केंद्रीय भूमि जल बोर्ड
जल संसाधन, नदी विकास और गंगा संरक्षण
विभाग, जल शक्ति मंत्रालय
भारत सरकार
Central Ground Water Board
Department of Water Resources, River
Development and Ganga Rejuvenation,
Ministry of Jal Shakti
Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

KOPPAL TALUK,

KOPPAL DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर
South Western Region, Bengaluru

AQUIFER MANAGEMENT PLAN OF KOPPAL TALUK, KOPPAL DISTRICT, KARNATAKA STATE

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AQUIFER MANAGEMENT PLAN OF KOPPAL TALUK, KOPPAL DISTRICT, KARNATAKA STATE

1. SALIENT INFORMATION

Name of the taluk : Koppal

District : Koppal

State : Karnataka

Area : 1,377 sq.km.

Population : 3,77,781

Annual Normal Rainfall : 623 mm

1.1 Aquifer management study area

Aquifer mapping studies were carried out in Koppal taluk, Koppal district of Karnataka, covering an area of 1,377 sq.kms under National Aquifer Mapping Project. Koppal taluk of Koppal district is located between north latitude 15º08'06" &15º25'47" and east longitude 75º53'06" & 76º25'47", and is covered in parts of Survey of India Toposheet Nos. 48M/15, 48M/16, 57A/3 and 57A/4. Koppal taluk is bounded by Yelburga taluk on north, Ballari taluk on south, Gangavathi taluk on east and Gadag on western side. Location map of Koppal taluk of Koppal district is presented in **Fig-1**.

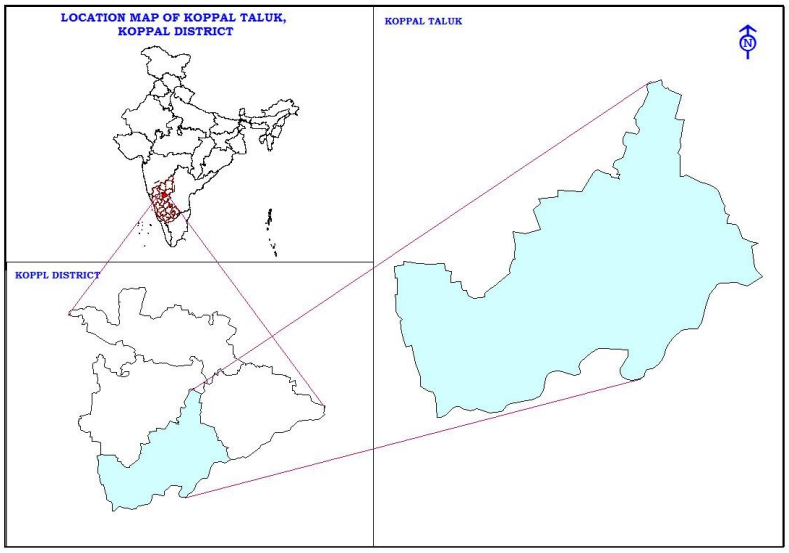

Fig 1: Location Map of Koppal Taluk, Koppal District

Koppal with population of about 3.77 lakh is the third least populous taluk of Karnataka. Taluk administration of Koppal taluk is divided into 4 Hoblies and 38 Gram Panchayaths. Koppal is the largest town in the taluk, which is the taluk and district

headquarter also. There are 144 inhabited and 7 uninhabited villages in the taluk. Out of 151 villages in the taluk, Koppal (Rural) is the most populous village with a population of 18988 and Attivatti is the least populous village with a population of 8. While Kawaloor is the biggest village in the taluk with an area of 103 km^2, Ayodhya is the smallest with one km^2 area. There are two cities in the taluk, Koppal City Municipal Council and Munirabad Project Area Census Town.

Koppal district was carved out of Raichur district on 1st April 1998. Koppal used to be known as Kopana Nagara, was an important town in olden days. It contains important historical locations such as Koppal Fort, Gavimath and the Male Mallappa Temple. It is also known as Jaina Kashi meaning the most sacred place for Jains, as it had more than 700 Basadis (Jain Prarthana Mandir).

