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

Koppa Taluk, Chikmagalur District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

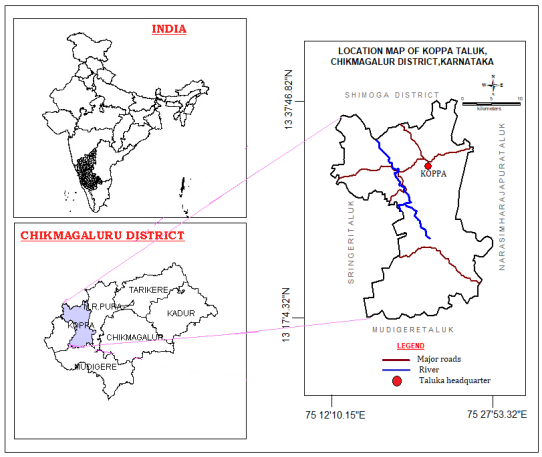
FOR OFFICIAL USE ONLY
No. SWR/RP/NQM/2023-24/13

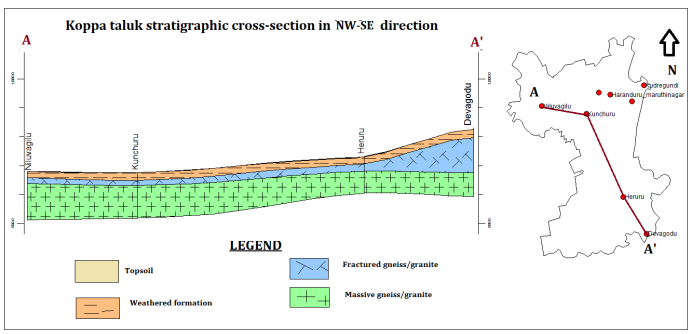
भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास एवं गंगा संरक्षण विभाग
केन्द्रीय भूमिजल बोर्ड
दक्षिण पश्चिम क्षेत्र,
बेंगलुरु

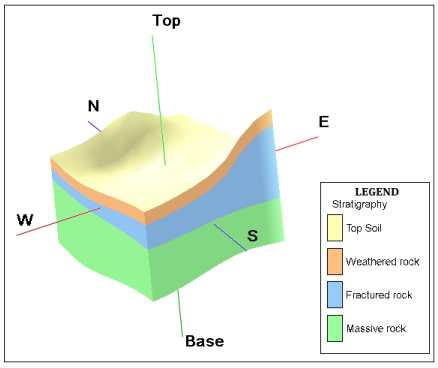
Government of India
Ministry of Jal Shakti
Department of Water Resources, River Development & Ganga Rejuvenation
Central Ground Water Board
South Western Region,
Bengaluru

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

(AAP – 2022-2023)







By

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

MAY 2023

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

Contents

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

1.0 SALIENT INFORMATION

Name of the Taluk: **KOPPA**

District: Chikmagalur

State: Karnataka

Area:566sq.km

Population: 84882

Annual Normal Rainfall:2907mm

1.1 Aquifer Management study area

Aquifer mapping studies were carried out in Koppa taluk, Chikmagalur district of Karnataka, covering an area of 566sq.kmunder National Aquifer Mapping Project. Koppa taluk of Chikmagalur district is located between North latitude 13°17'4.32" to 13°37'46.82" &East longitude 75°12'10.15" to 75°27'53.32"and is covered in parts of Survey of India Toposheet Nos. 48O/2, 48O/6 and 48O/7.Koppatalukis bounded by Shimoga district on North, Narsimharajapura taluk of Chikmagalur districton East, Sringeri taluk of Chikmagalur district on West and Mudigere taluk of Chikmagalur district on South side. Location map of Koppa taluk of Chikmagalur district is presented in **Figure 1.**

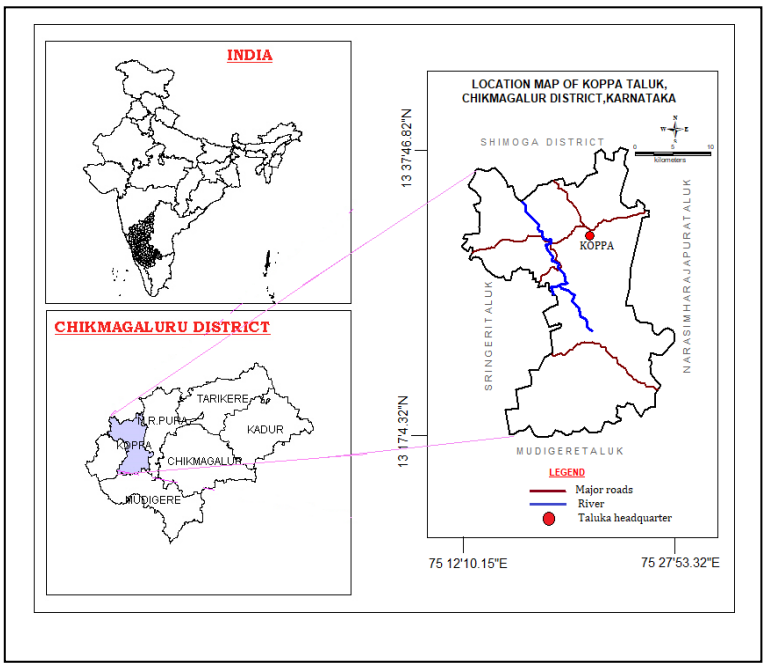


Figure 1: Location Map of Koppa taluk, Chikmagalur district, Karnataka

Taluk administration of Koppa is divided into 03 Hoblies and 22 Gram Panchayats. There are 80 inhabited and no uninhabited villages in the taluk.

1.2 Population

According to 2011census, the population in Koppa taluk is 84,882 ofwhich41,746 male and 43,136 female population.

1.3 Rainfall

There are twenty-three(23) rain gauge stations located in Koppa taluk. Normal annual rainfall is 2907mm.The monthly rainfall data from 2001 to 2021 is given in Table 1. The rainfall data reveals that the annual rainfall ranges from 1911 to 4046 mm. The highest annual rainfall is observed in the year 2018 while it is low in the year 2003. The annual rainfall trend is rising as evident from Fig. 2.

Table 1: Monthly rainfall data of Koppa taluk

Year	JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	MON	OCT	NOV	DEC	POST	ANNUAL
2001	0	0	0	109	40	149	513	681	604	148	1946	60	45	0	105	**2200**
2002	0	67	0	28	57	152	387	374	775	151	1687	204	7	0	211	**2050**
2003	0	0	2	107	2	111	355	656	465	133	1609	191	0	0	191	**1911**
2004	0	0	16	36	182	234	581	616	957	166	2320	34	28	0	62	**2616**
2005	0	0	0	80	64	144	428	1176	759	288	2651	176	17	0	193	**2988**
2006	0	0	4	5	202	211	501	1096	867	170	2634	44	237	0	281	**3126**
2007	0	0	0	33	35	68	670	1015	937	443	3065	146	34	0	180	**3313**
2008	0	56	203	65	37	361	488	761	1019	244	2512	104	22	0	126	**2999**
2009	0	0	118.8	21.4	58	198.2	258	1517	496	405	2676	192	45	86	323	**3197.2**
2010	2	0	21	100	82	224	417.	857.	677.	35	2309.	17	221	2	396	**2929.2**

	1						2	2	8	7	2	3				
2011	0	0	0	89	18	107	600	812	600	377	2389	120	5	0	125	**2621**
2012	0	0	0	143	13.2	156.2	247	578	996	320	2141	43	150	0	193	**2490.2**
2013	0	0	0	17	0	17	247	578	996	320	2141	43	150	0	193	**2351**
2014	1	5.4	8.6	56.2	127	198.2	287	1446	1007	330	3070	99	23	10	132	**3400.2**
2015	0	0	130	61	164	355	578	527	374	118	1597	97	73	0	170	**2122**
2016	1	0	10	23	117	151	525	726	565	219	2035	128	107	7	242	**2428**
2017	0.21	0	14	5	144	163.21	440	681	637	194	1952	150	0	0	150	**2265.21**
2018	0	0	68	105	328	501	923	1373	1043	100	3439	74	16	16	106	**4046**
2019	0	0	0	17.2	16.2	33.4	274	802	1356	541	2973	237	6	4	247	**3253.4**
2020	1	0	6	41	144	192	338	501	1030	505	2374	166	30	6	202	**2768**
2021	81.6	52.8	8.0	84.5	220.3	439.2	534.1	879.5	433	235	2081.6	275	203	5	483	**3013**

