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

Kollegal Taluk, Chamarajanagara District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

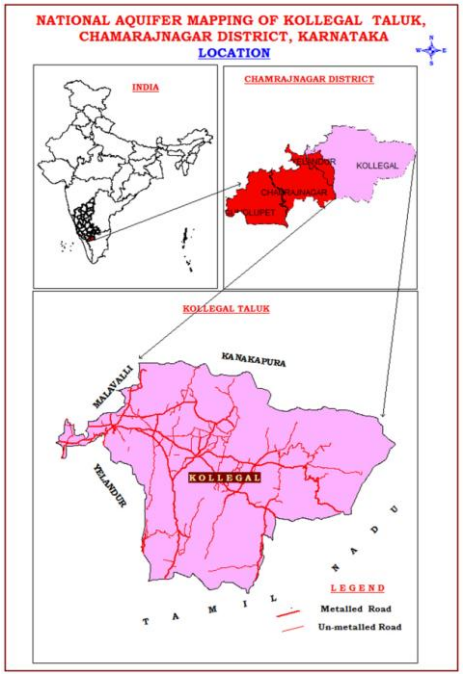
FOR OFFICIAL USE ONLY
No. *SWR/RP/NQM/2022-23/05*

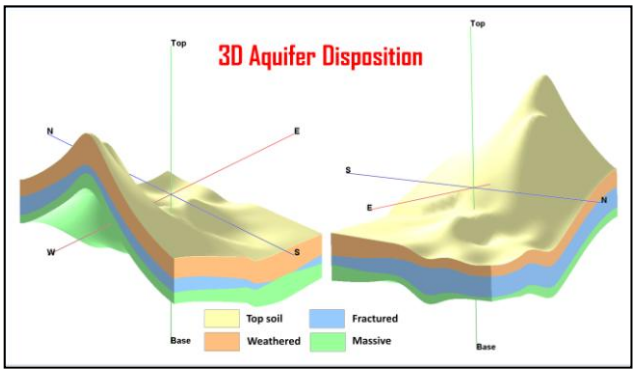
भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास
एवं गंगा संरक्षण विभाग
केन्द्रीय भूमिजल बोर्ड
दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

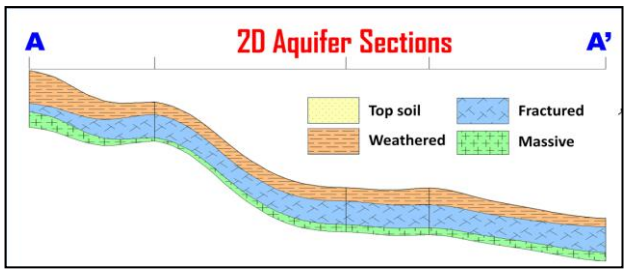
Government of India
Ministry of Jal Shakti
Department of Water Resources,
River Development &
Ganga Rejuvenation
Central Ground Water Board
South Western Region, Bengaluru

AQUIFER MAPS AND MANAGEMENT PLAN, KOLLEGAL TALUK, CHAMRAJNAGARA DISTRICT, KARNATAKA STATE

(AAP – 2020-2021)







By

Dr. S.S. Vittala, Scientist 'B', CGWB, SWR, Bengaluru

JUNE 2022

AQUIFER MAPS AND MANAGEMENT PLAN, KOLLEGAL TALUK, CHAMRAJNAGARA DISTRICT, KARNATAKA STATE

(AAP – 2020-2021)

Table of Contents

AQUIFER MAPS AND MANAGEMENT PLAN, KOLLEGAL TALUK, CHAMRAJNAGARA DISTRICT, KARNATAKA STATE

1 SALIENT INFORMATION

Name of the taluk: Kollegal

District: Chamarajanagara

State: Karnataka

Area: 2811 sq.km.

Population: 3,57,853

Annual Normal Rainfall: 587 mm

1.1 Study area

Aquifer mapping studies have been carried out in Kollegal taluk, Chamarajanagara district, Karnataka state under National Aquifer Mapping Programme. The taluk is covering an area of 2811 sq.kms. The geographical extents of Kollegal taluk of Chamarajanagara district is located between North Latitudes 11°44'45.91'' and 12°19'46.61" and East Longitudes between 76°57'34.16" to 77°47'19.12" and is falling in Survey of India Toposheets bearing no. 57 D/16, 57 H/3, H/4, H/7, H/8, H/12, 58 E/1, E/5 and E/9. The study area is bounded on the North by Malavalli taluk of Mandya district , Kanakapura taluk of Ramnagara district and T.Narasipura taluk of Mysuru district, Yelandur and Chamarajanagara taluks of Chamrajanagar district to the West and South and East is shared by the state of Tamil Nadu. Kollegal town is taluk head quarter and there are about 85 villages falling under its jurisdiction. Location map of Kollegal taluk of Chamarajanagara district is presented in Fig. 1.

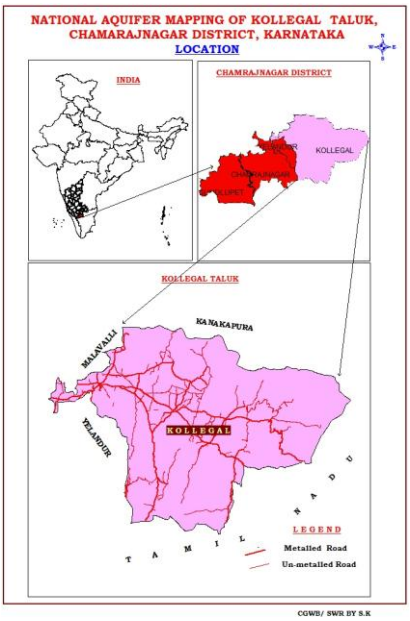


Fig. 1: Location map of Kollegal taluk.

