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

Kunigal Taluk, Tumkur District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

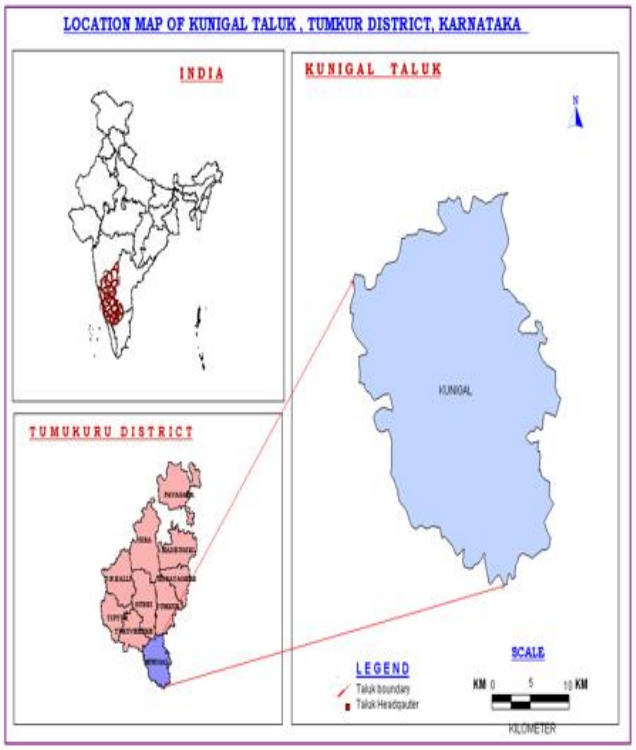
FOR OFFICIAL USE ONLY
No. SWR/RP/NQM/2022-23/41

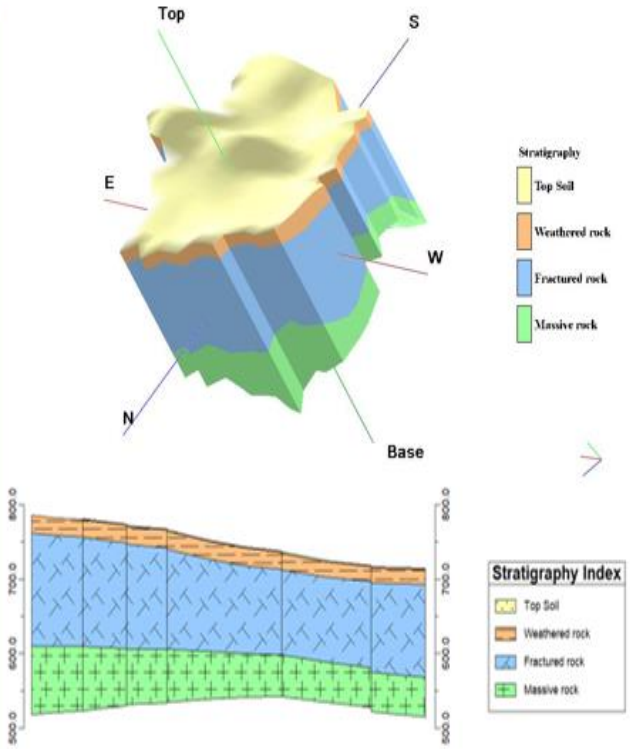
भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास एवं गंगा संरक्षण विभाग
केन्द्रीय भूमिजल बोर्ड
दक्षिण पश्चिम क्षेत्र,
बेंगलुरु

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, KUNIGAL TALUK, TUMKUR DISTRICT, KARNATAKA STATE

(AAP – 2021-2022)





By

Naresh Chandra Sahoo, Assistant Hydrogeologist, CGWB, SWR, Bengaluru

AUGUST-2022

AQUIFER MAPS AND MANAGEMENT PLAN, KUNIGAL TALUK, TUMKUR DISTRICT, KARNATAKA STATE

Contents

AQUIFER MAPS AND MANAGEMENT PLAN, **KUNIGAL** TALUK, **TUMKUR** DISTRICT, KARNATAKA STATE

1 SALIENT INFORMATION

Name of the taluk	: Kunigal
District	: Tumkur
State	: Karnataka
Area	: 999 sq.km.
Population	: 2,25,783
Annual Normal Rainfall	: 794mm

1.1 Study Area

Aquifer Mapping Studies have been carried out in Kunigal taluk, Tumkur district of Karnataka, covering an area of 999 sq.kms under National Aquifer Mapping Project. The Kunigal taluk is located between North Latitudes 12°44'45.02" and 13°07'41.25"and East Longitudes between 76°50'21.25" to 77°10'07.56". The study area is bounded on the East by Magadi taluk, Ramanagara District, on the North by Gubbi taluk, Tumkur District, on the South by Maddur taluk & on the West by Nagamangala Taluk of Mandya district. Location map of Kunigal taluk of Tumkur district is presented in **Fig-1**. Kunigal is taluk head quarter. There are 314 villages and 36 gram panchayats in this taluk.

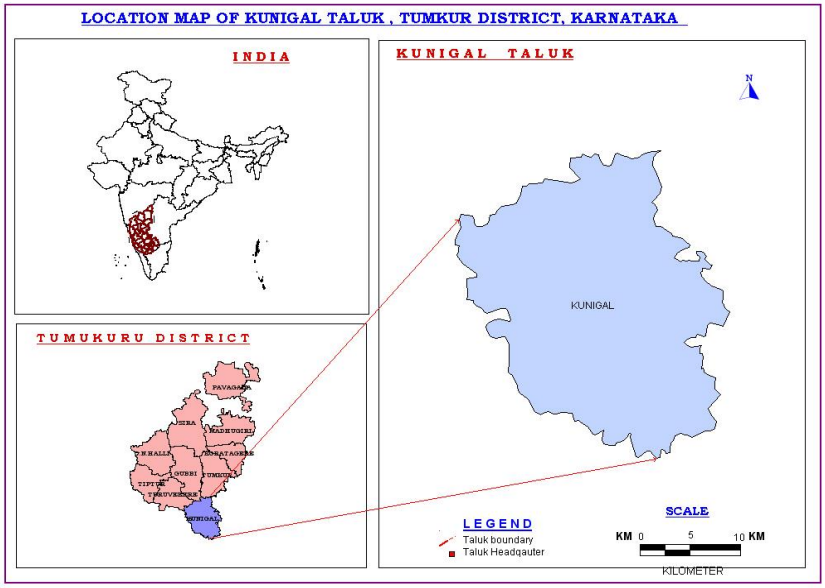


Fig-1: Location map of Kunigal taluk of Tumkur district

1.2 Population

According to 2011 census, the population in KunigalI taluk is 2,25,783. Out of which 1,12,803 are males while 1,12,980 are females. The average sex ratio of Kunigal taluk is 1002. The Kunigal taluk has an overall population density of 226 persons per sq.km. The decadal variation in population from 2001-2011 is -4.34 % in Kunigal taluk.