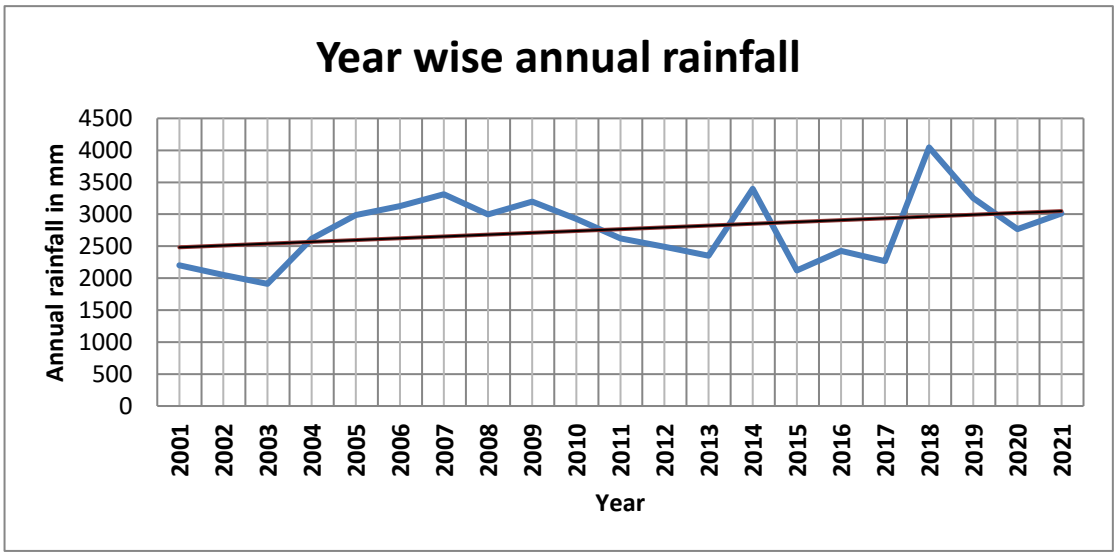


Figure 2: Year wise annual rainfall variation in Koppa taluk

Koppa 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.

1.4Agriculture and Irrigation

Agriculture is the main occupation in Koppa taluk. Pulses and Paddy are the major food crops grown in the taluk in 6613 ha area and 3136 ha area respectively. Total area under spices and condiments is 5223ha.Arecanut and coconut are major cash crops grown in 8551 ha and 221ha area respectively **(Table 2)**.

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

Paddy	Pulses	Fruits	Vegetables	Oil seeds	Total condiment and spices	Arecanut	Coconut	Total plantation crops
3136	6613	306	3779	4	5223	8551	221	11639

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

The total geographical area of the taluk is 56600 ha. The area under forest cover is 9684 ha. The area not available for cultivation is 3664 ha. Total fallow land is 5425 ha. The net sown area is 16747 ha and the area sown more than once is 14836 ha. Landuse pattern of the taluk is represented in map as Figure 3 and in pie diagram as Figure 4.As per figure 4,29% of the total geographical area is net sown area,38% is permanent pastures and groves,10% is fallow land and 17% is area under forest.

It is observed that net sown area accounts for about 30% of total geographical area, while area sown more than once is 26% of total geographical area in the taluk **(Table 3).** As per the data available, 166 tanks irrigate 293ha net area,200 dug wells irrigate 100ha net area and 741 borewells irrigate 259 net area. The net area irrigated through surface water is 293ha and net area irrigated through groundwater is 259ha.Net area irrigated through other sources is 8193ha **(Table 4).**The net area irrigated by various sources is represented in the pie diagram in **figure 5**. From the pie diagram it is evident that 3% area is irrigated by surface water, 4% area is irrigated by groundwater and 93% is irrigated by other sources. The net irrigated area vs net sown area is represented in the pie diagram in **figure 6.**

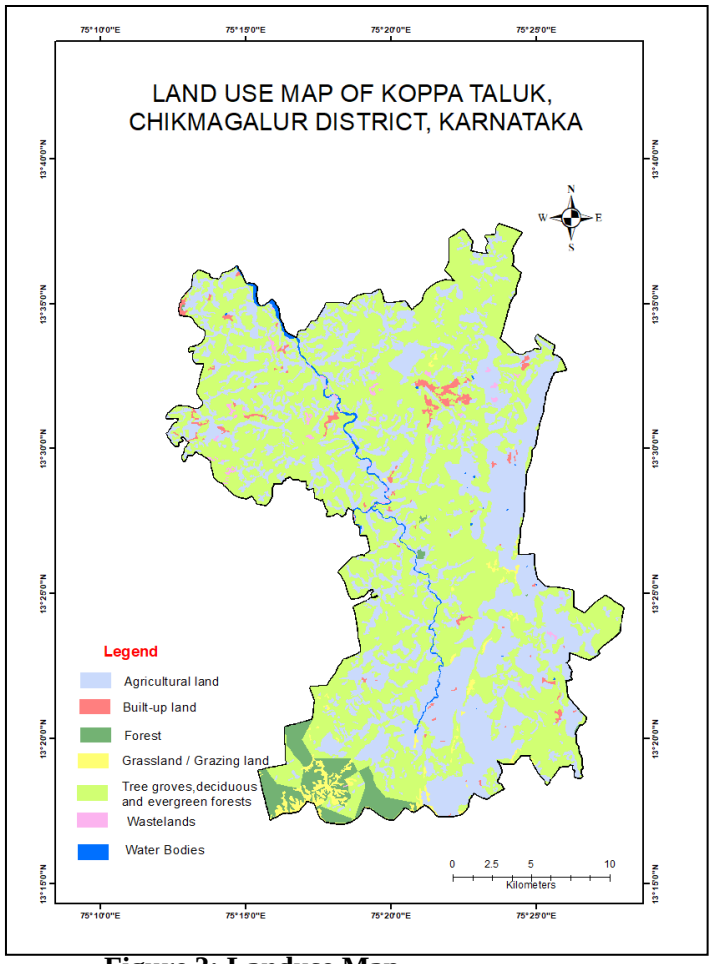


Figure 3: Landuse Map

Table 3: Details of landuse in Koppataluk2018-2019(Ha)

Total Geographical Area	Area under Forest	Area not available for cultivation	Other uncultivated waste	Fallow land	Net sown area	Area sown more than once
56600	**9684**	**3664**	**21700**	**5425**	**16747**	**14836**

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

Table 4: Irrigation details in Koppataluk(Ha)

Source of Irrigation	Nos./Length	Net area irrigated (Ha)	Gross area Irrigated (Ha)
Canals	0	0	0
Tanks	166	293	293
Total Surface water		**293**	**293**
Wells	200	100	100
Bore wells	741	259	259

Total ground water		**359**	**359**
Lift Irrigation	640	0	0
Other Sources (Rain water harvesting systems and water from springs)	-	8193	8193
Total		**8845**	**8845**