1.2 Population

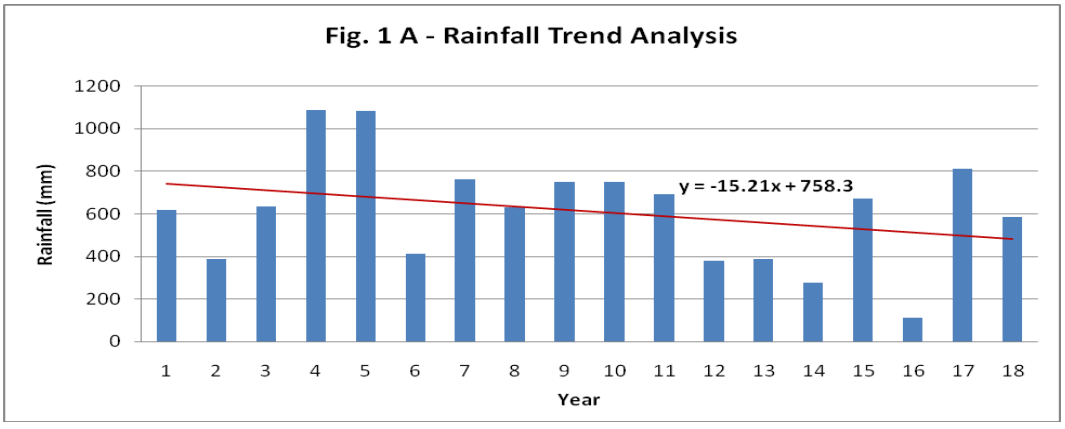
According to 2011 census, the population in Kollegal taluk is 3,57,853. Out of which 1,81,388 are males while 1,76,465 are females. The average sex ratio is 962. The taluk has an overall population density of 127 persons per sq.km. The sex-ratio of Kollegal taluk is around 973 which is equal to average ratio of Karnataka state. The literacy rate of Kollegal taluk is 57.1%, out of which 62.71% males are literate and 51.33% females are literate. The decadal change in population for the period (2001-2011) is 6.2% , it is 1.9 % in rural and 29.70% in urban.

1.3 Rainfall

Kollegal taluk receives rainfall from south west monsoon from June to September and north east monsoon from October to December. During May and retreating monsoon months, the area gets rainfall in association with thunderstorm followed by heavy pre-monsoon/retreating showers. The monthly rainfall data from 2001 to 2018 is given in Table 1. The rainfall data reveals that the annual rainfall ranges from 112 to 1090 mm. The highest annual rainfall is observed in the year 2004 while it is low in the year 2016. The annual rainfall trend is falling @ 15.21 mm/year as evident from Fig. 1A.

Table 1: Monthly rainfall data of Kollegal taluk

Year	JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	MON	OCT	NOV	DEC	POST	ANNUAL
2001	0	0	0	98	25	123	5	36	97	190	328	130	37	0	167	618
2002	0	0	12	14	69	95	8	59	13	35	115	126	51	0	177	387
2003	0	0	73	33	45	151	52	70	139	52	313	138	35	0	173	637
2004	0	0	14	119	200	333	71	149	27	268	515	176	66	0	242	1090
2005	6	0	0	90	82	178	129	54	121	68	372	331	166	39	536	1086
2006	0	0	2	39	87	128	30	11	31	45	117	69	98	0	167	412
2007	0	0	0	55	48	103	74	73	111	121	379	180	60	42	282	764
2008	0	22	38	35	53	148	21	54	137	32	244	195	43	0	238	630
2009	0	0	0	97	158	255	41	39	129	111	320	39	61	77	177	752
2010	0	0	8	126	106	240	12	34	102	92	240	97	175	0	272	752
2011	0	0	20	127	101	248	0	60	121	0	181	88	175	0	263	692
2012	0	0	0	77	46	123	0	29	27	10	66	125	64	0	189	378
2013	0	0	22	110	0	132	0	29	27	10	66	125	64	0	189	387
2014	0	0			0	0	0	21	43	90	154	114	0	8	122	276
2015	0	0	0	114	15	129	65	0	47	95	207	162	176	0	338	674
2016	0	0	0	7	30	37	44	24	1	6	75	0	0	0	0	112
2017	0	0	37	10	136	183	0	0	216	268	484	117	0	29	146	813
2018	0	0	4	11	176	191	65	20	13	149	247	119	30	0	149	587



1.4 Agriculture & Irrigation

Agriculture is the main occupation in Kollegal taluk, Chamarajanagar district. Major Kharif crops are Maize, Paddy, Ragi, Sugarcane, Mulberry, Coconut, Cotton, etc. Main crops of Rabi season are Ragi. The water intensive crops like sugarcane and paddy are grown significantly in the taluk. The net irrigated area is 0.15 lakhs ha. It is also observed that net sown area accounts about 0.32 lakh ha as per District at a glance 2016-17 and the gross cropped area is 0.35 lakh ha as per District at a glance 2016-17. The cropping intensity is 107%. The details of the land utilization is given in Table 2. The land use and land cover map is given in Fig. 2.

The taluk falls under southern dry zone and southern transitional zone. Accordingly there are two cropping seasons namely Kharif and Rabi. Kharif season starts in the month of June/July and ends in September/October. Whereas the Rabi season starts middle of October and ends in the middle of February. The major Kharif crops irrigated in the taluk are paddy and vegetables where as the main Rabi crops are Ragi, Maize, Jowar, pulses, etc. The major commercial crops grown in the area are sugarcane, paddy and cotton. The taluk depends heavily on monsoon for agricultural operations.

There are no perennial rivers flowing in the taluk. However, seasonal river like, Cauveri flows along northern border of the taluk where small individual lift irrigation pump sets with pipelines could be considered depending on its feasibility. Groundwater is the major source of irrigation (54%) followed by Canal irrigation (24%) from KRS project (Cauvery river). Groundwater for irrigation in agriculture sector is developed through 4632 bore wells and 2570 dug wells. Groundwater development is low as canal water is made available for irrigation. The ground water thus extracted is utilized for irrigation by adopting different efficient water use irrigation practices such as sprinklers irrigations and drip irrigations. For irrigation, dug wells are common abstraction structures in canal command areas of the taluk which are supplementing irrigation during water shortage in summer months. As the major part of the taluk is hilly and covered by forest, groundwater development is low.

Table 2: Distribution of land utilization in Kollegal taluk.

Sl. No	Particulars	Area (ha)
1.	Forests (Lakh hectares)	1,93,000
2.	Land not available for cultivation	16000
3.	Net Sown Area (NSA)	32000
4.	Gross Cropped Area (GCA)	35000
5.	Cropping intensity (CI) (Percentage)	107%
6.	Net Irrigated Area (NIA) (hectares)	15000
7.	Percentage NIA to NSA (Percentage)	47%
8.	**Cropping pattern**	**Area (ha)**
	Paddy	9345
	Ragi	12537
	Total cereals	28195
	Total pulses	6438
	Total oil seeds	11965
	Sugarcane	4626
	Mulberry	3898

	Coconut	1676
	Cotton	9372

Source: Chamarajanagar district at a Glance (2016-17)

1.5 Geomorphology, Physiography & Drainage

In general, the geomorphology of the taluk is a table land comprising of plains to undulating as well as mountainous undulating plains and hills. The southern and eastern ghat ranges in the area converges into group of hills. The area forms an undulating table land, mountain ranges covered with forests in the southern and especially in the eastern portion. In plain land, the master slope runs from south to north towards Cauvery River. Normally, the slopes are covered by debris and they have filled the channels. The general elevation of the taluk is 658 m amsl. Physiographically, the taluk may be divided into two distinct units viz., mountainous terrain and flat plains. The major part of the area is hilly tract. The eastern and southern parts of the taluk forms a continuous hill ranges covered by forests. The major hill ranges are M.M.Hills in the eastern parts which forma hill range of 976 m amsl. The southern part of the taluk is covered with thick vegetation where as in the eastern parts are covered with shrubby jungle. The western part of the taluk adjoining Yelandur and T.Narasipura taluk are falling under flat plain physiographical unit. The elevation ranging from 640 to 660 m amsl. The flat terrain drained by the Rivers Cauvery and Suvarnavathi. The geomorphology map is given in Fig. 3.