Table-1: Population details

Total	Male	Female	Share of the district population	Rural population	Urban population	Decadal change in population	Decadal change in rural population	Decadal change in urban population
225783	112803	112980	8.42	191628	34155	-4.34	-6.8	12.6

Source: District at a glance 2016-17, Govt. of Karnataka

1.3 Rainfall and Climate

Kunigal taluk enjoys semi-arid climate. Dryness and hot weather prevail in major part of the year. The area falls under Central Dry agro-climatic zone of Karnataka state and is categorized as drought prone. The climate of the taluk 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 annual rainfall data from 2009 to 2019 of the Kunigal taluk is collected and given in Table.2A

Statistical Analysis of Rainfall Data of Kunigal taluk (1990 to 2019), Annual rainfall (mm) in Kunigal rain gauge station from 2009 to 2019 recorded in various rain gauge stations in Kunigal and Monthly rainfall data is given in Table -2B and 2C respectively.

Table-2A Actual Annual Rainfall of Kunigal taluk from 2009 to 2019

Year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Rainfall (mm)	759	770	802	558	414	985	815	502	1112	970	643

Table-2B : Statistical Analysis of Rainfall Data Kunigal taluk, (1990 to 2019)

Stataion Kunigal	JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	ANNUAL
NRM	1	3	18	48	113	182	73	78	134	140	424	138	46	4	188	794
STDEV	2	7	39	35	78	104	52	66	64	95	153	83	42	10	83	215
CV%	327	248	217	73	69	57	72	85	48	68	36	60	92	260	44	27

Table 2C : Monthly rainfall data of Kunigal taluk

Year	JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEPT	SWM	OCT	NOV	DEC	NEM	ANNUAL
2009	0	0	82	30	215	327	112	13	68	207	400	14	14	4	32	759
2010	3	0	10	55	57	125	129	90	136	68	423	123	99	0.0	222	770
2011	0	0	0	126	119	245	44	99	108	94	345	154	58	0	212	802
2012	0	0	0	85	96	181	2	31	190	15	238	48	91	0	139	558
2013	0	5	0	32	0	37	2	31	190	15	238	48	91	0	139	414
2014	0	0	10	35	68	113	148	143	205	161	657	180	31	4	215	985
2015	0	0	0	37	197	234	149	15	36	161	361	63	156	1	220	815
2016	0	0	3	12	76	91	77	180	88	25	370	25	8	8	41	502
2017	0	0	11	51	266	328	35	60	232	331	658	122	4	0	126	1112
2018	0	0	48	81	276	405	61	25	134	318	538	24	3	0	27	970
2019	0	10	0	0	93	103	104	8	171	91	374	151	15	0	166	643

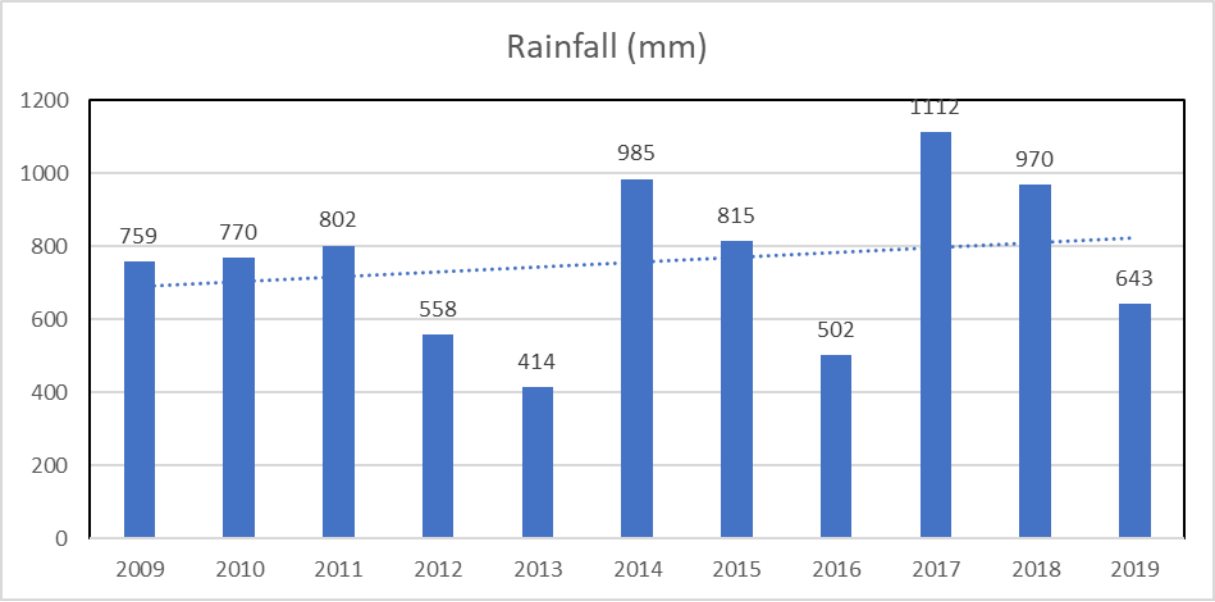


Fig. 2: Rainfall Trend Analysis

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Kunigal taluk. Major crops are Paddy, Maize, Tur, Pulses, Tobacco, Fruits and Vegetables. Water intensive crops like Paddy and Tobacco are grown in Kunigal Taluk **(Table.3A).**

Table-3A: Cropping pattern in Kunigal taluk 2016-2017 (Ha)

Crop	Paddy	Maize	Ragi	Wheat	Pulses	Fruits	Vege tables	Oil seeds	Sugar cane	Total crop
Area(ha)	4991	00	25301		4,651	2293	260	934	831	39261
Area %	12.71	0.00	64.44		11.84	5.84	0.66	2.37	2.11	100