1.2 Population

According to 2011 census, the population in Koppal taluk is 3,77,781 of which rural population is 2,98,411 constituting about 79%, and the urban population is 79,370, constituting about 21% of the total population. The taluk has an overall population density of 274 persons per sq.km and showed a decadal increase of about 20.3% during 2001-2011.

1.3 Climate and Rainfall

Koppal taluk enjoys arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Northern Dry agro-climatic zone of Karnataka state and is categorized as drought prone. The climate of the study area is quite agreeable and free from extremes. The year is usually divided into four seasons: summer from March to May; rainy season or south-west monsoon season from June to September; post- monsoon season covering the months of October and November and dry or winter Season from December to February.

The normal annual rainfall in Koppal taluk for the period 1981 to 2010 is 623 mm. Seasonal rainfall pattern indicates that, major amount of (406mm) rainfall is received during South-West monsoon seasons, which contributes to about 65% of the annual normal rainfall, followed by North-East monsoon season (139mm) constituting about 23% and remaining (77 mm) 12% during pre-monsoon season **(Table-1).**

Computations were carried out for the 30 year blocks of 1981- 2010, the mean

monthly rainfall in Koppal taluk is ranging between nil during February to 154 mm during September. The coefficient of variation percent for pre-monsoon, monsoon and post- monsoon season is 118, 211 and 156 percent respectively. Annual CV at this station works out to be 258 percent **(Table-1).**

Table-1: Statistical Analysis of Rainfall Data of Koppal Taluk (1981 to 2010)

Station		Jan	Feb	Mar	Apr	May	Pre	Jun	Jul	Aug	Sep	SW	Oct	Nov	Dec	NE	Annual
Koppal	Normal Rainfall (mm)	2	0	14	15	46	77	84	64	104	154	406	99	33	7	139	623
	ST DEV	5	2	48	19	38	65	70	45	83	115	193	73	51	19	89	241
	CV%	31	25	29	78	122	118	121	141	125	134	211	136	64	38	156	258

Based on occurrence and frequency of past drought events, the probability of occurrence of various intensities of drought at Koppal station has been studied. It has been observed that the frequency of occurrence of drought is once in 3 years in Koppal taluk.

1.4 Agriculture and Irrigation

Agriculture is the main occupation in Koppal taluk. Pulses, Maize, Bajra and Oil Seeds and Jowar are the main crops, covering major part of the cropped area. Jowar and Fruits are some other crops grown in the taluk. Due to limited availability of irrigation water, water intensive crops like Paddy and Sugarcane are grown in limited area only **(Table 2).**

Table 2: Cropping pattern in Koppal taluk 2016-17 (Ha)

Year	Paddy	Maize	Bajra	Jowar	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
	Area under cultivation (in ha)									
2016-17	4846	22798	15500	6822	26136	1425	2652	19510	698	727

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

It is observed that net sown area accounts for about 68% of total geographical area, while area sown more than once is about 8% of total geographical area in the taluk **(Table-3).**

Ground water is the major source for irrigation in the taluk, as about 89% of the net Irrigated area is catered through borewells **(Table-4).** About 10% (3000 hectares) of the net irrigated area is covered by canal system.

Table 3: land use in Koppal taluk 2016-17 (Ha)

Taluk	Total Geographical Area (sq.km)	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Koppal	1,36,755	10,779	16,902	13,421	93,527	10,694

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

Table 4: Irrigation details in Koppal taluk (Ha)

Source of Irrigation	Net area irrigated (Ha)	% of area
Canals	3000	10
Tanks	0	0
Wells	0	0
Bore wells	25,890	89
Lift Irrigation	38	1
Other Sources	0	0
Total	**28,928**	

Source: District at a Glance 2016-17, Government of Karnataka

1.5 Geomorphology, Physiography and Drainage

The geomorphology of the taluk is characterized by vast stretches of undulated plains interspersed with sporadic ranges or isolated clusters of low ranges of rocky hills. Ginigera hill with 622 m amsl represents the highest elevation point in the taluk **(Fig-2)**. The taluk is drained by only one major river system, Tungabhadra which is the tributary of Krishna. Tungabhadra a perennial river entering Koppal district near Kesalpura village, has a large number of rivulets and streams as tributaries, all of these generally go dry during the summer. The Maskihalla is one of the important non-perennial streams draining the taluk. Tungabhandra reservoir is located near Munirabad. Drainage of the taluk is presented as **Fig-3.**

1.6 Soil

The taluk is having predominantly fertile black soil with varying clayey and sandy mixtures. Red loamy soil cover is also seen in some parts of the taluk.