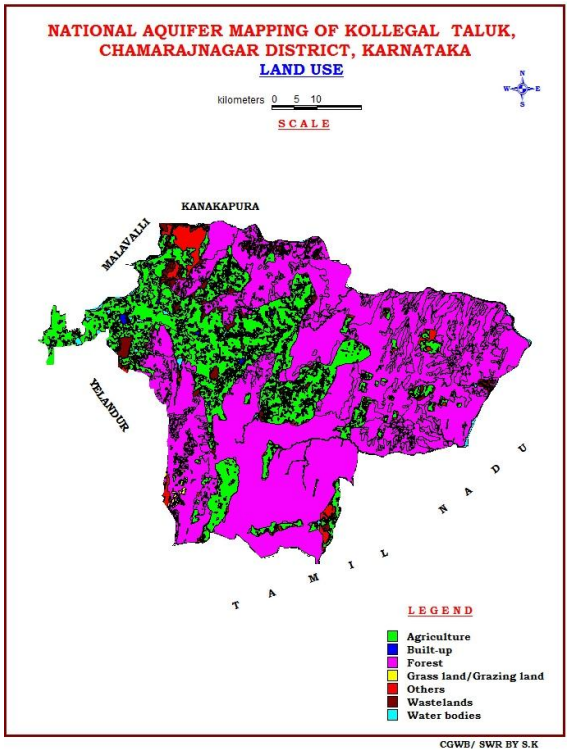


Fig. 2: Land Use and Land cover map.

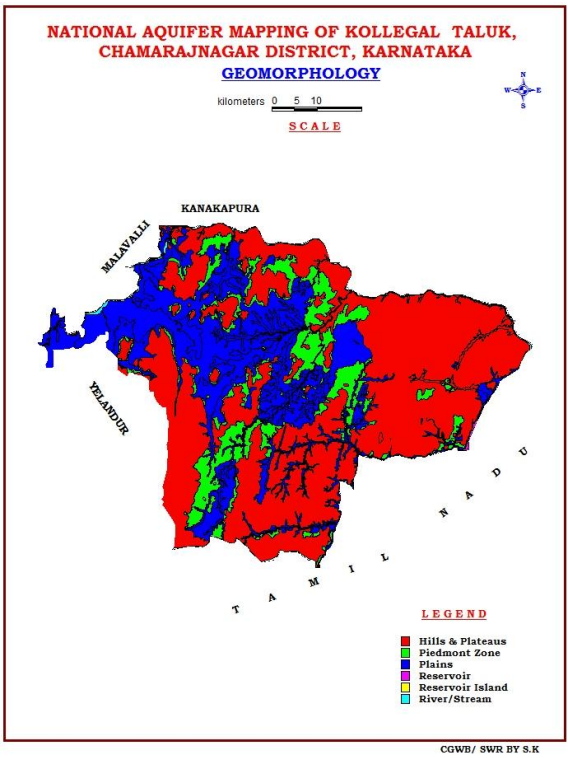


Fig. 3: Geomorphology map

The taluk forms a part of Cauvery river basin. All most all the area is drained by the river Cauvery and its tributaries along with number of ephemeral streams. The drainage pattern of the area can be described as dendritic in nature, having general south to north direction of flow. The most important river which drains the area is Cauvery and its tributaries like Suvarnavathi, Gundal, Hebbahalla, Thattehalla and Udutorehalla. The

southern and eastern parts of the taluk is drained by yet another tributary of Cauvery i.e. Palar River. The drainage map is given in Fig. 4.

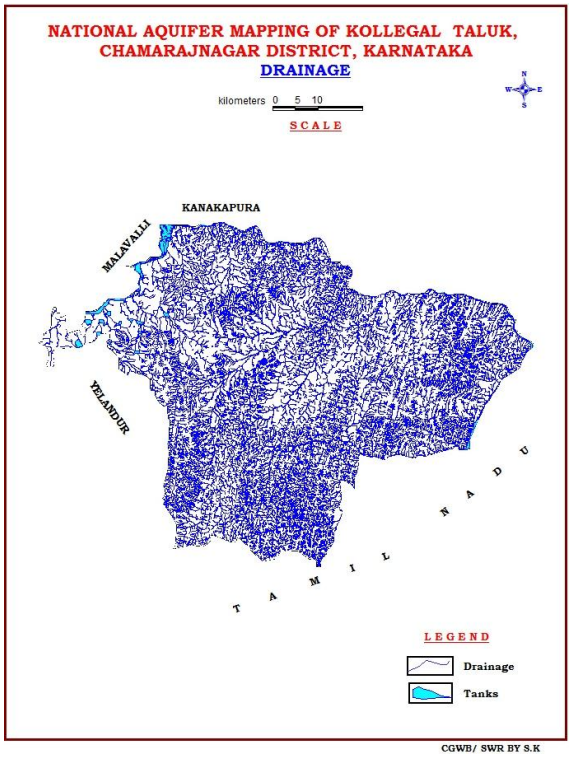


Fig. 4: Drainage map.