Source: District at a glance 2016-17, Govt. of Karnataka

It is observed that net sown area accounts for 43,556 (Ha) and area sown more than once is 6,101 (Ha) of total geographical area 99900 (Ha) in Kunigal taluk **(Table-3B).** Area under Forest is 6787 (Ha). Area not available for cultivation and Fallow land cover 12,708 (Ha) and 19,767 (Ha) of total geographical area respectively. 4376 (Ha) of net area is irrigated from surface water and 8978 (Ha) are irrigated from Groundwater **(Table.3C).**

Table-3B: Details of land use in Kunigal taluk 2016-2017 (Ha)

Total Geographical Area	Area under Forest	Area not available for cultivation	Other uncultivable land	Fallow land	Net sown area	Area sown more than once	Gross sown area
99900	6787	12,708		19,767	43,556	6,101	49,657
% of the area	6.78	12.72		19.78	43.59	6.10	49.70

Source: District at a glance 2016-2017

Table-3C: Irrigation details in Kunigal taluk (in ha)

Source of Irrigation	Length in Km/No of structures	Gross area Irrigated (Ha)	Net area Irrigated (Ha.)	% of area
Canals	61.1 KM	4099	4099	27.82
Tanks	229 Nos	277	277	1.88
Wells	2624 Nos	60	60	0.40
Bore/Tube wells	18614 Nos	10,295	8,918	69.88
Lift Irrigation				
Other Sources				
Total	21528.1	14731	13354	100

Source: District at a glance 2016-2017

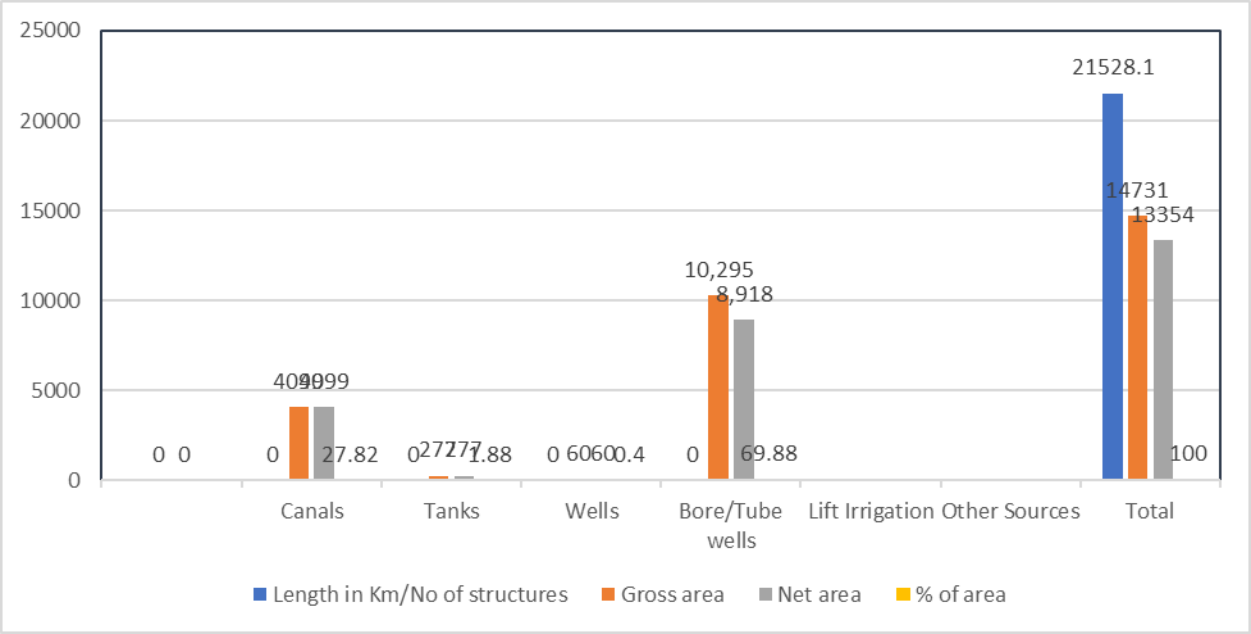


Fig. 3: Sources of Irrigation

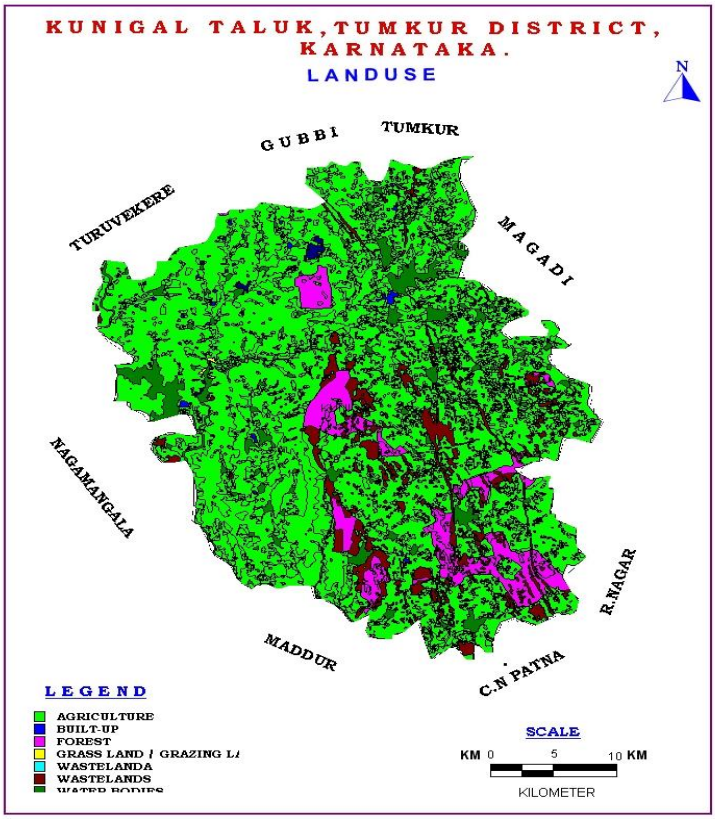


Fig 4: Land use Map

1.5 Geomorphology, Physiography & Drainage

The geomorphology of the Kunigal is formed by plain area in northern and central part. Southern parts of the taluk contain rivers, streams and settlements. The elevation in the taluk varies from 683 m to 865m amsl. The differential altitude is significant because, it is likely to cause irregular ground water flow patterns on the micro scale **(Fig.-5).** Topography is dominantly controlled by geological structures. The entire Kunigal taluk falls in Krishna & Cauvery river basins. The Drainage pattern is dendritic to subdendritic **(Fig.-6).**