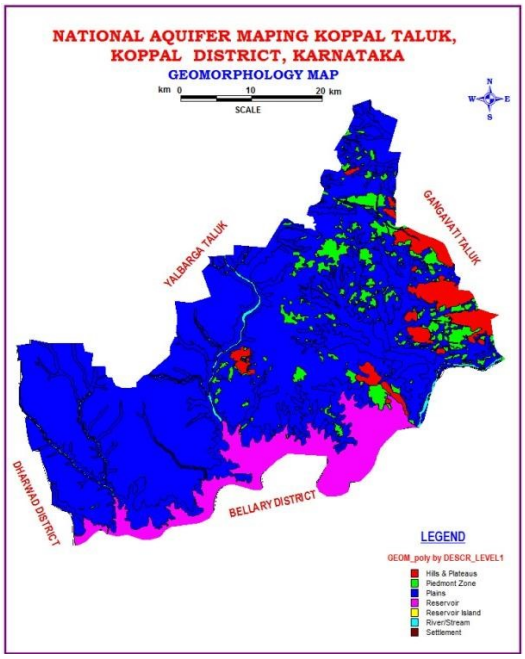

Fig 2: Geomorphology Map

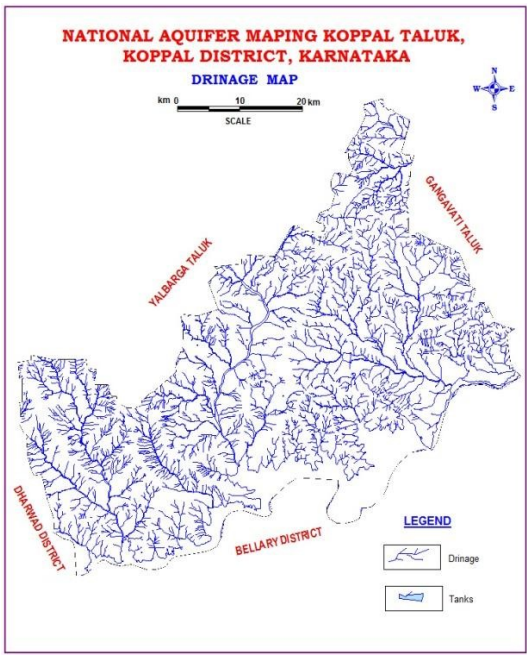

Fig 3: Drainage Map

1.7 Ground water resource availability and extraction

Aquifer-wise total ground water resources up to 200 m depth, is given in **Table-5** below.

Table 5: Total GW Resources (2017) (Ham)

Taluk	Annual Replenishable GW resources	Fresh In-storage GW Resources		Total availability of fresh GW Resources
		Phreatic	Fractured (down to 200 m)	Dynamic + Phreatic in-storage + fractured
Koppal	8396	10732	2970	22098

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

Net ground water availability for future irrigation development : 32.59

MCM Domestic and Industrial sector demand for next 25 years : 4.16

1.9 Water level behaviour

(a) Depth to water level(DWL)

Aquifer - I (Fig 4 & 5)

Pre-monsoon: 1.90 – 10.65 m bgl, Post-monsoon: 1.30 – 10.65 m bgl

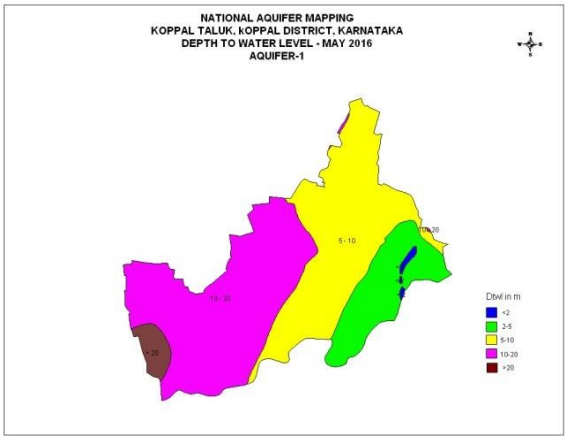

Fig.4: Pre-monsoon DWL (Aq-I)