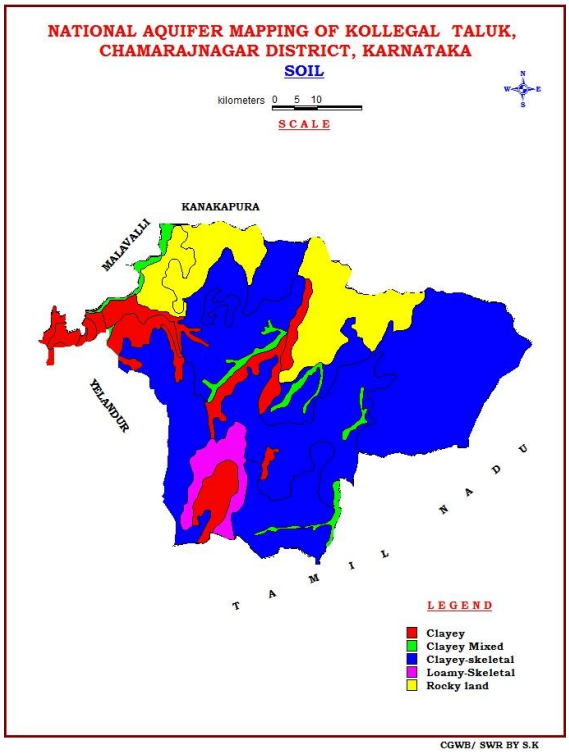


Fig. 5: Soil map

1.6 Soils

Soils in the taluk are derived from Gneissic and Charnockite rocks. Normally, red soils group are present in upland areas and the rest of the type along the streams flood plains and other areas. Less fertile soils are found on the mountain region, and undulating slopes towards eastern and southern parts of the taluk. Valley portions are generally covered with rich black silty soils. Alluvial tracts of the Cauvery, Suvernavathi and Gundal rivers have rich and fertile soils. To determine the infiltration characteristics of soil types, some infiltration tests were conducted using double ring infiltration method in the taluk earlier by CGWB through systematic hydrogeological surveys. The study indicates that the constant rate of infiltration is higher side in red gravelly type of soils in comparison with black clayey soils. Mixed soil type showed intermediate values of rate of infiltration. In undulating and mountainous terrain, the rainfall flows ad surface runoff in the major part of the area resulting low rate of recharge to groundwater. The soil map of Kollegal taluk is given in Fig. 5.

1.7 Ground water resource availability and extraction

As per the ground water resources estimation 2017 (able-3), the data on ground water resources shows that the net annual ground water availability is 14223 ham. The existing gross groundwater for irrigation is 9295 ham. The stage of ground water development is 71% and falling under 'Semi- Critical' category.

Aquifer wise total ground water resources down to 200 m depth are given in **Table-4** below as per 2017 estimations.

Table.3 Dynamic Ground Water Resource, Kollegal taluk (March 2017 Figures in Ham)

Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross GW Draft For Domestic And Industrial Water Supply	Existing Gross Ground Water Draft For All Uses	Allocation For Domestic And Industrial Use For Next 25 Years	Net Ground Water Availability For Future Irrigation Develop-ment	Existing Stage of Ground Water Development	Category
14223	9295	746	10042	976	4573	71%	SEMICRITICAL

Table 4: Present total Ground Water Resource (Ham) as per GEC 2017.

Taluk	Annual Replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (Down to 200m)	Dynamic + phreatic in-storage + fractured
Kollegal	14223	14674	2859	31756

1.8 Existing and future water demands (as per GEC-2017 and 2020)

The details of dynamic (Phreatic) ground water resources for Kollegal taluk as on March 2020 is shown in Table.5. It is observed that the stage of ground water extraction is increased in the taluk from 71 % to 82 % from 2017 to 2020. The net ground water availability for future irrigation is 786.32 ham.

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

Annual Extractable GW Resource (Ham)	GW Extraction for Irrigation Use (Ham)	GW Extraction for Industrial Use (Ham)	GW Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net GW Availability for future use (Ham)	Stage of GW Extraction (%)	Categorization
4578.93	3404.31	0.00	349.78	3754.08	388.31	786.32	81.99	Semi-Critical

1.9 Water level behavior

The water level data have been monitored from the representative dug well and borewells under NHS monitoring programme for both pre and post-monsoon seasons (Table 6). During premonsoon season water level ranges from 2.85 to 20.00 mbgl, whereas in postmonsoon it varies from 0.01 to 7.61 m bgl.

During pre-monsoon, water level map shows that in 10% of the area water level is upto 2 mbgl, in 10% of the area water level ranges between 2 and 5 mbgl, in 70 % of the area water level ranges between 5 and 10 mbgl and in 10% of the area water level ranges in between 10 and 20 mbgl. During post monsoon, water level map shows that in 60 % of the

area water level ranges in between 2 and 5 mbgl, in 20 % of the area water level ranges in between 5 and 10 mbgl. The pre-monsoon and post monsoon water level maps are shown in **figure 6 and 7** respectively.

Table 6: Depth to water level (Pre & Post monsoon 2019)

Sl. No.	Well type	Village name	Depth of the well (m bgl)	MP (m agl)	DTWL (m bgl) (Pre-monsoon 2019)	DTWL (m bgl) (Post-monsoon 2019)
1	Bore Well	Kollegal	51.50	0.60	36.40	4.92
2	Dug Well	Hanur	22.00	1.00	9.75	7.61
3	Dug Well	Kombutuki	20.00	0.80	20.00	0.10
4	Dug Well	Kunthur	12.02	0.82	12.02	1.83
5	Dug Well	Kurubaradoddi	12.08	0.10	5.00	1.50
6	Dug Well	Mahadeswarabetta	9.70	0.94	4.9	2.56
7	Dug Well	Palanimedu	12.00	0.85	8.84	7.22
8	Dug Well	Ramapura	10.00	0.55	2.85	1.14
9	Dug Well	Thagarapura	11.00	1.07	11.00	0.01
10	Dug Well	Uttaballi	10.50	0.80	9.92	1.41

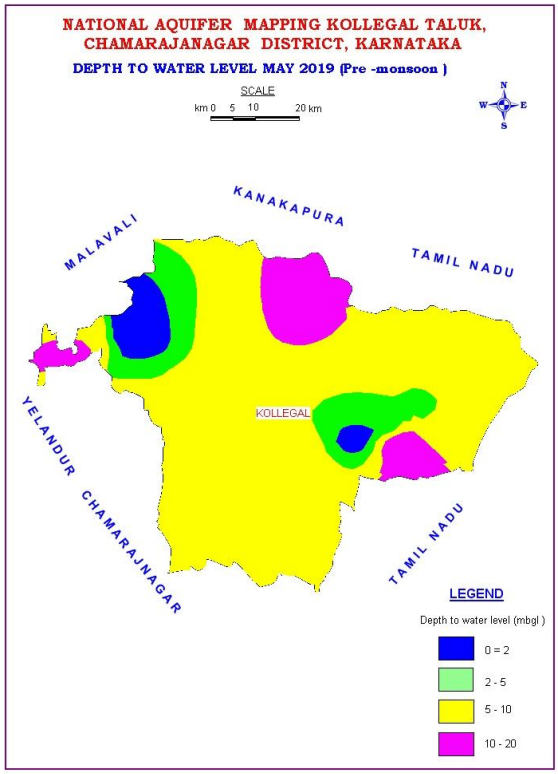


Fig. 6: Depth to water level map (Pre-monsoon 2019)