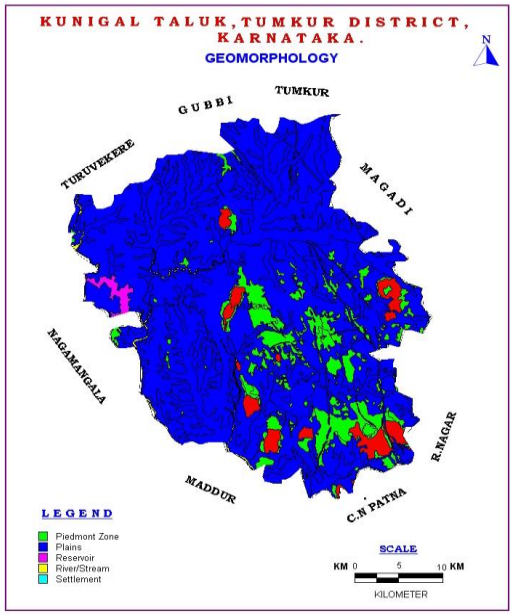


Fig-5: Geomorphology Map

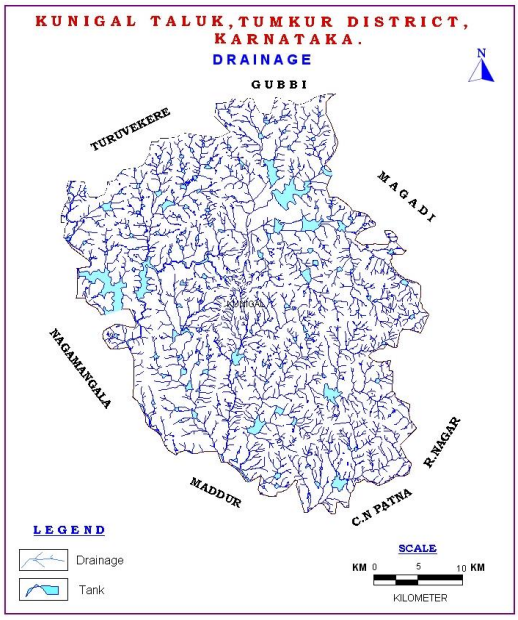


Fig-6: Drainage Map

1.6 Soil

The soils of Kunigal taluk can broadly be classified into Red loamy soil and red sandy soil. These soils vary in depth and texture, depending on the parent rock type, physiographic settings and climatic conditions **(Fig-7).**

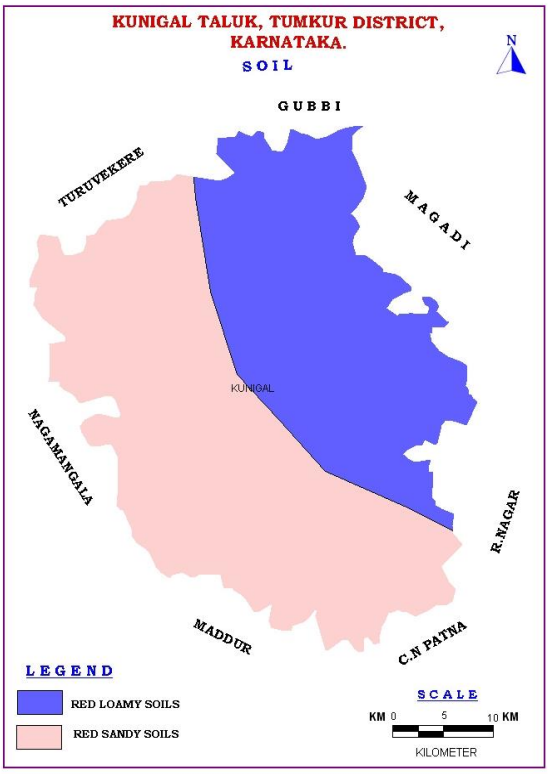


Fig-7: Soil Map

1.7 Ground water resource availability and extraction

As per the ground water resource estimation 2020 **(Table 4B),** the data on ground water resources shows that the net annual ground water availability is 9766.58 ham. The existing gross groundwater for irrigation is 5804.41 ham. The stage of groundwater development is 65.47 and falling under **Safe** category

Aquifer wise total ground water resources up to 200 m depth is given in **Table-4A** below. The details of dynamic (Phreatic) ground water resources are shown in **Table- 4B.**

Table-4 A: Total Ground Water Resources (2020) (Ham)

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
KUNIGAL	9766.58	6935	1685	18386.58

Table-4 B: Present Dynamic Ground Water Resource (2020)

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 Development	Existing Stage of Ground Water Development	Category
9766.58	5804.41	589.32	6393.73	644.21	3317.96	65.47	Safe

1.8 Existing and Future Water Demands (as per GWRA-2017 and 2020)

The details of dynamic (Phreatic) ground water resources for Kunigal taluk as on 2017 and 2020 is shown in Table.5A and Table.5B. It is observed that the stage of ground water extraction is 65 % to 65.47 % from 2017 to 2020.

Table.5A Dynamic Ground Water Resource, (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
8750	5216	474	5690	609	2989	65	SAFE

Table-5B: Present Dynamic Ground Water Resource (2020)

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 Development	Existing Stage of Ground Water Development	Category
9766.58	5804.41	589.32	6393.73	644.21	3317.96	65.47	Safe

1.9 Water level behavior

The water level data have been monitored from the representative dug wells and borewells under NHS monitoring programme for both pre and post monsoon seasons during 2019 in Aquifer I & Aquifer II (Table 6 A). During premonsoon season water level ranges from 4.12 to 12.08 mbgl, whereas in postmonsoon it varies from 1.69 to 10.55 mbgl. Whereas in Aquifer II, the water level ranges from 17.11 to 89.80 mbgl in premonsoon and 13.73 to 30.85 mbgl during post monsoon as per Ground water Department, Govt of Karnataka data. **(Table 6 B)** and the maps shown in **Fig 8 and 9.**