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

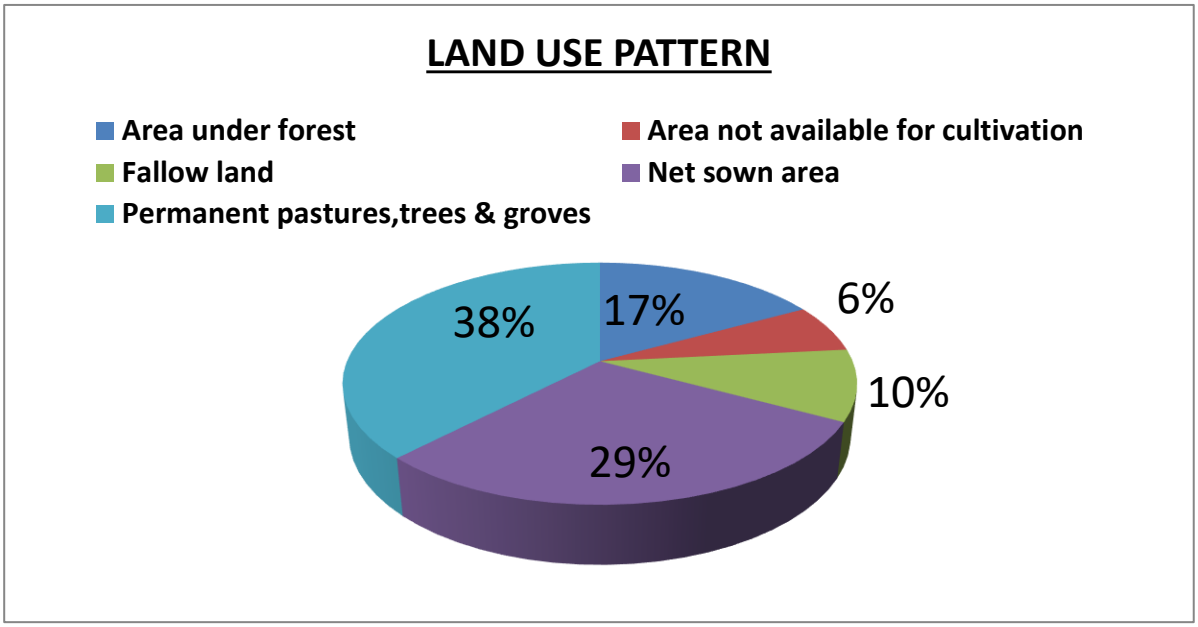


Figure 4: Pie diagram depicting land use pattern in Koppa taluk

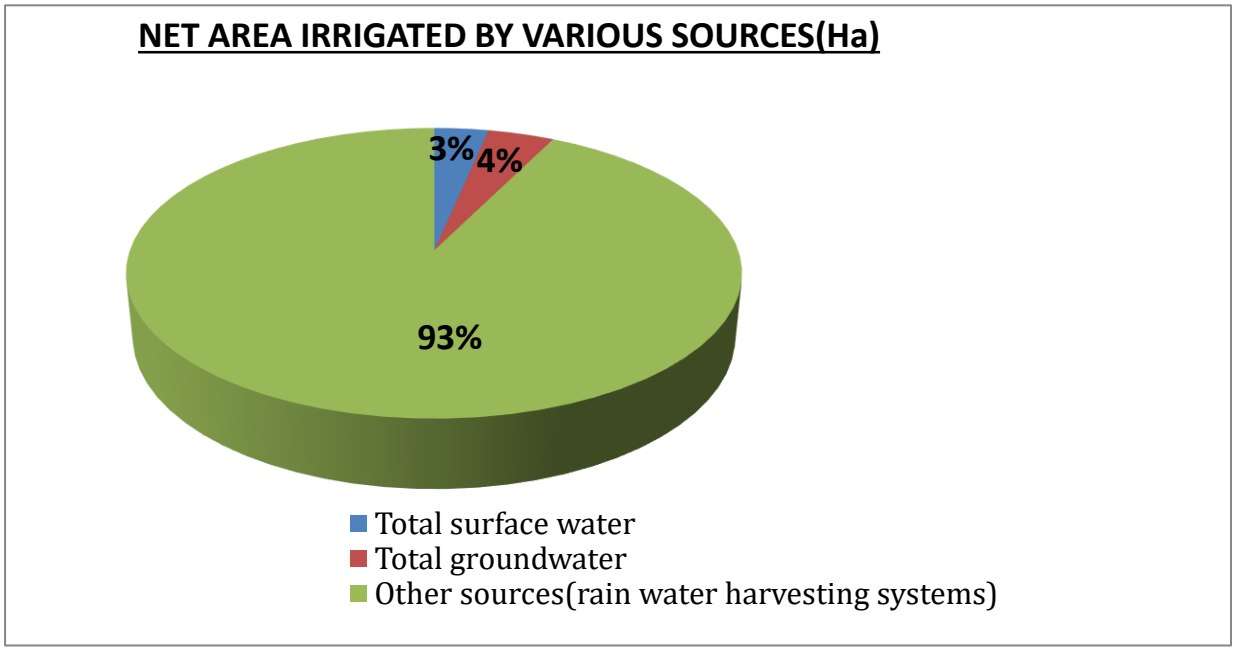


Figure 5: Pie diagram depicting net area irrigated by various sources in Koppa taluk

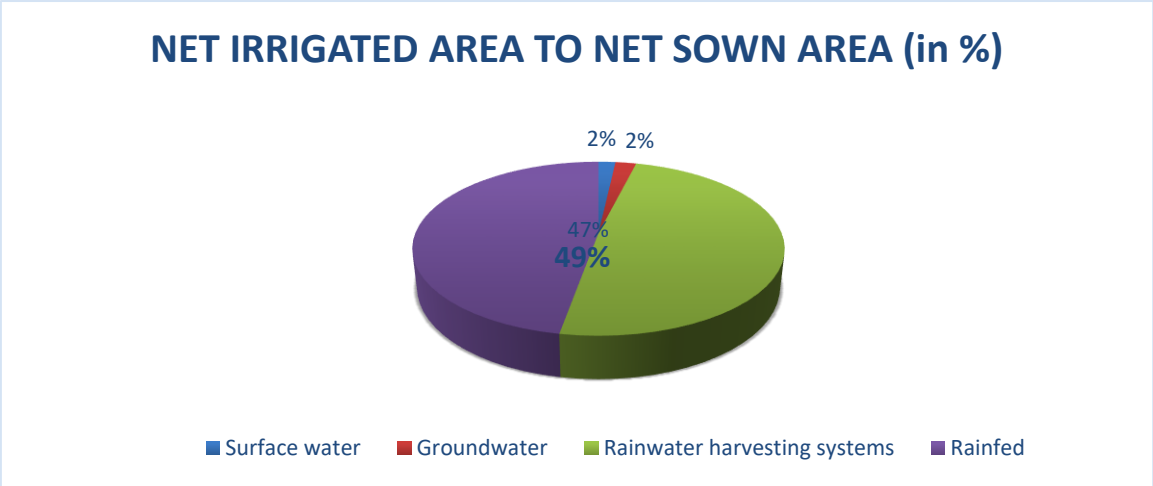


Figure 6: Pie diagram depicting net area irrigated to net area sown in Koppa taluk

1.5Geomorphology, 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 789m amsl. There are out crops of rocks as hills and few fertile shallow valleys **(Figure 7)**. The taluk is drained by Tunga river and Sita river **(Figure 8).**The drainage pattern is dendritic to sub-dendritic. Elevation >1000m amsl is seen in the Eastern and Southern part of the taluk **(Figure 9)**. In hilly areas of the taluk, slope varies between 15° to 20° **(Figure 10)**. Due to steep slope of land, denser drainage pattern and high runoff water infiltration is low in the north-eastern and south-western part of taluk. The general slope in the taluk is in southeast to northwest direction.