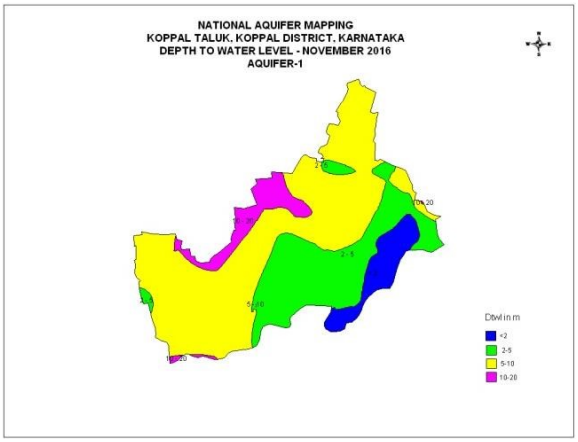

Fig.5: Post-monsoon DWL (Aq-I)

Fluctuation in Aquifer I is shown in Fig. 6

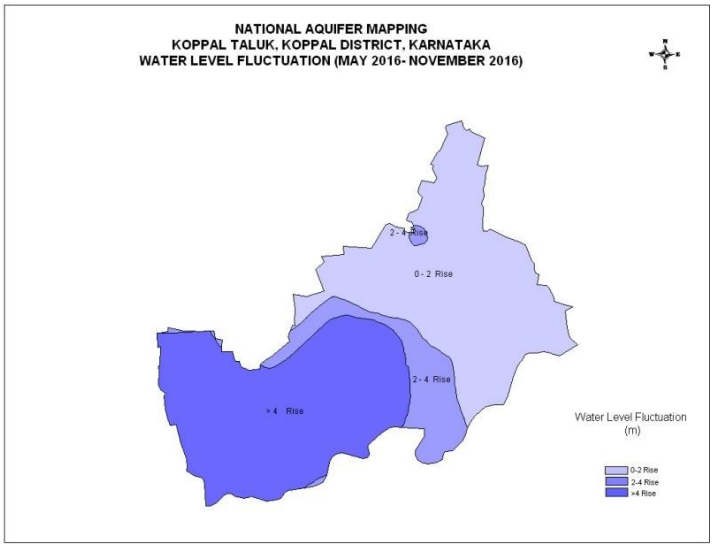

Fig.6: Water Level Fluctuation

2. AQUIFER DISPOSITION

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

i. **Aquifer-I (Phreatic aquifer)** comprising Weathered Granite Gneiss

ii. **Aquifer-II (Fractured aquifer)** comprising Fractured Granite Gneiss

In Koppal taluk, granite gneiss of Peninsular Gneissic Complex is the main water bearing formation **(Fig.7).** Ground water under phreatic conditions occurs in the weathered and decomposed mantle (Aquifer-I) and under semi-confined to confined conditions within in the deeper fractures of these formations (Aquifer-II). Depth of weathered zone (Aquifer-I) ranges from 4.0 mbgl to 38.0 mbgl, it is predominantly exploited through dug wells. The Phreatic aquifer has become partially de-saturated at places due to over-exploitation of the resource. Aquifer-II is exploited through borewells, these bore wells are generally drilled up to a maximum of 200 m bgl **(Table-6).** Ground water exploration reveals that aquifer-II fractured formation (Granite gneiss) was encountered between the depth range of 17 to 190 m bgl. Yield ranges from 0.29 to 24.2 m^3/hour. Transmissivity ranges from 1 to 100 m^2/day. The basic characteristics of each aquifer are summarized in **Table-7.**