Table 6 A: Depth to water level of Pre and Post-monsoon (2019), CGWB

Sl.No.	SITE_TYPE	Location name	Depth of the Well (m bgl)	May-19	Nov-19
1	Dug Well	Anchihalli	11.60	10.55	10.55
2	Dug Well	Kunigal-A	19.50	12.08	10.90
3	Bore Well	Nagavalli	60.00	27.11	25.60
4	Bore Well	Yediyur	60.00	26.24	19.80
5	Dug Well	Yellappana Gudde	8.70	4.12	1.69

Table 6 B : Depth to water level of Pre and Post-monsoon (2019) (State GW Directorate, Govt. of Karnataka

Sl No	Well Type	Location name	Depth of well (m bgl)	May-19	Nov-19
1	Bore well	Amruthuru	51	26.05	12.27
2	Bore well	Chowdanakuppe	65.85	43.96	30.85
3	Bore well	Doddamavattur	58	31.45	30.21
4	Bore well	Halappanagudda	60	17.11	13.73
5	Bore well	Kempanahalli	132.1	89.80	70.82
6	Bore well	Kunigal	60	26.80	12.50
7	Bore well	Manavalli	60	31.95	25.92
8	Bore well	Vajarapalya	65.55	102.25	81.80

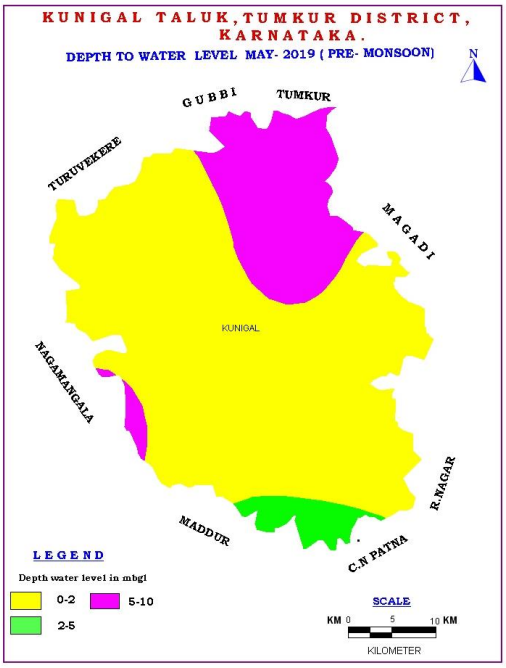


Fig-8: Pre-monsoon Depth to Water Level

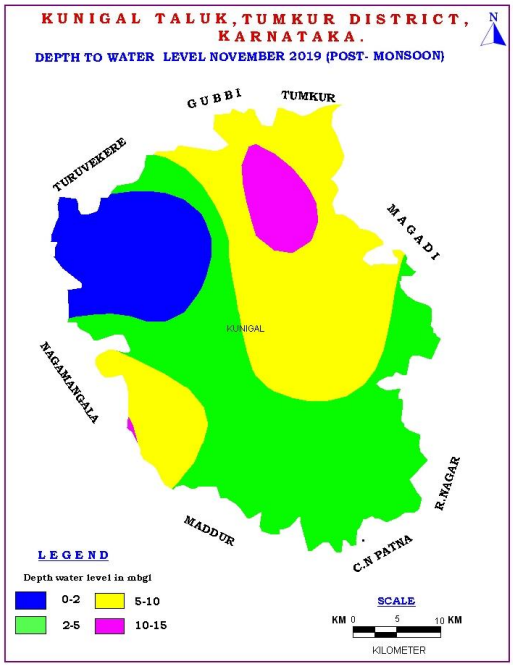


Fig-9: Post-monsoon Depth to Water Level

2 AQUIFER DISPOSITION

The occurrence and movement of water in the subsurface is broadly governed by geological frameworks i.e., nature of rock formations including their porosity (primary and secondary) and permeability. The principal aquifers in the area are Gneisses and Schist and the occurrence and movement of ground water in these rocks is controlled by various factors and it primarily depends on the degree of interconnection of secondary pores/voids developed by fracturing and weathering in the hard rock.

2.1 Aquifer Types

In Kunigal taluk, there are mainly two types of aquifer systems

i. Aquifer-I (Phreatic aquifer) comprising of Weathered Banded Gneissic complex
ii. Aquifer-II (Fractured aquifer) Fractured Banded Gneissic complex

In Kunigal taluk, Banded Gneissic complex is the main water bearing formation **(Fig-10).** Ground water occurs within the weathered and fractured Schist, Granite and Granitic gneiss under water table condition and semi-confined condition. In Kunigal taluk bore wells were drilled to a maximum depth of 200 mbgl. Depth of weathered zone ranges from 6 mbgl to 32.04mbgl. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depths of 31 mbgl to 184mbgl. Yield ranges from Negligible to 11.76lps.

The 3D aquifer disposition models, 2D aquifer sections and 3D aquifer fence diagrams have been prepared and presented in **Fig. 11 a, b and c.**