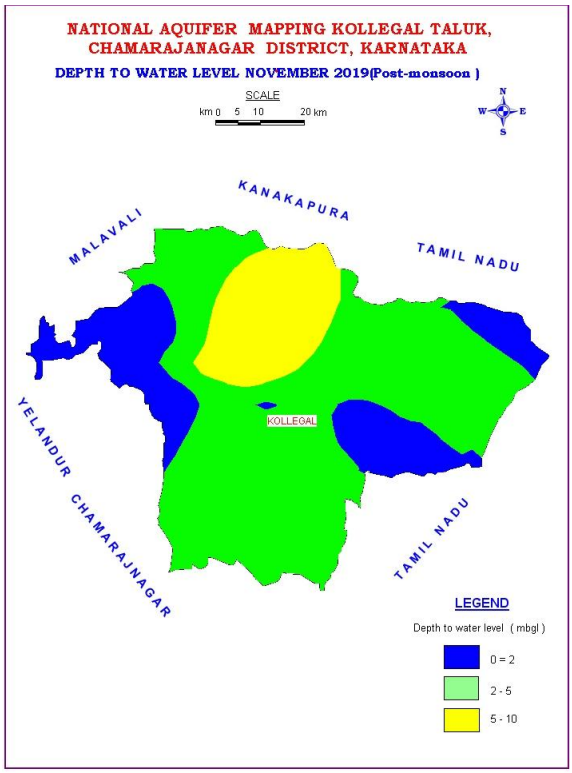


Fig. 7: Depth to water level map (Post-monsoon 2019)

2 AQUIFER DISPOSITION

In Kollegal taluk, there are mainly two types of aquifer systems;

- **Aquifer-I (Phreatic aquifer)** comprising weathered Charnockite and Grantic Gneisses.
- **Aquifer-II (Fractured aquifer)** comprising Fractured Charnockite and Grantic Gneisses.

Geologically, the taluk forms a high grade Granulites. The rock types exposed in the area are Charnockites occurring as large lentoid bodies forming hill ranges. These are followed by granitic gneisses in northern part of the taluk. Very limited amount of recent alluvium is distributed all along and adjacent to river courses. These hard formations viz., Charnockites and Granitic gneisses are intruded by basic and ultra basic intrusive.

In Kollegal taluk, Charnockites and Granitic gneiss are the main water bearing formations**.** Ground water occurs within the weathered and fractured formations under water table condition and semi-confined condition. The geology map is given in Fig. 8.

In this taluk bore wells were drilled from a minimum depth of 104.70 mbgl to a maximum of 201.0 mbgl. Depth of weathered zone ranges from 12.10 mbgl to 34.60 mbgl.

Ground water exploration reveals that aquifer-II fractured formation was encountered between the depth of 18 to 163 mbgl. Yield ranges from 0.014 to 14.13 lps. The basic characteristics of each aquifer are summarized in Table 4. The basic characteristics of weathered and fractured aquifers is given in Table 5. The 3D aquifer disposition models, 2D aquifer sections and 3D aquifer fence diagrams have been prepared and presented in Fig. 9, 10 & 11.

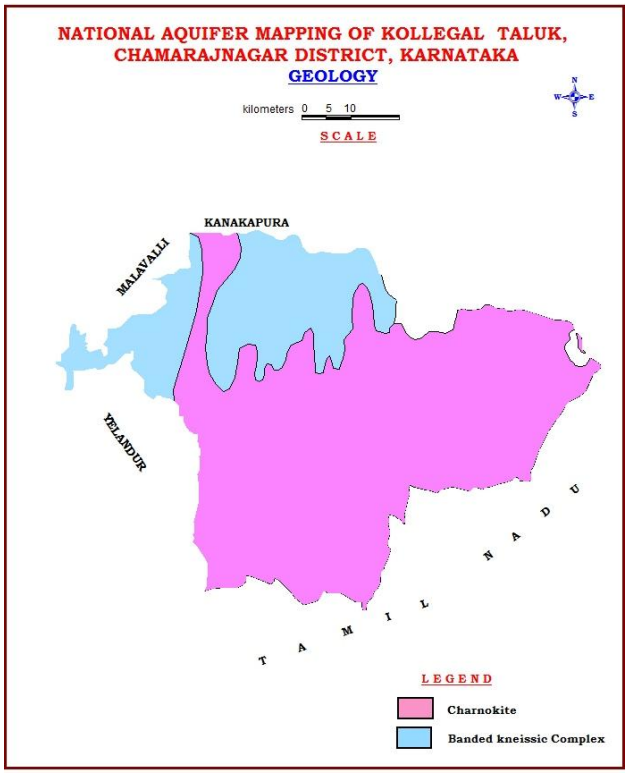


Fig. 8: Geology map of Kollegal taluk.

Table 7: Details of Ground Water Exploration

Sl. No.	Name	Latitude	Longitude	Total depth (mbgl	Casing (mbgl	DTWL (mbgl)	Yield (lps)	Lithology
1	Chennalinganahali EW	12.088889	77.240278	200.00	34.60	33.50	0.0138	Charnockite
2	Ajjipura EW	12.043056	77.352778	201.00	12.54	1.36	1.22	Charnockite
3	Hanur EW	12.084722	77.300000	200.00	14.20	10.14	0.59	Charnockite
4	Halagapura EW	12.175000	77.386111	121.96	24.00	5.91	10.12	Granitic gneiss
5	Halagapura OW	12.173611	77.384722	110.00	29.90	5.69	14.13	Granitic gneiss
6	Kottanur EW	12.213889	77.266667	200.00	20.75	Dry	Dry	Granitic gneiss
7	Lokkanahalli EW	12.029167	77.248611	193.15	24.50	16.50	0.08	Charnockite
8	Kempaiahnahatti	12.033333	77.433333	190.10	30.00	35.40	0.08	Charnockite

Sl. No.	Name	Latitude	Longitude	Total depth (mbgl	Casing (mbgl	DTWL (mbgl)	Yield (lps)	Lithology
	EW							
9	Palya EW	12.184722	77.168889	132.15	24.50	8.97	6.88	Charnockite & Granitic gneiss
10	Palya OW	12.187500	77.168889	104.70	24.00	8.30	11.00	Charnockite & Granitic gneiss
11	Kollegal EW	12.133333	77.115278	171.80	28.50	9.06	4.36	Granitic gneiss
12	Kollegal OW	12.137500	77.115278	132.15	29.30	8.84	5.54	Granitic gneiss
13	Chilukavadi EW	12.116667	77.008333	191.10	12.10	15.48	0.14	Granitic gneiss

Table 8: Basic characteristics of weathered and fractured aquifer.