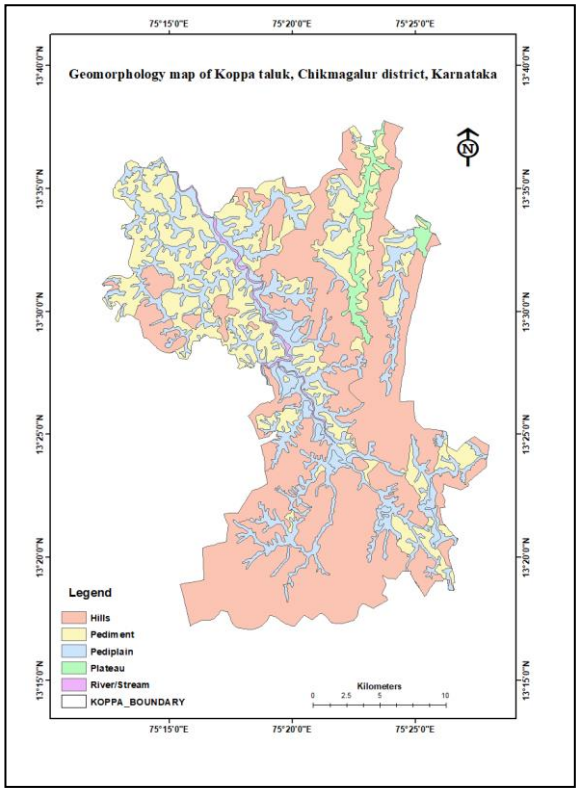


Figure 7: Geomorphology map

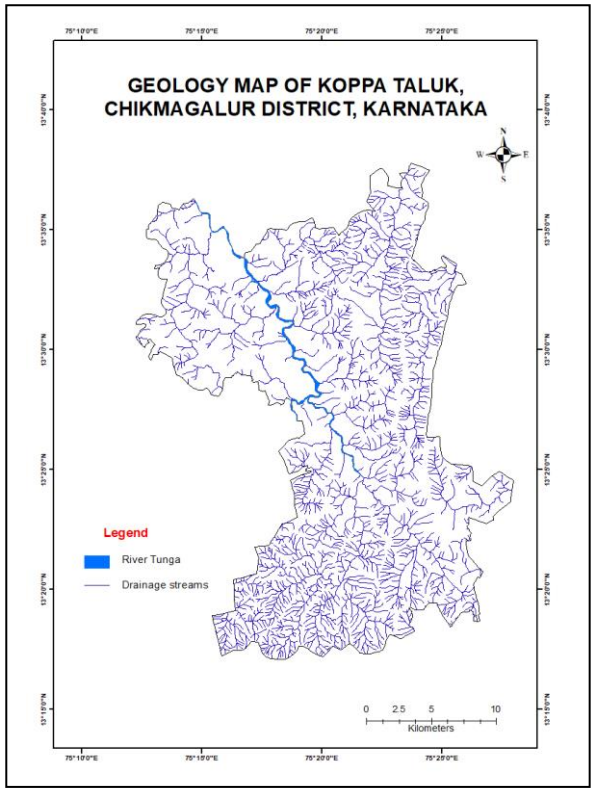


Figure 8: Drainage map

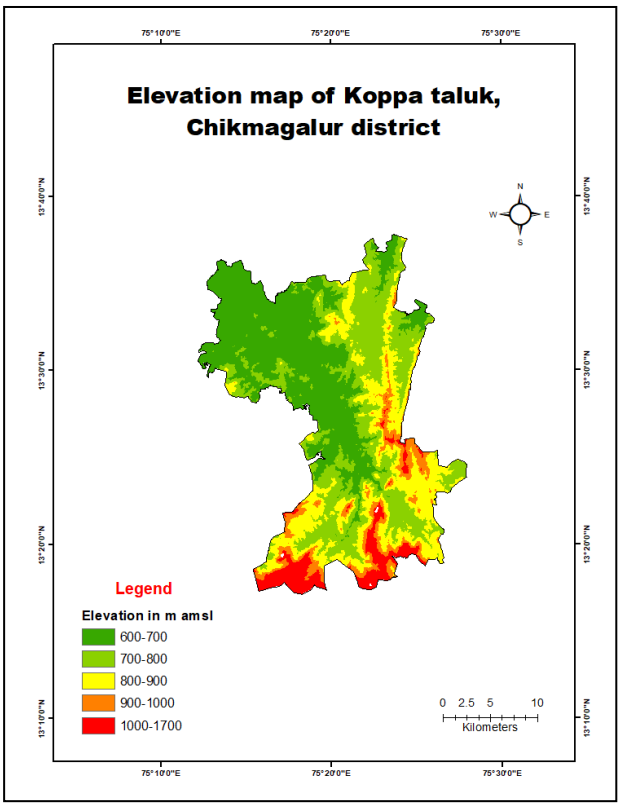


Figure 9: Land Elevation map of Koppa taluk

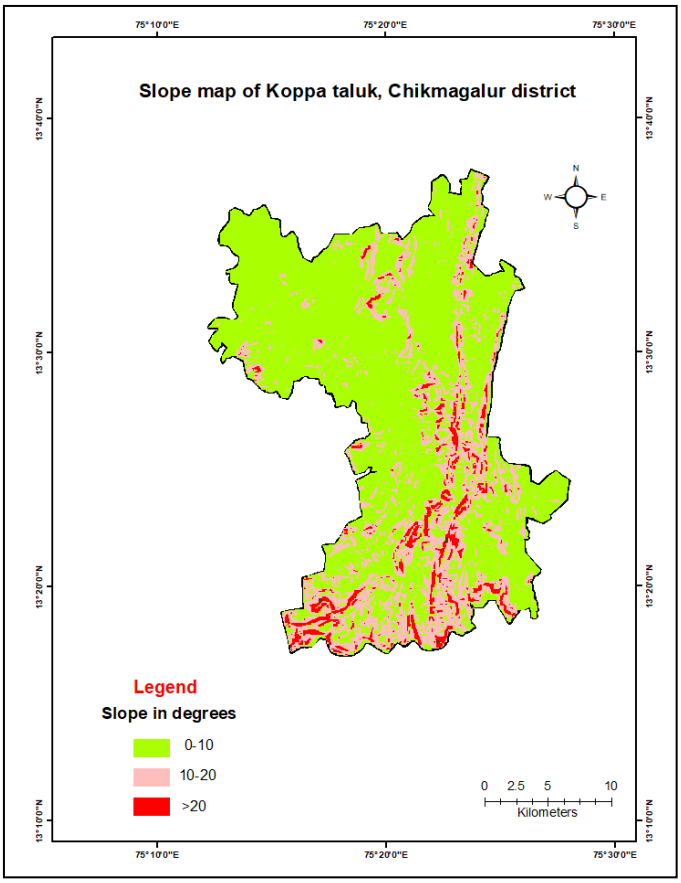


Figure 10: Slope map of Koppa taluk

1.6 Soil

Ultisols and alfisols, i.e, deep red clayey soils and deep brown clayey soils form 80% of the soils of the taluk. 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. **(Figure11).**

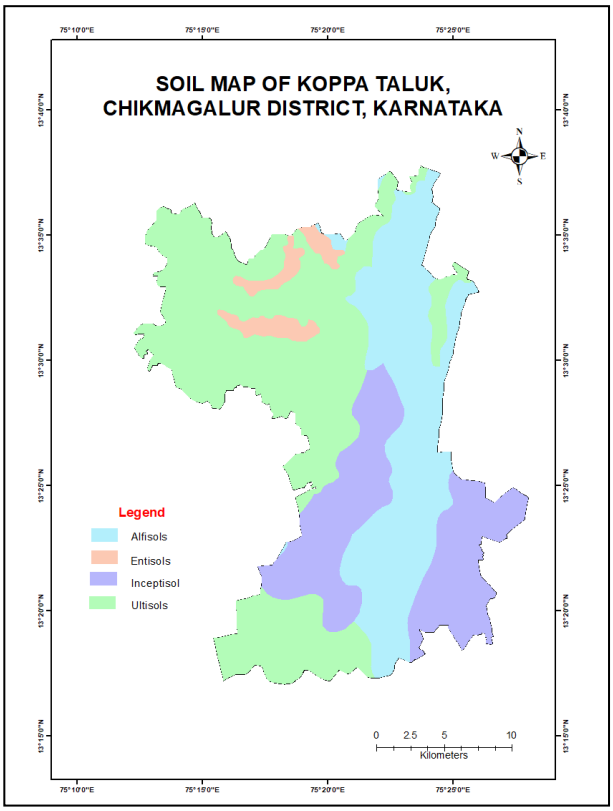


Figure 11: Soil map

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 Koppa taluk as in 2022 is shown in **Table5a**. The annual extractable water resource is 4434.49 ham. Total groundwater extractions for irrigation and domestic use is 1229.63 ham. Annual GW Allocation for domestic use as on 2025 is160.97ham.Net Ground Water Availability for future use is 3203.64ham. The stage of extraction is 27.72% and taluka falls in Safe category. The details of dynamic (Phreatic) ground water resources for Koppa taluk as in

2020is shown in **Table5b**.The annual extractable water resource is 7866.83 ham. Total groundwater extractions for irrigation and domestic use is 987.98 ham. Annual GW Allocation for domestic use as on 2025 is154.17ham.Net Ground Water Availability for future use is 6873.05ham.The stage of extraction is 12.56% and taluka falls in Safe category.

The details of dynamic (Phreatic) and phreatic in-storage and fractured aquifer ground water resources for Koppa taluk as in 2017 is shown in **Table5c**.The stage of development of the taluk was 17%(safe).

Table5a: Detail of Dynamic Ground Water resource, Koppa taluk (as on March 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 (%)
Koppa	4434.49	1069.88	159.75	1229.63	160.97	3203.64	27.72(safe)

Table 5b: Detail of Dynamic Ground Water resource, Koppa 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 (%)
Koppa	7866.83	839.60	148.38	987.98	154.17	6873.05	12.56 (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**
Koppa	5918	**Phreatic**	**Fractured (Down to 200m)**	**Dynamic + phreatic in-storage + fractured**
		21415	1239	28572

1.8 Data Availability, Data Adequacy and Data gap Analysis

The taluk has total geographical area of 566 sq.km, out of which 392.96 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, sono 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**.

Table6: Data availability and gap analysis, Koppa taluk

Activity		Required	Available	Gap
Exploration		7	8	2
Water level monitoring	Aquifer-I	7	9	nil
	Aquifer-II	0	4	0
Quality monitoring		7	7	nil
Geophysical studies		10	nil	10

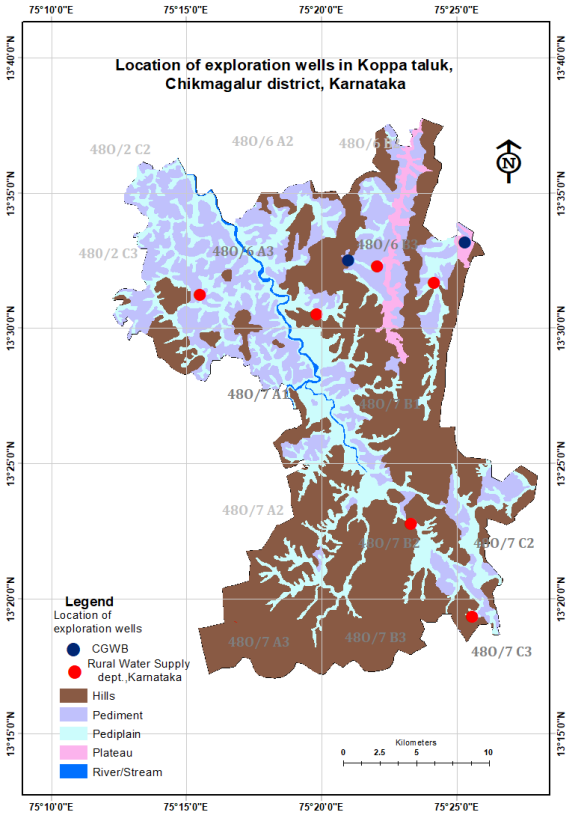


Figure 12: Location of exploration wells drilled by CGWB and RWS, Karnataka in Koppa taluk