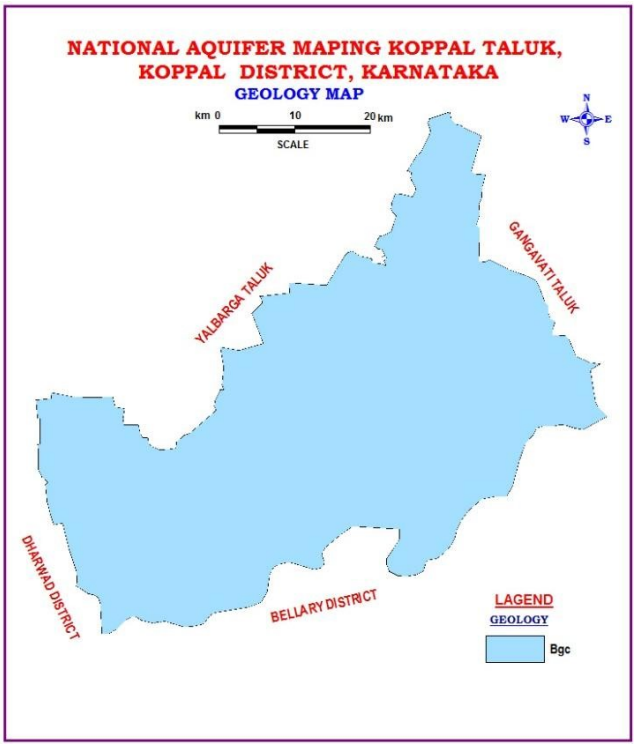

Fig 7: Geology Map

Table 6: Details of Ground water Exploration

Sl. No.	Location	Latitude	Longitude	Depth Drilled (m bgl)	Casing Depth (m bgl)	Fracture Zones (mbgl)	SWL (mbgl)	Q (lps)
1.	Indragi	15°26'25"	76°19'34"	200.00	7.93	19.0 – 20.0, 188.0 – 189.0	7.31	1.39
2.	Hosagal	15°31'49"	76°17'41"	200.00	12.47	17.4 – 18.4, 55.1 – 56.0,98.6 – 99.6	6.88	0.21
3.	Hatti	15°31'49"	76°11'42"	200.00	9.56	Dry		
4.	Chikkabagnal	15°16'30"	76°14'36"	200.00	17.55	27.36 – 28.50	10.63	0.75
5.	Ginigeri	15°20'45"	76°14'47"	200.00	17.16	Dry		
6.	Bisarhalli	15°16'30"	76°04'36"	200.00	11.29	63.84 – 64.50, 140.0 – 141.0	26.74	2.01
7.	Alawandi	15°13'58"	76°58'59"	200.00	25.69	32.1 – 33.1, 40.0 – 41.0	4.41	6.71
8.	Koppal	15°20'59"	76°09'16"	200.00	4.12	74.0 – 75.0	8.04	0.08
9.	Kavalur	15°17'22"	75°56'48"	200.00	27.46	Dry		
10.	Hire Kasanakandi	15°18'03"	76°16'11"	200.00	38.99	115.0 – 116.0, 170.0 – 171.0	10.48	2.44
11.	Bettagiri	15°12'41"	76°03'05"	200.00	23.58	Dry		

Table 7: Basic characteristics of each aquifer

Aquifer	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Weathered Granite Gneiss	Jointed /Fractured Granite Gneiss
Thickness range (m bgl)	4.0 – 38.00	Fractures upto to 190.00 mbgl depth
Depth range of occurrence of fractures (mbgl)	-	17.00 - 190.00 80% between 25.00 - 145.00
Range of yield potential (lps)	Partially de-saturated, up to 1.25 mbgl	0.08 - 6.71
T (m^2/day)	-	1
Quality, Suitability for Irrigation	-	Suitable
Suitability for Domestic purposes	-	Suitable
Remarks	Partially de-saturated, limited scope in topographic lows	Ground water potential fractures, 1 to 3sets likely up to the depth of 200 m bgl.

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

a. Aquifer-wise resource availability and extraction

(a) Present Dynamic Ground Water Resource (2017)

Taluk	Net Annual Ground Water Availability	Existing Gross Ground Water Draft For Irrigation	Existing Gross Ground Water 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
	HAM						%	
Koppal	8396	5365	359	5724	416	3259	68	SAFE

(b) Present total Ground Water Resource (in ham)

Taluk	Annual Replenishable GW Resources	Fresh In-storage GW Resources		Total availability of
		Phreatic	Fractured	Dynamic + phreatic in-storage + fractured in-storage
Koppal	8396	10732	2970	22098

(c) Comparison of Ground Water Availability and Draft Scenario in Koppal 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	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development
	2009			**2011**			**2013**					
Koppal	8395	5733	68%	7846	4834	62%	7869	5477	70%	8396	5724	68%

b. Chemical Quality of Ground Water and Contamination

In general, ground water quality in Koppal taluk is good for drinking purpose as per "Indian Standard Drinking Water Specification 2009" except at some places where higher concentrations of Nitrate and Fluoride and higher Electrical Conductivity have been recorded in ground water samples. Fluoride, Nitrate and Electrical Conductivity maps are given as **Fig 8, 9 & 10**.