Aquifers	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Weathered Granitic Gneiss / Charnockite	Fractured / Jointed Granitic Gneiss / Charnockite
Thickness range (mbgl)	12 - 35	Fractures upto 200 mbgl
Depth range of occurrence of fractures (mbgl)	6-12	18 - 163
Range of yield potential (lps)	Poor yield	0.014 to 14.13
Specific Yield	2%	0.01%
Quality Suitability for Domestic &Irrigation	Suitable	Suitable

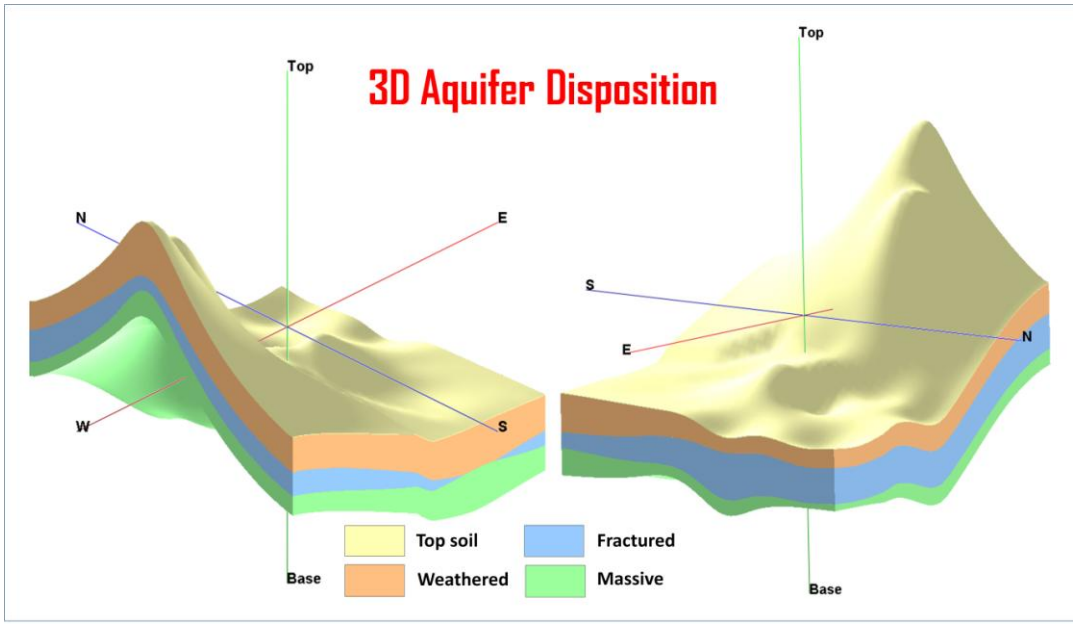


Fig. 9: 3D Aquifer models for Kollegal taluk.

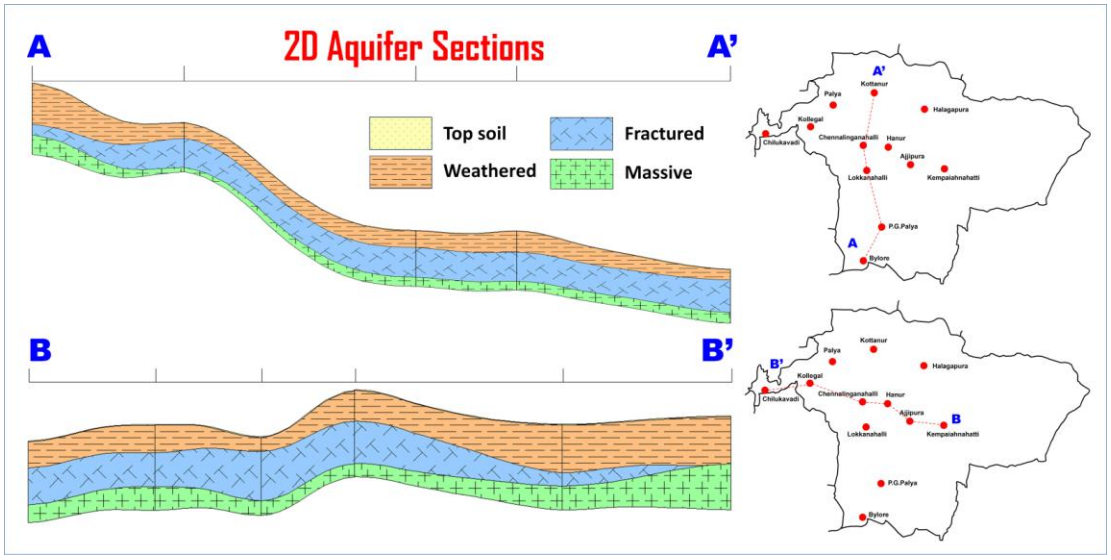


Fig. 10: 2D Aquifer sections for Kollegal taluk.

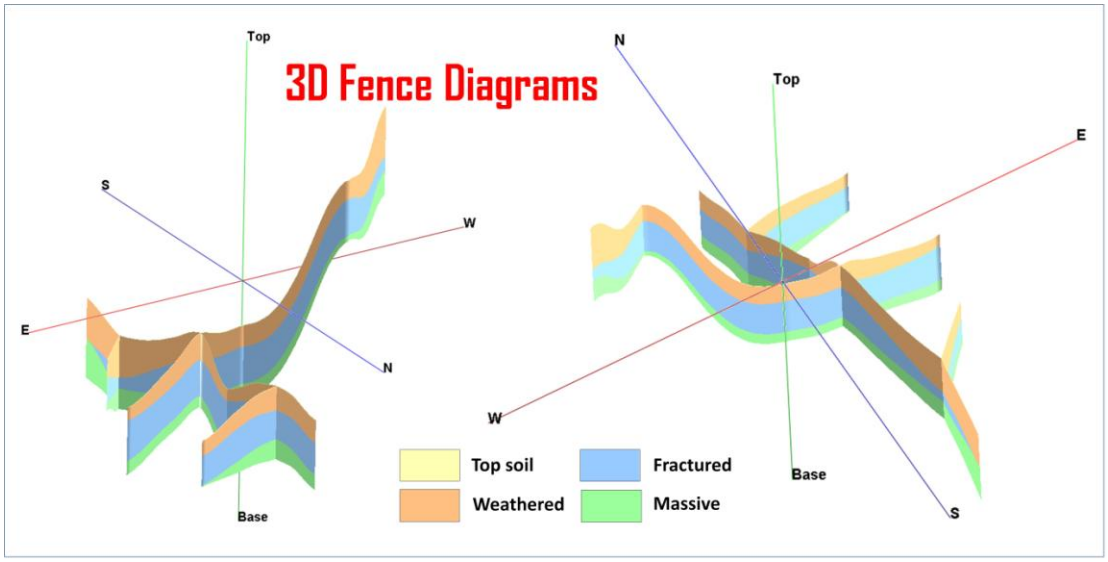


Fig. 11: 3D Aquifer fence diagrams for Kollegal taluk.