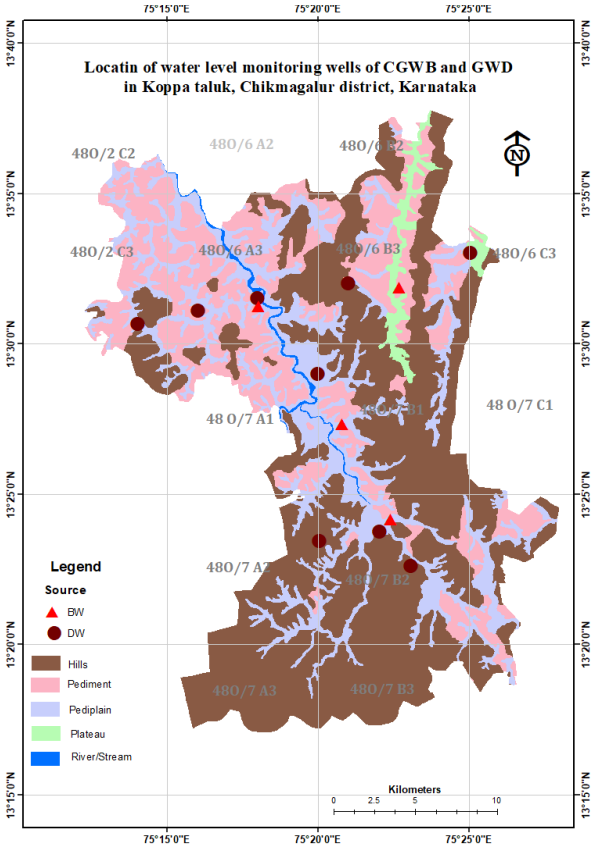


Figure 13: Location of water level and quality monitoring wells of CGWB and GWD, Karnataka in Koppa taluk

Table.7 Detail of data gap analysis, Koppa taluk Koppa taluk falls in Survey of India toposheet nos.48 O/2, 48O/6 and 48O/7			
Toposheet no.	**48O/2**		
	Keywell	**EW**	**Geophysical**
C3	Present **Aquifer-I** 1.Shanuvalli DW	Data gap Proposed village:Shanuvalli	Data gap Proposed village:Shanuvalli
Toposheet no.	**48O/6**		
Quadrant	**Keywell**	**EW**	**Geophysical**
A3	Present **Aquifer-I** 1.Kalanayakanakatte DW 2.HariharpuraDW **Aquifer-II** 1.HariharpuraBW	Present 1.Niluvagilu 2.Kunchuru	Data gap Proposed village: Hariharapura, Niluvagilu, Bhandigadi
B2	Dense mixed jungle	Dense mixed jungle	Dense mixed jungle
B3	Present **Aquifer-I** 1.KoppaDW **Aquifer-II** 1.Koppa BW	Present 1.Koppa 2.Nuggi 3.Haranduru Maruthinagara	Data gap Proposed village:Koppa
C3	Present **Aquifer-I** 1.Kudregundi DW **Aquifer-II** 1.Kudregundi BW	Present 1.Kudregundi	Data gap Proposed village:Kudregundi
Toposheet no.	**48O/7**		
Quadrant	**Keywell**	**EW**	**Geophysical**
A1	Present **Aquifer-I** 1.Narve DW	Data gap Proposed village:Narve	Data gap Proposed village:Narve
A2	Present **Aquifer-I** 1.AgalagundiDW	Data gap Proposed village:Agalagundi	Data gap Proposed village:Agalagundi
A3	Forest and hills	Forest and hills	Forest and hills
B1	Present **Aquifer-I** 1.KalkereBW	Data gap Proposed village:Kalkere	Data gap Proposed village:Kalkere
B2	Present **Aquifer-I** 1.JayapuraDW 2.HerurDW **Aquifer-II** 1.JayapuraBW	Present 1.Heruru	Data gap Proposed village:Jayapura, Heruru
B3	Forest and hills	Forest and hills	Forest and hills
C2	Present **Aquifer-I** Seegodu DW	Present 1.Devagodu	Data gap Proposed village: Seegodu,Devagodu

1.9 Water level behaviour

The water level data have been monitored from the representative dug well and borewells for both pre and post-monsoon seasons (Table 9). During pre-monsoon season in i) aquifer-I (phreatic) water level ranges from 3.45 to 11.05mbgl**(Figure 14)**, ii) aquifer-II (fractured) water level ranges from 10.90 to 25.10mbgl, whereas in post-monsoon it varies from 3.27 to 8.25 m bgl in aquifer-I (phreatic)**(Figure 15)** and 6.90 to 22.60 mbgl in aquifer-II (fractured). The seasonal water level fluctuation in aquifer-I is rise in the range of 0.15 m to 3.05 m and fall in the range of 0.19m to 0.21m.The seasonal water level fluctuation in aquifer-II is rise in the range of 0.50m to 2.50m and fall in the range of 0.19m to 0.30m. The pre-monsoon decadal (2012-2021) average water level for aquifer-I varies from 3.41 to 12.01mbgl **(Figure 16)**. The post-monsoon decadal average water level for aquifer-I varies from 2.51 to 8.23mbgl **(Figure 17)**. The pre-monsoon decadal (2012-21) average water level vs May 2022 water level fluctuation map for phreatic aquifer indicates fall 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 also indicates fall in water level in major parts of the taluk**(Figure 19)**.

Table.9: Depth to water level monitoring stations in Koppa taluk

Sl. No.	Well type	Village name	DTWL (m bgl) (Pre-monsoon 2022)	DTWL (m bgl) (Post-monsoon 2022)	Seasonal Fluctuation (m)
1	Dugwell	Agalegundi	9.30	6.25	3.05
2	Dugwell	Hariharapura	8.10	7.06	1.04
3	Dugwell	Herur	7.30	4.99	2.31
4	Dugwell	Jayapura	8.20	8.05	0.15
5	Dugwell	KalanaikanaKatte	9.90	8.25	1.65
6	Dugwell	Koppa A	6.6	4.9	1.70
7	Dugwell	Kudregudi	7.79	8	(-)0.21
8	Dugwell	Narve	5.77	4.44	1.33
9	Dugwell	Samse	5.72	3.27	2.45
10	Dugwell	Shanuvalli	3.45	3.64	(-)0.19
11	Dugwell	Seegodu	11.05	7.94	3.11
12	Borewell	Hariharapura	10.90	10.40	0.50
13	Borewell	Jayapura	12.60	12.90	(-)0.30
14	Borewell	Koppa (Rural)	25.10	22.60	2.50