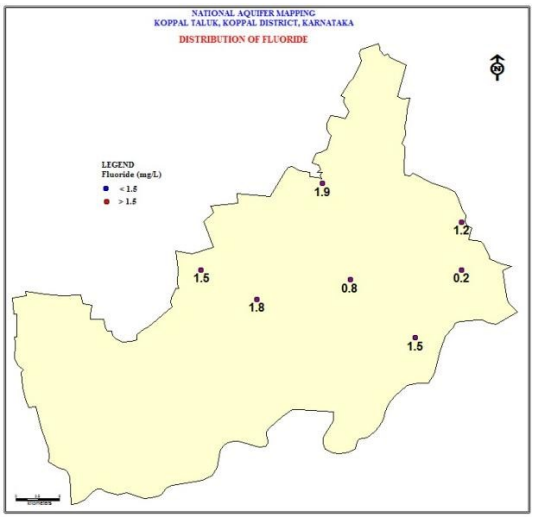

Fig 8: Fluoride Map

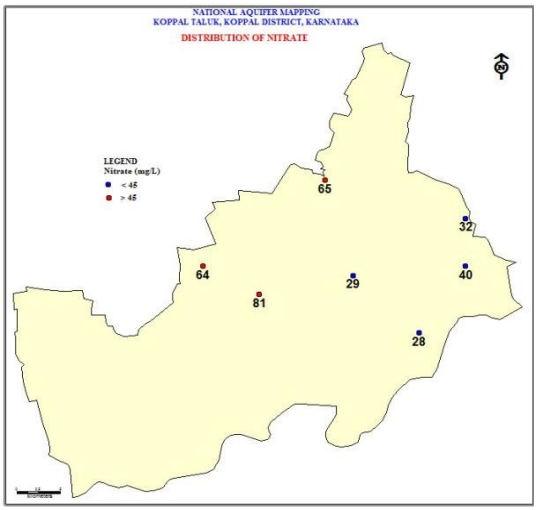

Fig 9: Nitrate Map

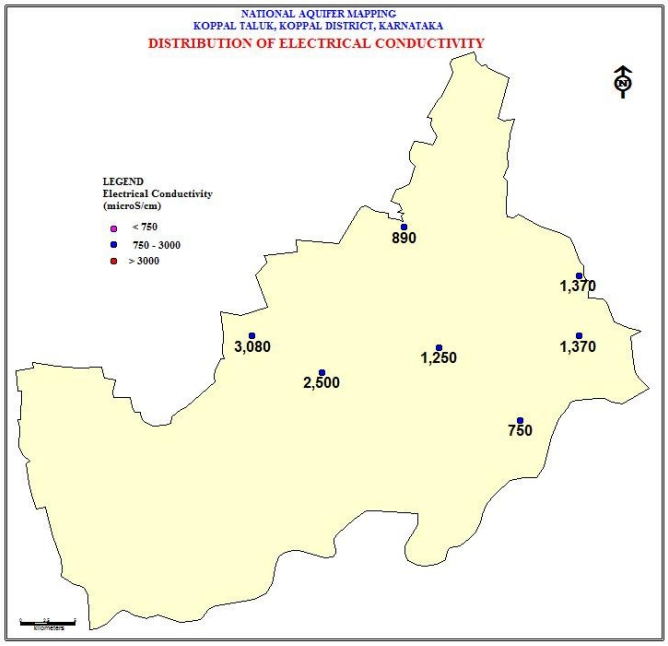

Fig 10: Electrical Conductivity Map

4. GROUND WATER RESOURCE ENHANCEMENT

4.1 Aquifer wise space available for recharge and proposed interventions

Recharging the drying phreatic aquifer (Aq-I) in the taluk through construction of artificial recharge structures, viz., check dams, percolation tanks and point recharge structures **(Table-8)** is a viable option in non-command feasible areas. 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 8: Quantity of non-committed surface runoff and expected recharge through AR structures (As per Master Plan on Artificial Recharge in Karnataka & Goa,2020)