3 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

The main ground water issues are Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, declining water level trend which are all inter-related or inter dependent and Inferior ground water quality due to nitrate contamination in major part of the area.

3.1 Comparison of Ground Water Resource and Extraction

The Dynamic Ground Water Resource 2017 and as on 2020 have already been summarised above and are shown in Table 4 and 5. The comparison of the resource as on 2013, 2017 are summarised below, the GWRA 2020 data has not been considered as the taluk was bifurcated into 2 taluka. It is observed that the ground water availability, draft and stage of development has increased during the year 2017 as compared to 2013.

Table – 8: Comparison of ground water availability and draft scenario

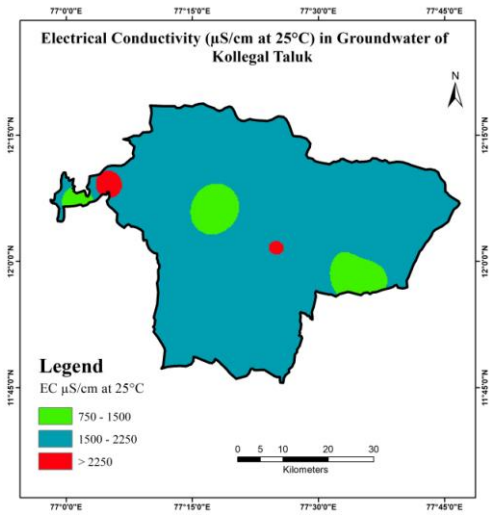
GW availability (ham)	GW draft (ham)	Stage of GW Development (%)	GW availability (ham)	GW draft (ham)	Stage of GW Development (%)
2013			**2017**		
12959.84	8229.66	64	14223	10042	71

3.2 Chemical quality of ground water and contamination

Interpretation from Chemical Analysis of Aquifer - I results in Kollegal taluk (Table 9) shows that the Electrical Conductivity ranges from 1170 to 2500 µ/mhos/cm in the aquifer-I at 25°C (Fig. 12) while Chloride concentration ranges from 21 to 178 mg/L (Fig.13). The Nitrate value ranges from 1 to 118 mg/l and Fluoride concentration in groundwater ranges between 0.29 – 0.48 mg/l and. The sites with point values for Nitrate and Fluoride is given in Fig.14 and 15 respectively.

Table 8: Quality of ground water (Aquifer-I)

S. No.	Latitude	Longitude	Well type	Location	pH	EC	Chloride	Nitrate	Fluoride
1	12.0917	77.3056	Dug Well	Hanur	8.52	1170	21	1	0.35
2	12.1472	77.0750	Dug Well	Uttaballi	8.84	2500	178	58	0.29
3	12.1250	77.0356	Dug Well	Kunturu	8.38	1230	36	7	0.34
4	12.0375	77.3542	Dug Well	Kurubaradoddi	8.27	1930	149	118	0.31
5	12.0056	77.4083	Dug Well	Palanimedu	8.53	2400	156	118	0.31
6	12.0306	77.5875	Dug Well	Mahadeswarabetta	8.61	1620	78	23	0.48
7	11.9833	77.5667	Dug Well	Kombutuki	8.47	1250	28	7	0.32
8	12.0056	77.4083	Dug Well	Yeriyuru	8.23	1970	85	34	0.29



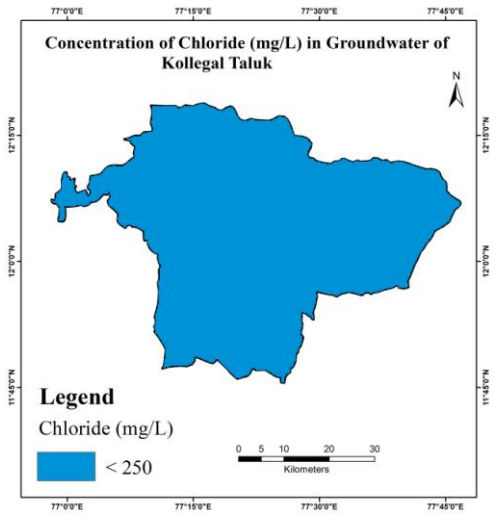


Fig-12: Electrical conductivity distribution

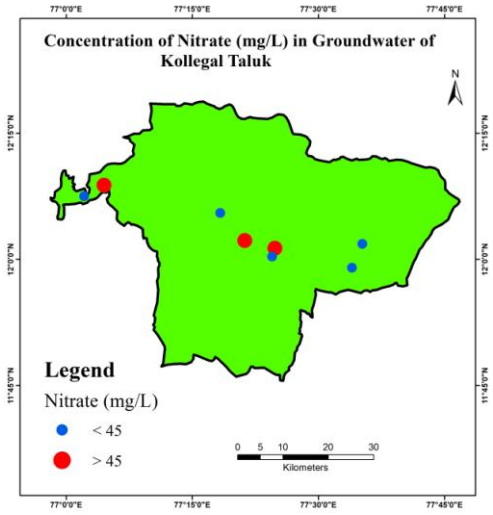


Fig-14: Nitrate distribution

Fig-13: Chloride distribution

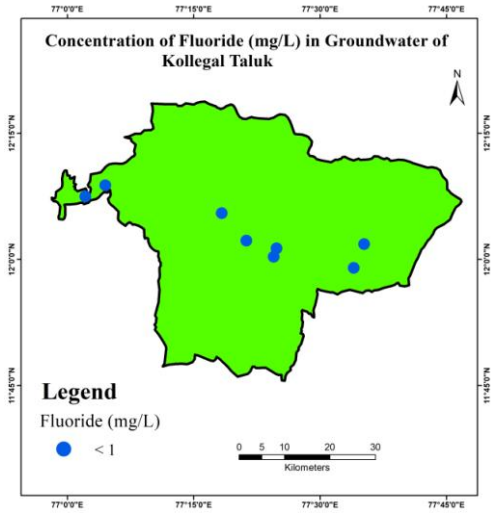


Fig-15: Fluoride distribution

In general, ground water quality in Kollegal taluk is good for drinking purpose except in some areas as depicted in above illustrated maps, where nitrate is found to be greater than the permissible limit as per "Indian Standard Drinking Water Specification 2012" of BIS. Ground water samples have also been tested and found suitable for agriculture & irrigation purposes.