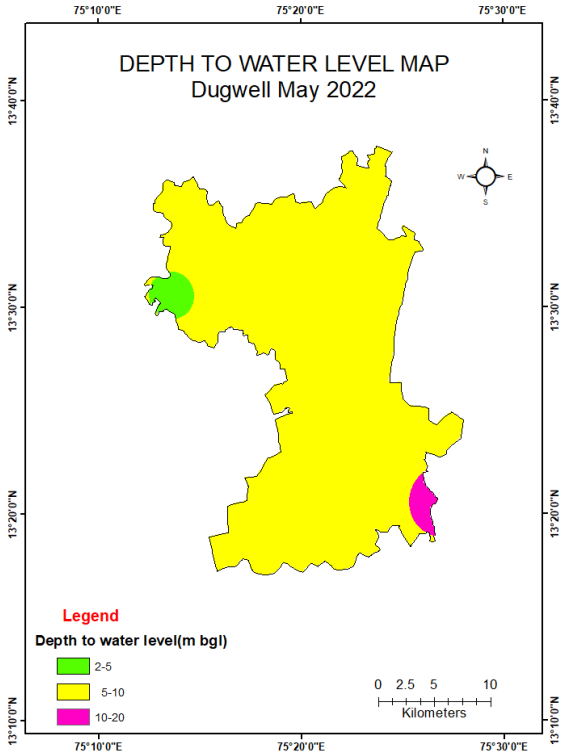


Figure 14: Pre-monsoon depth to water level map of aquifer-I of Koppa taluk

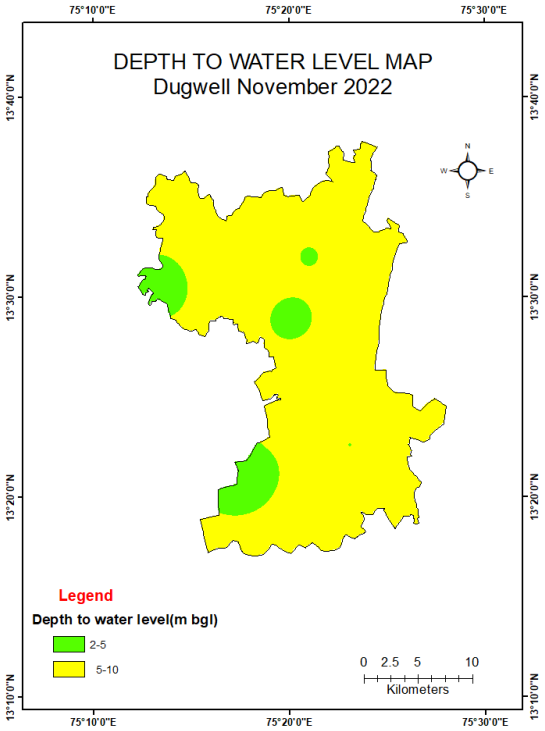


Figure 15:Post-monsoon depth to water levelmap of aquifer-I of Koppa taluk

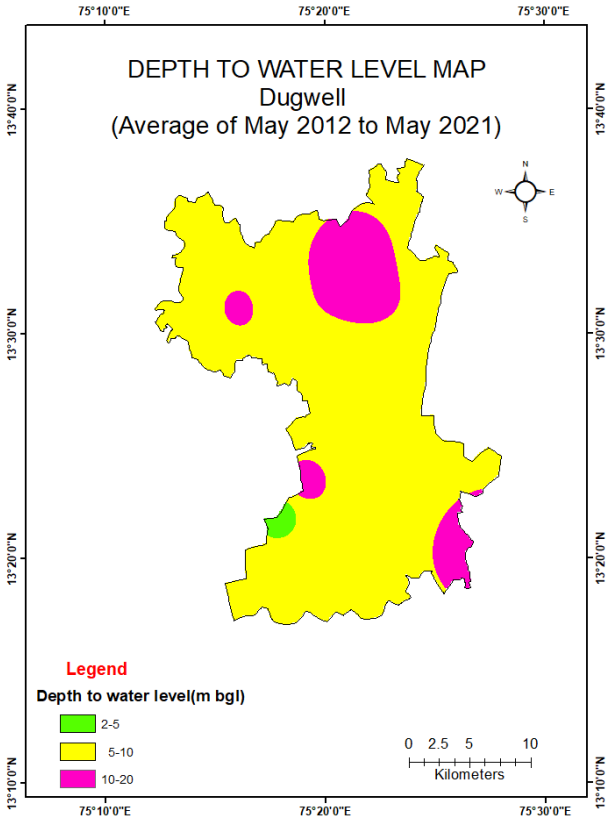


Figure 16: Pre-monsoon decadal average water level map

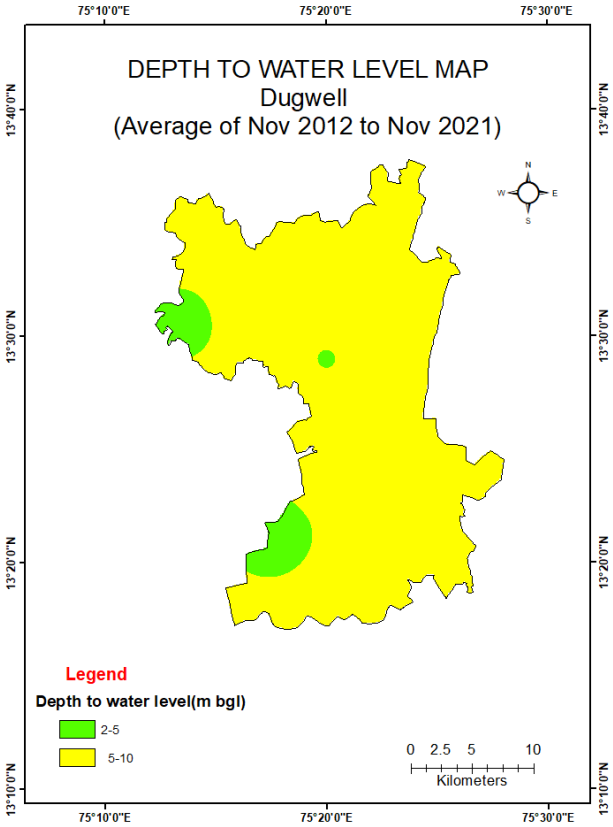


Figure 17: Post-monsoon decadal average water level map

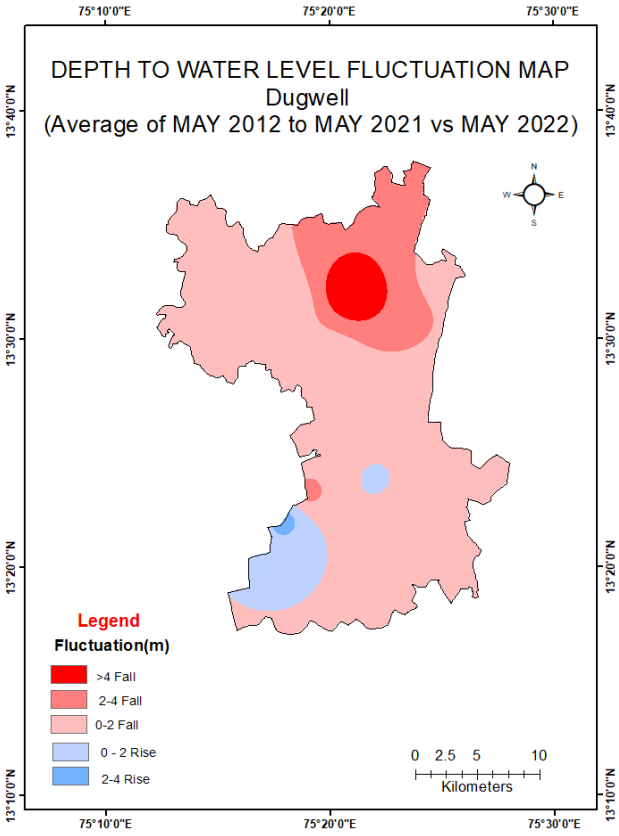


Figure 18: Pre-monsoon decadal average water level vs Pre-monsoon 2022 fluctuation

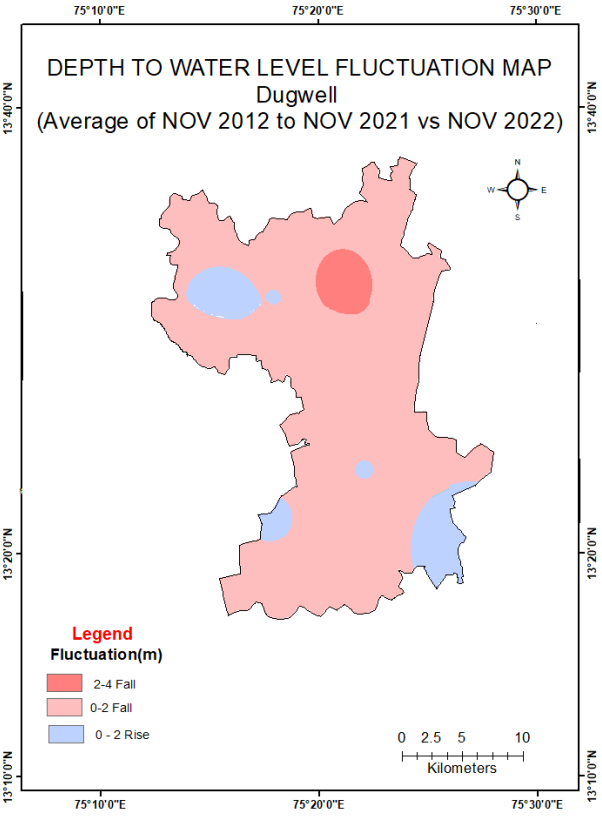


Figure 19: Post-monsoon decadal average water level vs Post-monsoon 2022 fluctuation

The long term groundwater trend (2010-2019) for pre-monsoon period shows a fall in the range 0.0094m/year to 0.3675m/year and rise in the range of 0.06m/year to 0.3258m/year (Table 10).The long term groundwater trend (2010-2019) for post-monsoon period shows a fall in the range of 0.0164m/year to 0.1443m/year and rise in the range of 0.0496m/year to 0.1702m/year (Table 11). During both pre-monsoon and post-monsoon period monitoring stations are mostly showing rising trend. **Figure 20** is the hydrograph of Herur village for pre-monsoon period showing falling trend. **Figure 21** is the hydrograph of Herur village for post-monsoon period showing rising trend. **Figure 22** is the hydrograph of Jayapura village for both pre and post-monsoon period showing slightly rising trend.