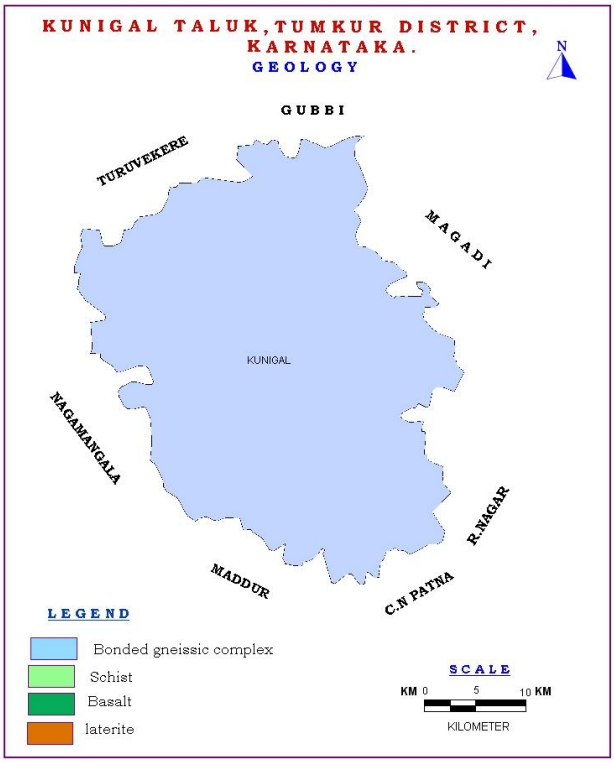


Fig-10: Geology Map

3 D aquifer disposition and Cross-Sections

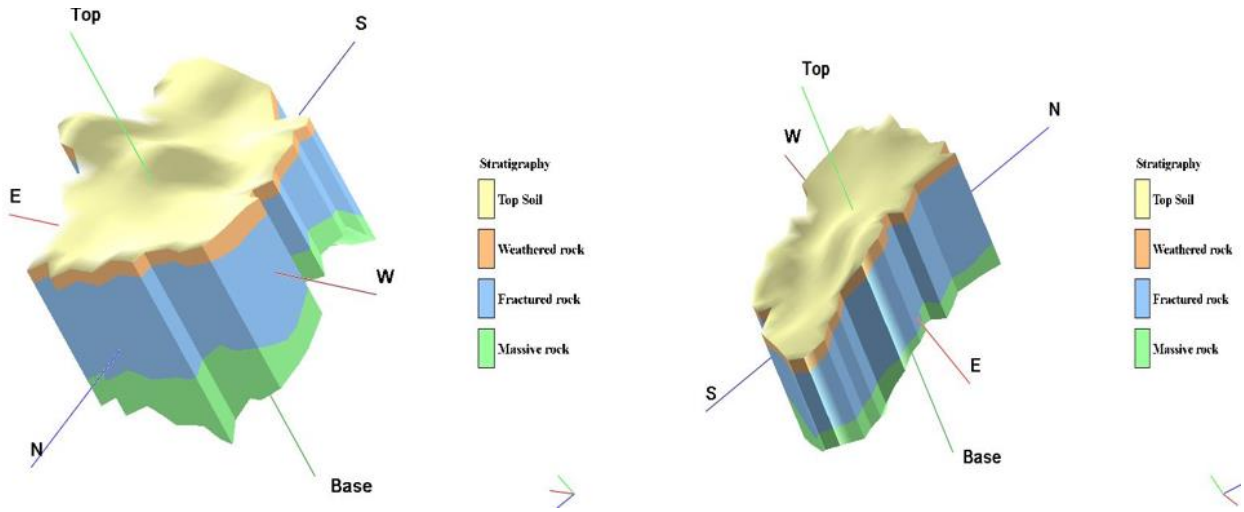


Fig. 11 a: 3D Aquifer model

2D AQUIFER DISPOSITION

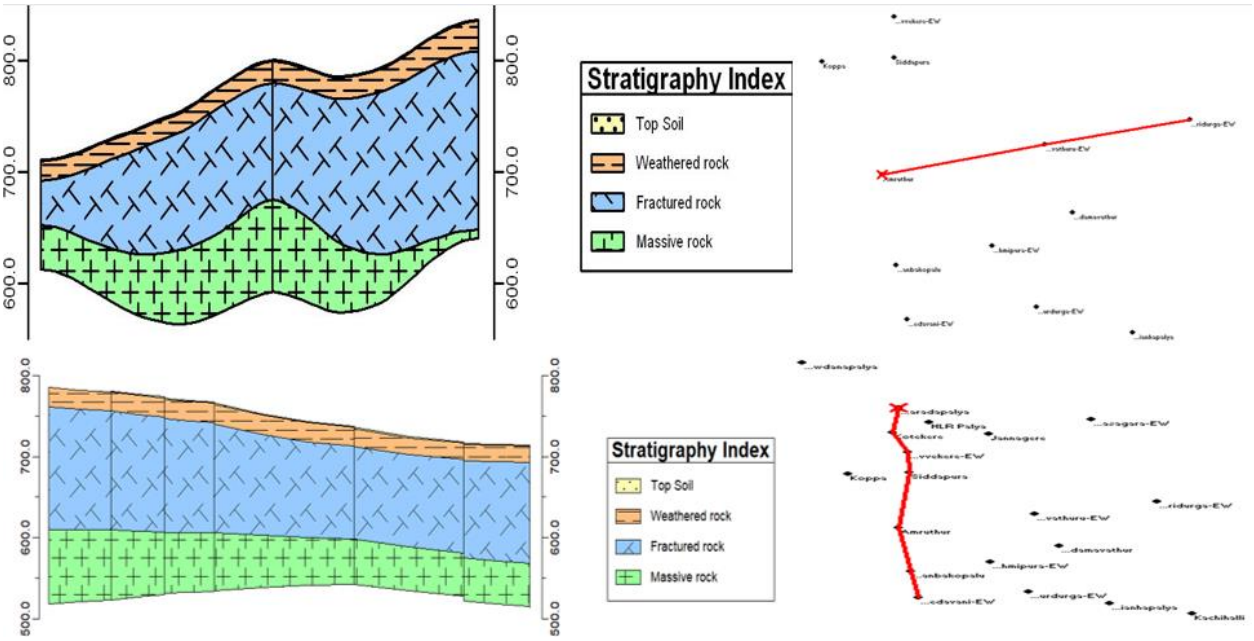


Fig. 11 b: 2D Aquifer section

3D Aquifer Fence Disposition

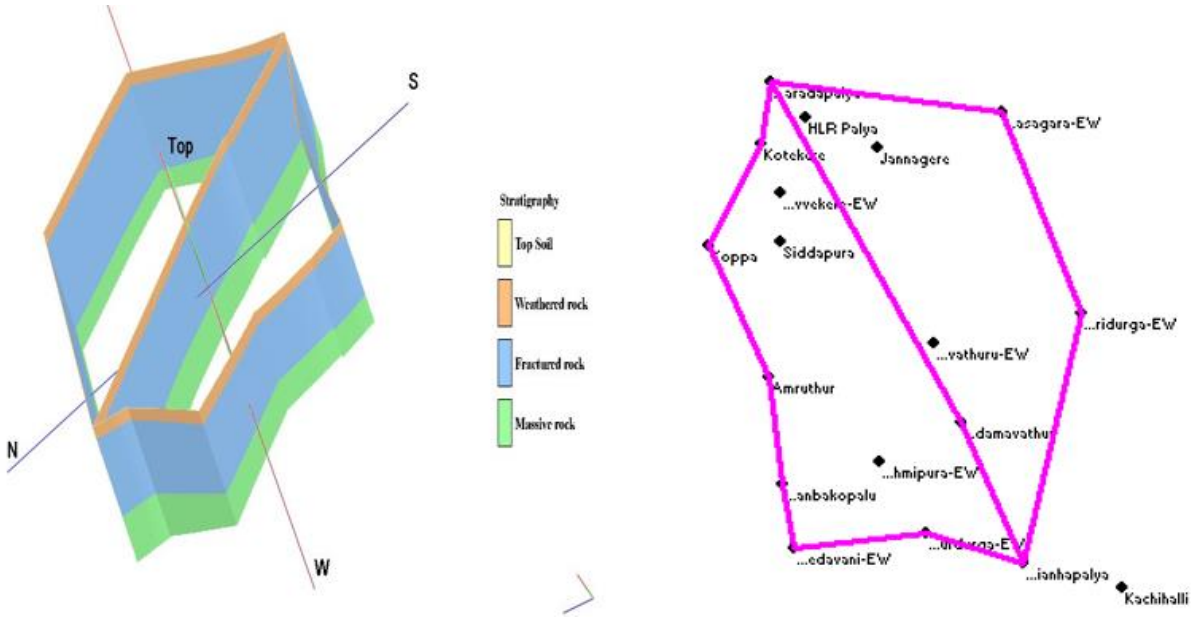


Fig. 11 c: 3D Aquifer fence diagram

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 7**. It is observed that the ground water availability in 2020 is more as compared to to 2017 due to increase in rainfall and in water table. It is attributable to the improvement in the irrigation practice, influence of command area and also due to the water conservation / recharge activities carried out in the taluk by various state govt. and other agencies. There is no change of in the stage of ground water development & the taluk is categorized as "**Safe".**

Table 7 : Comparison of groundwater availability and draft scenario (in ham)

Taluk	March 2017			March 2020		