4 GROUND WATER RESOURCE ENHANCEMENT

4.1 Resource Enhancement by Supply Side Interventions

The overall stage of ground water development is 82% as per GEC 2020. Considering the long-term water level trend and seasonal water level, seasonal fluctuation and declining trend of annual rainfall **(Fig-1A),** it is proposed to construct artificial recharge (AR) structures to enhance the ground water resources and to arrest the decline in long term ground water level **(Table-9).** The area feasible for recharge in Kollegal taluk is worked out as 2530 sq.km. and the surface surplus non-committed runoff availability is 183.05 MCM, which is considered for planning of AR structures. For this, a total of 5 sub-surface dykes, 165 percolation tanks and 867 check dams are proposed. The volume of water expected to be conserved/recharged @75% efficiency is 137.23 MCM through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 12127.86 Lakhs. The additional area which can be brought under assured ground water irrigation will be about 16500 hectares. 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 Kollegal taluk, Chamarajangarar district have been carried out and given in below Tables 10.

Table 10: Details of Proposed Recharge Structures (As per Master Plan on Artificial Recharge in Karnataka, 2020)

Artificial Recharge Structures Proposed	Kollegal taluk
Non committed monsoon runoff available (MCM)	183.05
Number of Check Dams	867
Number of Percolation Tanks	165
Number of Subsurface dykes	5
Number of Filter beds	42
Tentative total cost of the project (Rs. in lakhs)	12127.86
Expected recharge (MCM)	137.28
Additional irrigation potential (in hectares)	16500

Note: The numbers proposed are tentative and actual feasibility studies are required in field to finalize the actual locations for the construction of AR structures.

4.2 Resource Savings by Demand Side Interventions

4.2.1 Water Use Efficiency by Micro Irrigation Practices

It is observed that 7202 wells and bore wells are the source for 8100 ha of net irrigation in the taluk constituting about 54% of the irrigated area. Adoption of water use efficiency (WUE) techniques will contribute in ground water resource enhancement in the long run by way of saving of water. Efficient irrigation practices like Drip irrigation & sprinkler needs to be adopted by the farmers in the existing 8100 ha of net irrigated area by wells & bore wells. At present (2017), the irrigation draft is 9295 ham.

The water efficient methodology may be applied for growing sugarcane which is grown in 4626 ha and is largely ground water dependent as compared to the other crops which are mainly grown during kharif. Efficient irrigation techniques will contribute in saving ground water by 1318 ham considering 50% of the sugarcane area is dependent on ground water irrigation and thus will improve stage of development marginally. However, in long run the practice of Efficient irrigation techniques will add to the ground water resource in large extent. **(Table-11).**

Table 11: Improvement in GW availability (2017) due to saving by adopting water use efficiency

Net annual ground water availability	Existing gross ground water draft for all uses	Existing stage of ground water development	Saving due to adopting WUE measures	Cumulative annual ground water availability	Expected improvement in stage of ground water development after the implementation of the project	Expected improvement in overall stage of ground water development
HAM	HAM	%	HAM	HAM	%	%
14223	10042	71	1318	15541	7	64

4.2.2 Change in cropping pattern

Water intensive crops like paddy & sugarcane are grown in 9345 ha and 4626 ha of net cropped area of 32,000 ha. However, paddy is grown during kharif period and sugarcane grown only in 14% of the cropped area. At present (2017), the stage of ground water extraction is also on higher side @ 71% and taluk has been categorised as Semi-Critical. However, the supply side and demand side interventions will definitely help in improving the situation, thus change in cropping pattern has not been suggested.

4.3 Regulation and Control

The taluk has been categorized as Semi-Critical, since the Stage of ground water development has reached 71% (GEC 2017). Hence, ground water regulation by including the industries, bulk water consumers etc under the ambit of NOC needs to be taken up by Karnataka State Ground Water Authority to control further ground water exploitation in the taluk**.**

Ground water recharge component needs to be made mandatory in the non-command area of the taluk for further development of ground water.

4.4 Other Interventions Proposed

- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Excess nitrate concentration is found in ground water samples which require remedial measures viz. dilution of nitrate rich ground water through artificial recharge & water conservation.
- Build up awareness among local village community about proper disposal of sewage/runoff from chemical fertilizers contributing to nitrate
- Roof top rain water harvesting in semi-urban areas.

5 SUMMARY AND RECOMMENDATIONS

The main ground water issues are Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, Deeper Water Levels particularly in Aquifer-II in some parts, hilly and plateau areas which are all inter-related or inter dependent and Inferior Ground Water Quality due to nitrate contamination major part of the area. The summary of ground water management plan of Kollegal taluk is given in **Table-12.**

Table 15: Summary of Management plan of Kollegal taluk

Stage of GW Extraction and Category (2017)	71 %, Semi-Critical
Annual Extractable GW Resource (Ham)	14223
Total Extraction (Ham)	10042
Total GW Resources (Dynamic & Static up to the depth of 200 mbgl) (Ham)	31756
Ground Water Draft for Irrigation (Ham)	9295
Ground Water Resource Enhancement by Supply side Interventions	
No of Proposed AR structures SSD PT CD Filter Beds	 5 165 867 42
Expected Additional Recharge to GW due to AR (Ham)	13728
Additional Irrigation Potential that can be created (Ha)	16500

Total Estimated Expenditure (Rs. in Cr.)		121.28
Ground Water Resource Savings by Demand side Interventions		
Expected Saving due to adopting WUE measures in sugarcane area (Ham)		1318
Change in Stage of GW development (%)		71 to 64
Ground Water Quality – Nitrate contamination	Improving quality by proper drainage of sewage and Limited usage of Nitrogenous fertilizers	

As per the resource estimation – 2017, Kollegal taluk falls under Semi-Critical category with the stage of ground water extraction is 71 %. Thus, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk in the coming days to avoid water crisis in the future. It is suggested to adopt a scientific and multi-pronged ground water management strategy covering supply side interventions, demand side interventions, ground water development interventions and ground water quality protection aspects as mentioned in the management plan suggested above

Ground water resource enhancement by supply side interventions: Quantity of surface water available through non-committed surface run-off is estimated to be 18305 ham. This can be used to recharge the aquifer mainly through percolation tanks (165), check dams (867), filter beds (42) and sub surface dyke structures (5). The volume of water expected to be conserved/recharged @ 75% efficiency is 13728 ham through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 121.28 Cr. The additional area which can be brought under assured ground water irrigation will be about 16500 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 54 % 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 sugarcane crop which is grown in 4626 ha area and considering 50% area is dependent on ground water irrigation, efficient irrigation techniques will contribute in saving ground water by 1318 ham and thus will improve stage of development marginally. However, in long run the practice of efficient irrigation techniques will add to the ground water resource in large extent.

Change in cropping pattern: Water intensive crops like paddy & sugarcane are grown in 9345 ha and 4626 ha of net cropped area of 32,000 ha. However, paddy is grown during kharif period and sugarcane grown only in 14% of the cropped area. At present (2017), the stage of ground water extraction is also on higher side @ 71% and taluk has been categorised as Semi-Critical. However, the supply side and demand side interventions suggested above will definitely help in improving the situation, thus change in cropping pattern has not been suggested.