Table 10:Pre-monsoon Trend of Groundwater monitoring stations(2010 to 2019)

SL_No	LOCATION	RISE (M/YEAR)	FALL (MYEAR)	AQUIFER_TYPE
1	Hariharapura	0.0719		Unconfined
2	Herur		0.3675	Unconfined
3	Jayapura	0.0639		Unconfined
4	Kalanaikana Katte	0.3258		Unconfined
5	Koppa	0.0682		Unconfined
6	Kudregundi		0.0094	Unconfined
7	Narve	0.2413		Unconfined
8	Samse	0.1415		Unconfined
9	Shanuvalli	0.0794		Unconfined

Table 11:Post-monsoon Trend of Groundwater monitoring stations (2010 to 2019)

SL_No	LOCATION	RISE (M/YEAR)	FALL (MYEAR)	AQUIFER_TYPE
1	Hariharapura		0.0164	Unconfined
2	Herur	0.1354		Unconfined
3	Jayapura	0.0542		Unconfined
4	KalanaikanaKatte	0.0986		Unconfined
5	Koppa		0.1443	Unconfined
6	Kudregundi		0.0436	Unconfined
7	Narve	0.1702		Unconfined
8	Samse		0.0109	Unconfined
9	Shanuvalli	0.0496		Unconfined

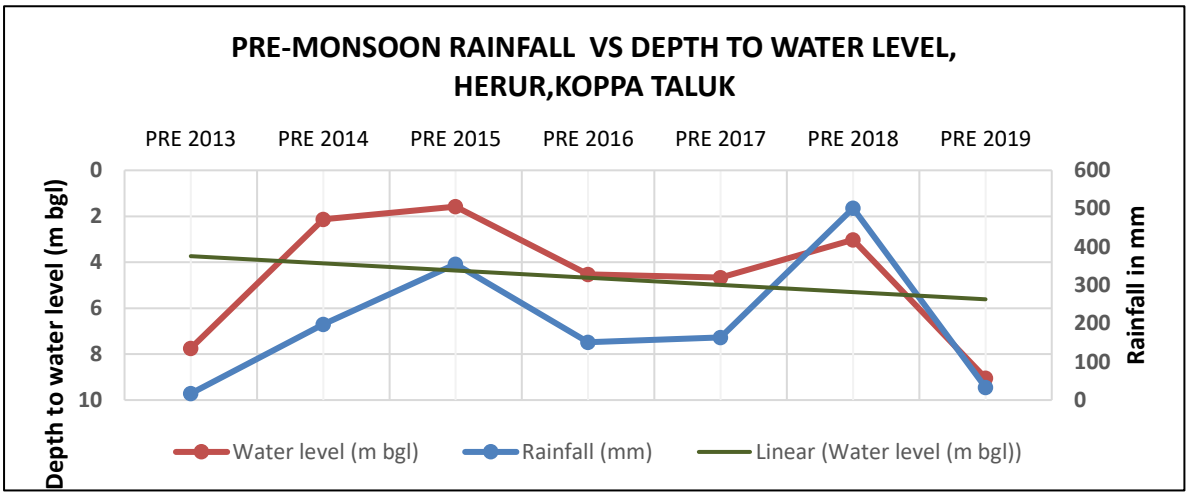


Figure 20: Pre-monsoon rainfall vs depth to water level graph of Herur village,Koppa taluk

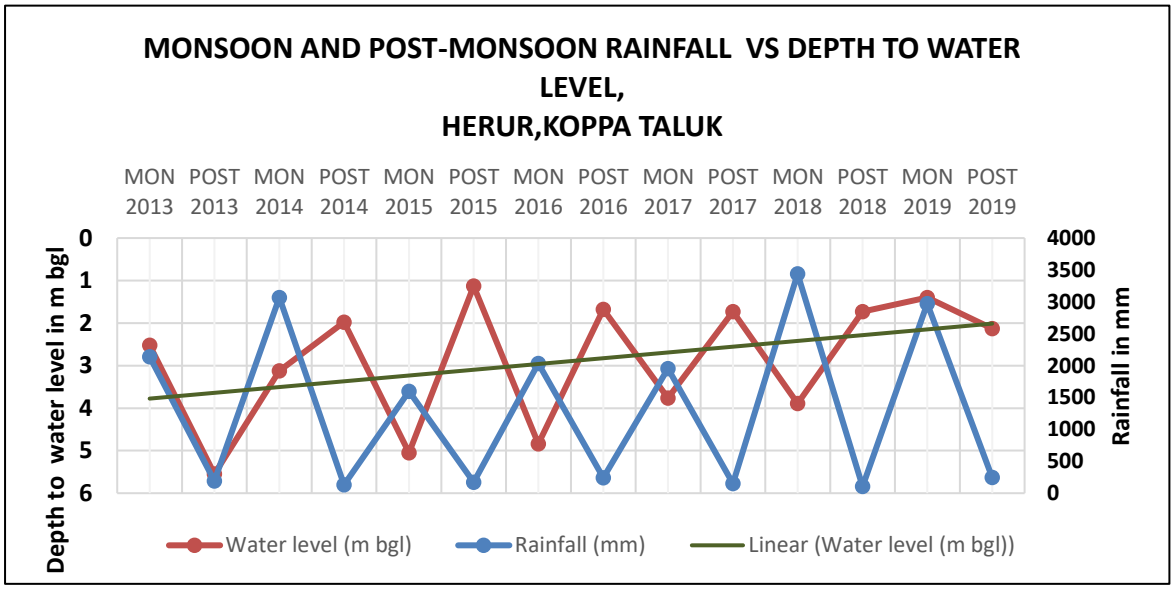


Figure 21: Post-monsoon rainfall vs depth to water level graph of Herur village,Koppa taluk

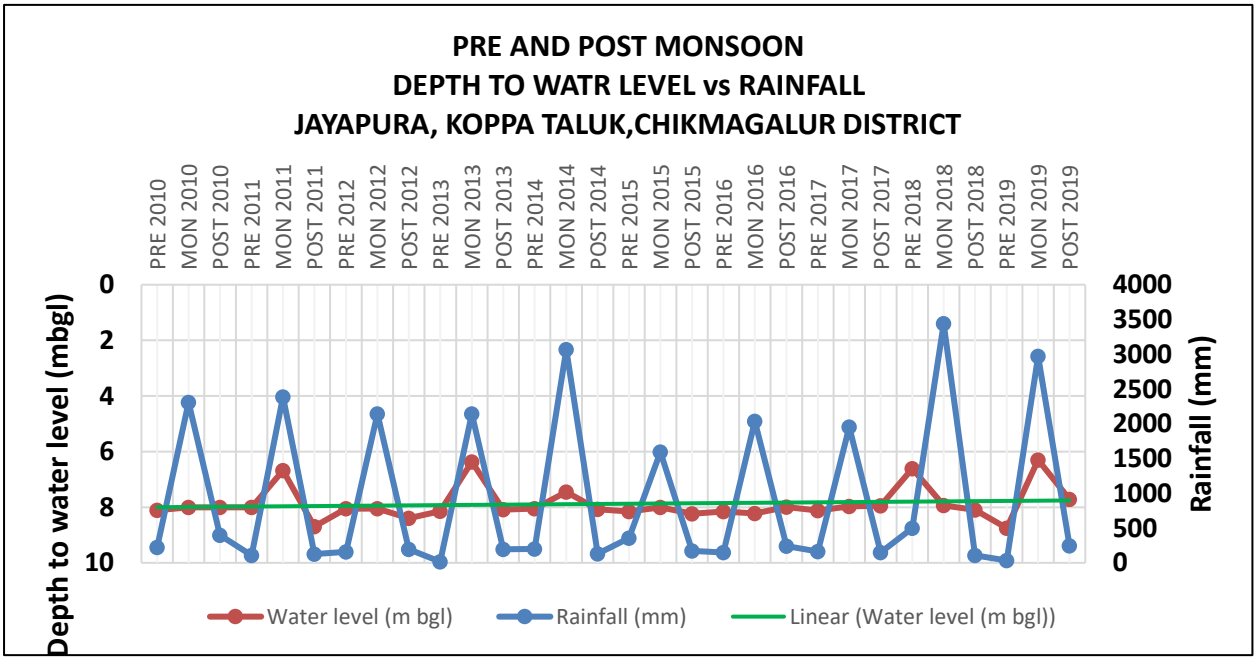


Figure 22: Pre &Post-monsoon rainfall vs depth to water level graph of Jayapura village,Koppa taluk

2. AQUIFER DISPOSITION

2.1 Number of aquifers: In Koppa 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 Koppa taluk, fractured gneiss and schist are the major water bearing formations. **(Figure 23)**. Groundwater occurs within the jointed and fractured granitic gneiss and schist under semi-confined to confined conditions. In Koppa taluk borewells were drilled from a minimum depth of 98.5mbgl to a maximum of 202.5mbgl **(Table12)**. Depth of weathered zone**(Aquifer-I)** ranges from 19.4mbgl to 37.0mbgl.In major part of the taluk, the weathered one varies between 20 to 30m bgl**(Figure 24)**. **Aquifer-II** fractured formation is generally encountered between the depth of 30 to 115m bgl**. From figure 25,** it is evident that most of the fractures are shallow and lie between 40 to 60m bgl depth. **Figure 26** is a map of the fractured aquifer of Koppa taluk, where yield of maximum number of borewells is between 1 lps to 2lps. **Figure 27** represents the stratigraphic cross-section of exploration wells drilled in Koppa taluk in NW-SE direction considering the wells of Niluvagilu, Kunchuru, Heruru and Devagodu. The fracture thickness is more at Devagodu. **Figure 28** represents stratigraphic cross-section of exploration wells drilled in Koppa taluk in NW-NE direction considering the wells of Niluvagilu, Kunchuru, Haranduru, Nuggi and Kudregundi. **Figure 29a,b** represent the 3D aquifer disposition. **Figure 30** represents the fence diagram of the taluk. Yield ranges from 0.2 to 2.4lps.