Artificial Recharge Structures Proposed	Koppal Taluk
Non committed monsoon runoff available (MCM)	76.490
Number of Check Dams	256
Number of Percolation Tanks	69
Number of Subsurface dykes	02
Tentative total cost of the project (Rs. in lakhs)	3977.062
Expected recharge (MCM)	57.367
Additional irrigation potential (in Lakh hectares)	0.069
Cost Benefit Ratio (Rupees / cu.m. of water harvested)	6.93

4.2 Improvement in GW availability due to Recharge, Koppal taluk

Table 9: Improvement in GW availability due to Recharge, Koppal taluk

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	Additional potential from proposed irrigation development schemes through inter-basin transfer	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	HAM	%	%
Koppal	8396	5724	68	5736.7	-	14132	40.5	27.5

After implementation of Artificial Recharge structures for GW recharge, the annual ground water availability will increase from 8396 to 14132 ham and the expected improvement in stage of development is 27.5% i.e., from 68% to 40.5%.

5. DEMAND SIDE INTERVENTIONS

5.1 Advanced irrigation practices

It is observed that presently, ground water through borewells is the only source for irrigation in the taluk. Water use efficiency measures are need of the hour. Adopting these measures will contribute in ground water resource enhancement in the long run. Efficient irrigation practices like drip irrigation and sprinkler need to be adopted by the farmers in the existing 25,890 ha of gross ground water irrigated area. Presently, draft through irrigation is 5365 ham. Efficient irrigation techniques will contribute in saving ground water by 1609.5 ham and thus, will improve stage of development by 4.14%, bringing stage of GW development from 40.5% to 36.36% **(Table-10).**

Table-10: Improvement in GW availability due to saving by adopting water use efficiency

Taluk	Cumulative annual ground water availability	Existing gross groundwater draft for all uses	Stage of groundwater development after implementing AR structures &Surface water schemes	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 groundwater development
	Ham	Ham	%	Ham	Ham	%	%
Koppal	14132	5724	40.5	1609.5	15741.5	36.36	4.14

5.2 Change in cropping pattern

In Koppal taluk, no water- intensive crop, like Paddy or Sugarcane is being grown using ground water, and hence, it may not be of any consequence to apply any modifications in cropping pattern. Hence, change in cropping pattern is not suggested.

5.3 Additional area of irrigation

After adopting various water use efficiency techniques and recharge measures and its resultant savings, the stage of development is expected to be 36.36% in the taluk, which

will bring the taluk in a much better condition. Hence bringing additional area under irrigation may be possible with a long-term resource management point of view. Further, courtsey canal irrigation, the taluk now has a vast water-logged area (DTWL 0 – 2.0 m bgl) and water-logging prone area (DTWL 2.0 – 5.0 m bgl). Theoretically, withdrawal of ground water to the tune of about 950 ha m from these water-logged and water-logging prone areas, is possible. Such withdrawal will help in improving the ground water resource position as well as increase in the area of irrigation.

5.4 Regulation and Control

Koppal taluk has been categorized as 'SAFE', since the Stage of ground water development is 68% (GE March 2017). Judicious utilisation of Ground Water resources i.e., controlled additional development of the resources coupled with conservation measures is very much required. Ground water recharge component needs to be encouraged in feasible areas in the taluk to have sustainability of the abstraction structures and the development.

5.5 Other interventions proposed:

Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.

5.6 Summary

The summary of Management plan of Koppal taluk is given in **Table-11**.

Table-11: Summary of Management plan of Koppal taluk

Koppal taluk is "SAFE" and present stage of GW Development (2017)	68%
Net Annual Ground Water Availability (MCM)	83.96
Existing Gross Ground Water Draft for all uses (MCM)	57.24
Total GW Resources (Dynamic & Static up to the depth of 200 m bgl) (MCM)	220.98
Cumulative Ground Water Availability after Implementation of Artificial Recharge Structures (MCM)	141.32
Change in Stage of GW development (%)	68 to 40.5
Expected Saving due to adopting WUE measures (MCM)	16.095
Cumulative Ground Water Availability (MCM)	157.415
Change in Stage of GW development (%)	4.14
Change in Stage of GW development (%)	40.5 to 36.36