	GW Availability (in ham)	GW Extraction (in ham)	Stage of GW Development %	GW Availability (in ham)	GW Extraction (in ham)	Stage of GW Development%
Kunigal	8750.35	5689.93	65%	9766.57	6393.73	65%

3.2 Chemical Quality of Ground Water and Contamination

The water samples were collected in different parts of **Kunigal** taluk during NAQUIM studies in September 2021 the data is given below in **Table 8**. The results of quality parameters shows that the EC ranges from 641to 1846 while Nitrate varies from 0.28 to 54.04mg/l and Fluoride ranges from 0.11 to 1.03 mg/l **(Fig 12 A, B and C).**

Table 8 : Water quality parameters

Sl No	Location	PH	EC	Cl	NO3	F
1	Doddamavathur	7.73	930	60.35	5.48	0.83
2	Kenchianhapalya	7.86	1148	67.45	11.26	0.85
3	Kachihalli	8.23	1230	102.95	0.28	ND
4	Sanbakopalu	7.86	1604	216.55	1.96	0.56
5	Amruthur	8.03	1486	177.5	0.66	0.51
6	Venkate Gowdanapalya	8.15	1052	99.4	36.54	0.23
7	Siddapura	7.91	1140	120.7	7.76	0.62
8	Koppa	8.12	1172	142	54.04	1.03

9	Kotekere	8.04	941	49.7	11.02	0.04
10	Tenginamaradapalya	8.15	1017	42.6	50.74	ND
11	HLR Palya	8.2	957	56.8	ND	ND
12	Jannagere	7.82	1877	315.95	33.42	ND

