.4128	GANDAGHATTA
33	75.2280	13.4131	GANDAGHATTA
34	75.2258	13.4138	GANDAGHATTA
35	75.2005	13.4166	KOGODU
36	75.3033	13.4173	KIKARI
37	75.3004	13.4178	KIKARI
38	75.2300	13.4186	HONNALLI
39	75.1985	13.4196	KOGODU
40	75.2898	13.4203	MASIGE
41	75.1900	13.4205	RUSHYASHRINGAPURA
42	75.2271	13.4233	HONNALLI
43	75.2462	13.4249	BELANDUR
44	75.2330	13.4250	HONNALLI
45	75.2256	13.4252	GANDAGHATTA
46	75.2861	13.4256	MASIGE
47	75.2405	13.4301	HONNALLI
48	75.2467	13.4315	BELANDUR
49	75.2485	13.4401	BELANDUR

50	75.2229	13.4462	DAREKOPPA
51	75.2255	13.4486	DAREKOPPA
52	75.2394	13.4511	BELANDUR
53	75.2439	13.4514	MELINKOPPA
54	75.3029	13.4542	ADDAGADDE
55	75.2282	13.4546	DAREKOPPA
56	75.2321	13.4569	DAREKOPPA
57	75.3064	13.4572	ADDAGADDE
58	75.2459	13.4589	MELINKOPPA
59	75.2306	13.4625	DAREKOPPA
60	75.2909	13.4644	KELKOPPA
61	75.2887	13.4668	KELKOPPA
62	75.2406	13.4672	MELINKOPPA
63	75.2523	13.4679	MELINKOPPA
64	75.2360	13.4685	MELINKOPPA
65	75.2679	13.4712	KELKOPPA
66	75.2730	13.4734	KELKOPPA
67	75.2841	13.4752	KELKOPPA
68	75.2792	13.4758	KELKOPPA
69	75.2743	13.4791	KELKOPPA
70	75.2233	13.4793	NELANDUR
71	75.1705	13.4888	HASANBALU
72	75.2239	13.4903	NELANDUR
73	75.1781	13.4920	HASANBALU
74	75.1710	13.4935	HASANBALU
75	75.2065	13.4936	BEGARU
76	75.2220	13.4964	NELANDUR
77	75.1718	13.4989	HASANBALU

ANNEXURE-II

Tentative locations of proposed Percolation tanks in Sringeri taluk

Sl.no.	Longitude	Latitude	Village
1	75.2468	13.3612	ARUR
2	75.2708	13.4010	VAIKUNTAPUR
3	75.2014	13.4196	KOGODU
4	75.2341	13.4198	HONNALLI
5	75.2390	13.4254	HONNALLI
6	75.2175	13.4260	GANDAGHATTA
7	75.2841	13.4276	MASIGE
8	75.2814	13.4565	KELKOPPA
9	75.2520	13.4611	MELINKOPPA
10	75.2747	13.4619	KELKOPPA
11	75.2467	13.4666	MELINKOPPA
12	75.2088	13.4701	MIGA
13	75.2130	13.4712	NELLUR
14	75.2317	13.4720	NELANDUR

ANNEXURE-III

List of Key wells

sl no.	Taluk	Village	Type	Longitude	Latitude	Total depth drilled(mbgl)mtr	Depth of casing pipe lowered (mbgl)mtr	Water tapped zones fractures	yield of well lps	Location
1	Sringeri	Nemmaru	BW	75.2169	13.3867	152.4	24.34	146.3	0.5	Nayara Petrol bunk at junction
2	Sringeri	Kellar	BW	75.1932	13.4187	60.96	42.67	45.72	1.5	Land of Sh.Ratnakar,Sample could not be collected as motor has fallen into the borewell
3	Sringeri	Nalluru	BW	75.2117	13.4747	91.44	18.28	30.48	0.7	House of Sh.Bhaskarachari
4	Sringeri	Begaru	BW	75.2001	13.502	152.4	12.19	140.21	1	Plantation of Sh.Shrinath
5	Sringeri	Kigga	HP	75.1875	13.4179	not available	not available	not available	not available	100m before gram panchayat office and village gate
6	Sringeri	Mathuvalli	HP	75.1885	13.3433	not available	not available	not available	not available	Adjacent to main road towards village entrance
i	Sringeri	Gulaganjemane	DW	75.1537	13.3313	10	cement casing entirely			Roadside Adjacent to Umamaheshwari temple
ii	Sringeri	Kerekatte	DW	75.1436	13.3246	9.8	cement casing entirely			Opposite to Anganwadi and Primary school at village entrance
iii	Sringeri	Hulgarmane Adikiruru grama	DW	75.2088	13.3179	7.2	cement casing entirely			House of Sh.Sudesh
iv	Sringeri	Nemmaru	DW	75.2178	13.3885	8.71	cement casing entirely			Govt.Higher Secondary school premises