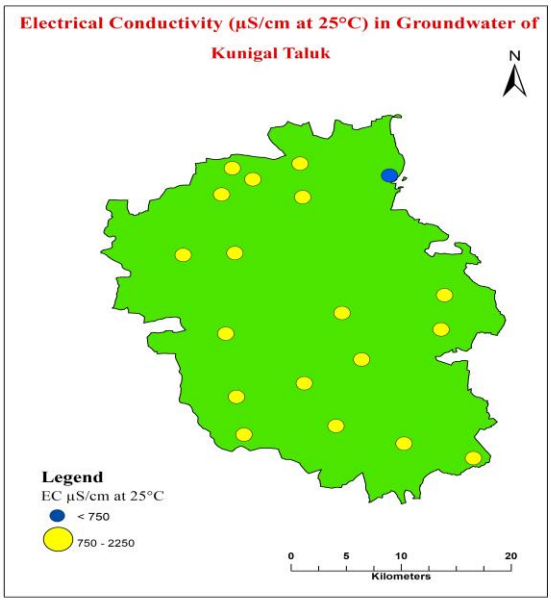


Fig. 12 A: EC distribution map

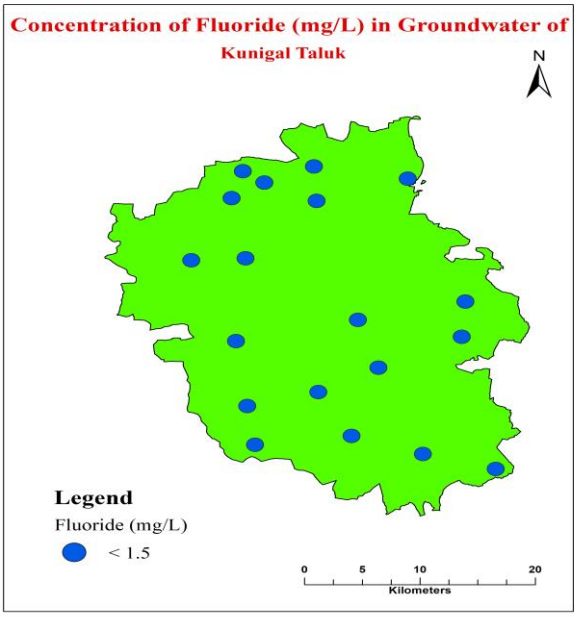


Fig. 12 B : Fluoride distribution map

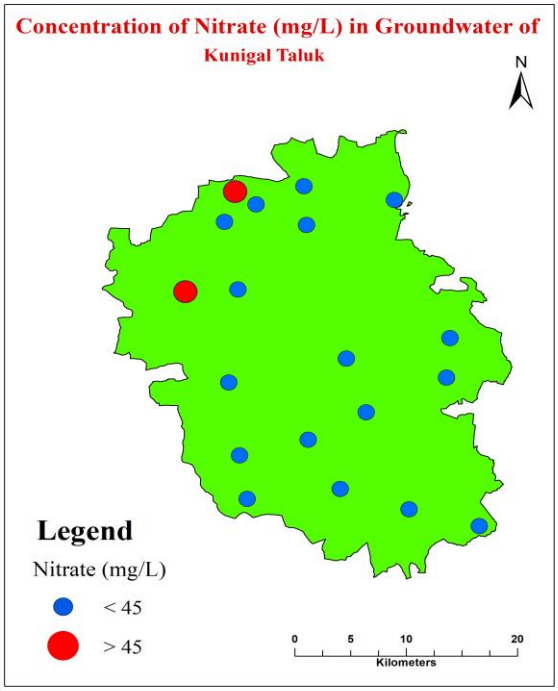


Fig. 12 C: Nitrate distribution map

4 GROUND WATER RESOURCE ENHANCEMENT AND PROPOSED MANAGEMENT STRATEGY

4.1 Resource Enhancement by Supply Side Interventions

Recharge dry phreatic aquifer (Aq-I) in the taluk, through construction of artificial recharge structures, viz; percolation tanks & Sub surface dyke **(Table-9a).** 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 9a: Quantity of non-committed surface runoff & expected recharge through AR structures (As per Master Plan on Artificial Recharge in Karnataka, 2020)

Artificial Recharge Structures Proposed	Kunigal taluk
Non committed monsoon runoff available (MCM)	70.601
Number of Check Dams	0
Number of Percolation Tanks	64
Number of Sub surface dyke	2
Tentative total cost of the project (Rs. in lakhs)	1308.466Lakhs
Excepted recharge (MCM)	52.951
Additional irrigation potential (in hectares)	6400

Table 9b: Improvement in GW availability due to Recharge as per GWRA 2020

Taluk	Net annual ground water availability	Existing gross ground water draft for all uses	Existing stage of ground water development	Expected recharge from proposed Artificial Recharge structures	Cumulative annual ground water availability	Expected improvement in stage of ground water development after the implementation of the project	Expected improvement in overall stage of groundwater development
	HAM	HAM	%	HAM	HAM	%	%
Kunigal	**9766.57**	6393.73	**65**	5295.1	15061.67	23	42

4.1.1 Strategic Action Plan:

The provision for minimum protective irrigation can only improve the agricultural growth in the taluk which is dependent on rain. This objective can be achieved by utilizing the rain water more efficiently by harvesting structures like farm ponds, check-dams, barrages and other surface structures. The Strategic Action Plan, prepared for the taluk has included the irrigation infrastructure for major irrigation, minor irrigation, ground water recharge, harvesting of rain water, improvement of irrigation efficiency and strengthening the adoption of micro-irrigation. Considering the existing infrastructure in the taluk and considering the irrigation potential required to be created to meet the gap between demand and supply of all the sectors of water use, the Strategic Action Plans are developed under PMKSY project and the same is given below.

4.1.2 Benefits of Artificial recharge scheme:

Artificial recharge structures namely check dams 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 indicate 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.

The cropping pattern has shown that farm households have resumed growing crops such as grapes which were not previously grown in the area.

4.2 Resource Savings by Demand Side Interventions

4.2.1 Water Use Efficiency by Micro Irrigation Practices

Kunigal Taluk falls under Safe category with the stage of groundwater extraction of 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.

4.3 Ground Water Development Plan

Kunigal taluk has been categorized as **Safe**. 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

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 require remedial measures viz.
- Dilution of nitrate rich ground water through artificial recharge & water conservation.
- Roof top rain water harvesting

5 SUMMARY AND RECOMMENDATIONS

The main ground water issues are Low Ground Water Development, Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, 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 Kunigal taluk is given in **Table- 10.**

Table 10 : Summary of Management plan

Stage of GW Extraction and Category (2020)	65%, Safe
Annual Extractable GW Resource (Ham)	**9766.57**
Total Extraction (Ham)	6393.73
Total GW Resources (Dynamic & Static up to the depth of 200 mbgl) (Ham)	18386.58
Ground Water Draft for Irrigation (Ham)	5804.41
Ground Water Resource Enhancement by Supply side Interventions	
No of Proposed AR structures SSD PT	 2 64
Expected Additional Recharge to GW due to AR (Ham)	5295.1
Additional Irrigation Potential that can be created (Ha)	6400
Total Estimated Expenditure (Rs. in Cr.)	13.085
Change in Stage of GW Extraction (%)	65 to 42

- **Ground water resource enhancement:** Continuous drought, increase in agricultural activity, subjected to excessive ground water withdrawal leading to depletion of ground water level, reduction in yield and deterioration of ground water quality etc., suggests a need for proper ground water management and enhancement of storage capacity of aquifers, protection of ground water quality and proper utilization of ground water. To enhance the storage capacity of aquifers, the dewatered aquifers are to be recharged, for which the artificial recharge structures like Check dams, percolation tanks, point recharge structures etc have to be constructed.
- **Ground Water resource**: As per the resource estimation – 2020, Kunigal taluk falls under Safe category with the stage of ground water extraction of 65.47%. However, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk during the summer and scarcity of water during the future days.
- **Ground water resource enhancement**: Increase in agricultural activity, excessive ground water withdrawal, depletion of ground water levels, reduction in yield and ground water quality related issues etc., suggests the need for scientific ground water management, enhancement of storage capacity of the aquifers and protection of ground water quality.
- **Quantity of water available through non-committed surface run-off:** The surplus non-committed monsoon run off is estimated to be approximately 52.951 MCM. This can be used to recharge the aquifer mainly through Sub Surface Dykes, percolation tanks, Check Dams, Filter Beds.
- **Advanced irrigation practices:** The important crops grown are Paddy, Ragi, Maize, gram, tur, groundnut and sugarcane. Water Use Efficiency (WUE) practices like Drip needs and Micro irrigation to be strengthened to save irrigation water by way of precision farming mechanism. This ultimately enhances the area under irrigation potential.
- **Change in cropping pattern**: Farmers are facing inadequacy of groundwater for agriculture during summer and can opt for more rain-fed millets and water efficient Pulses for agricultural production.
- **Drinking water Supply**: In view of ground water contamination with mainly higher concentration Nitrate and fluoride, drinking water supply from surface water needs to be explored/ ensured.
- **Regulation and control:** Taluk is categorized as "Safe". However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority needs to be strictly implemented in the taluk, so that quality of ground water will improve in due course of time.
- **Participatory management**: Awareness programmes and practice of participatory approach needs to be strengthened with the involvement of all the stake holders for sustainable management.