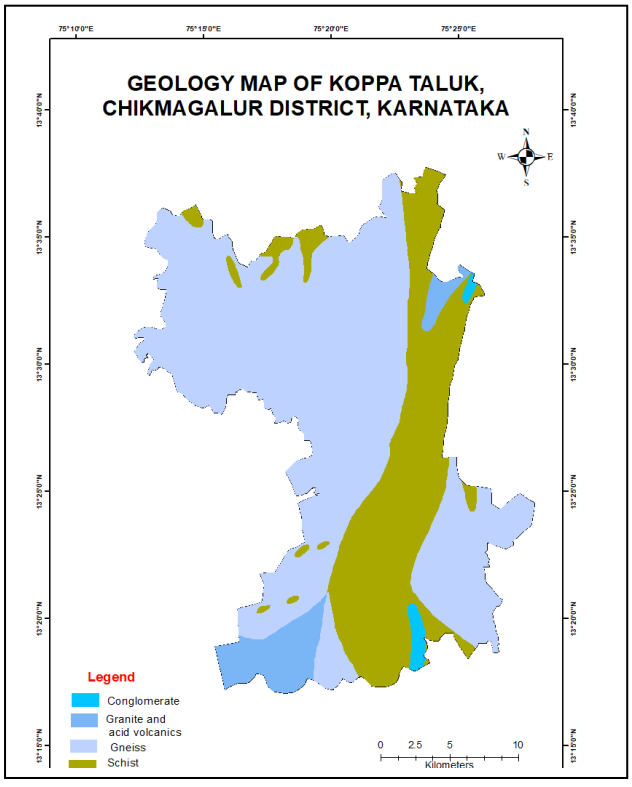


Figure 23: Geology map of Koppa taluk

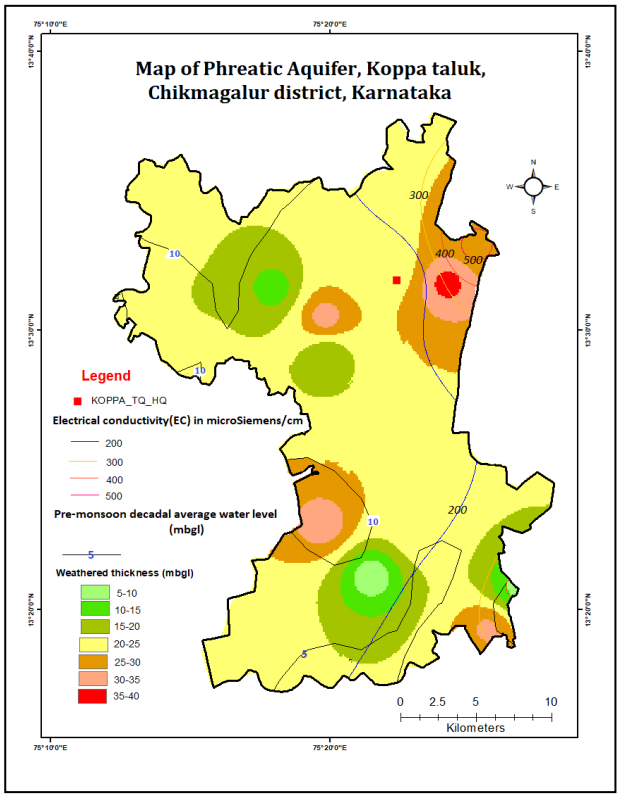


Figure 24: Map of phreatic aquifer, Koppa taluk

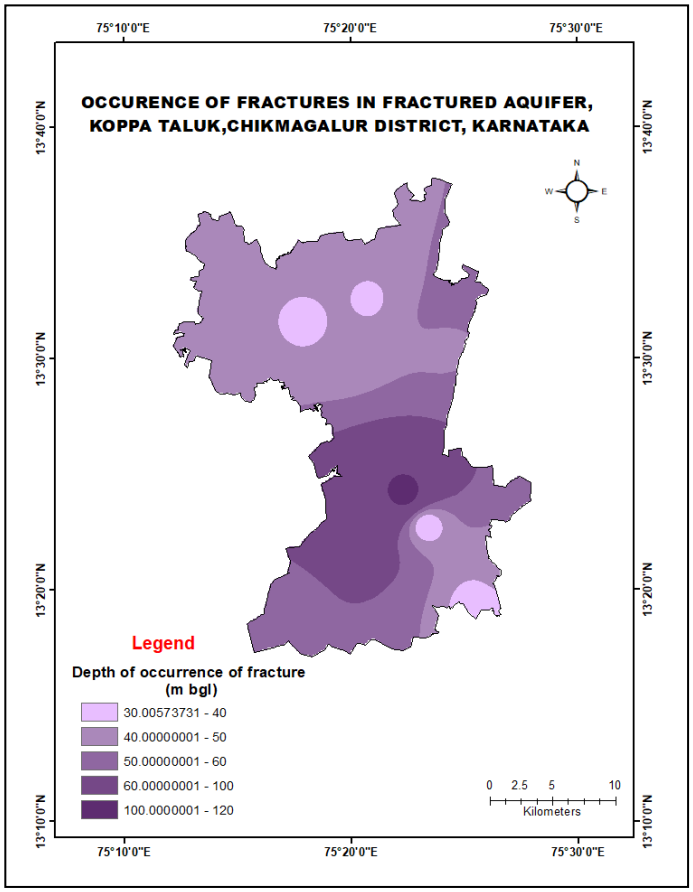


Figure 25: Depth of occurrence of fractures in aquifer-II (fractured aquifer)map

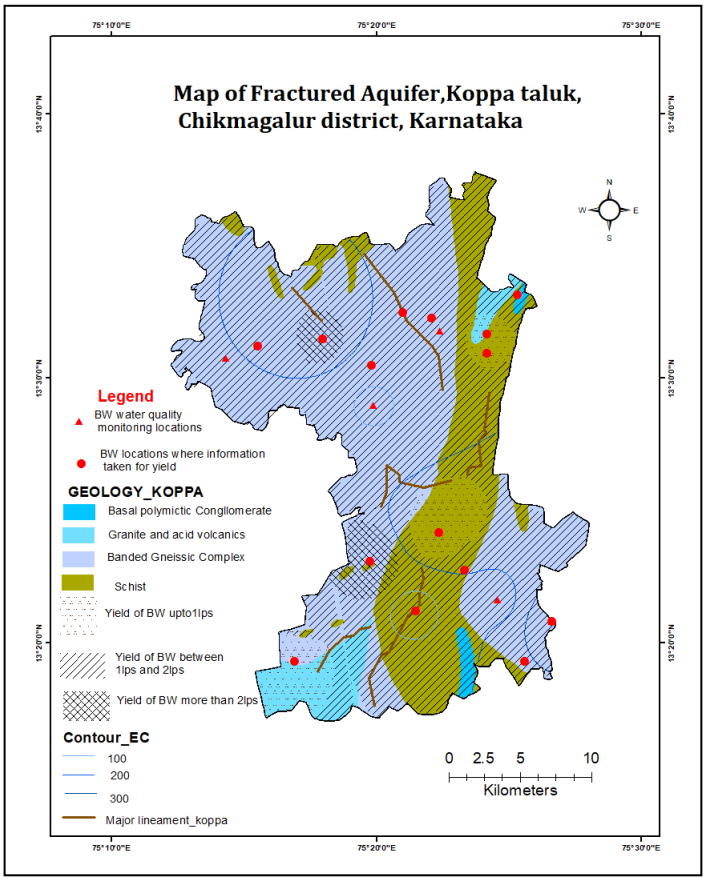


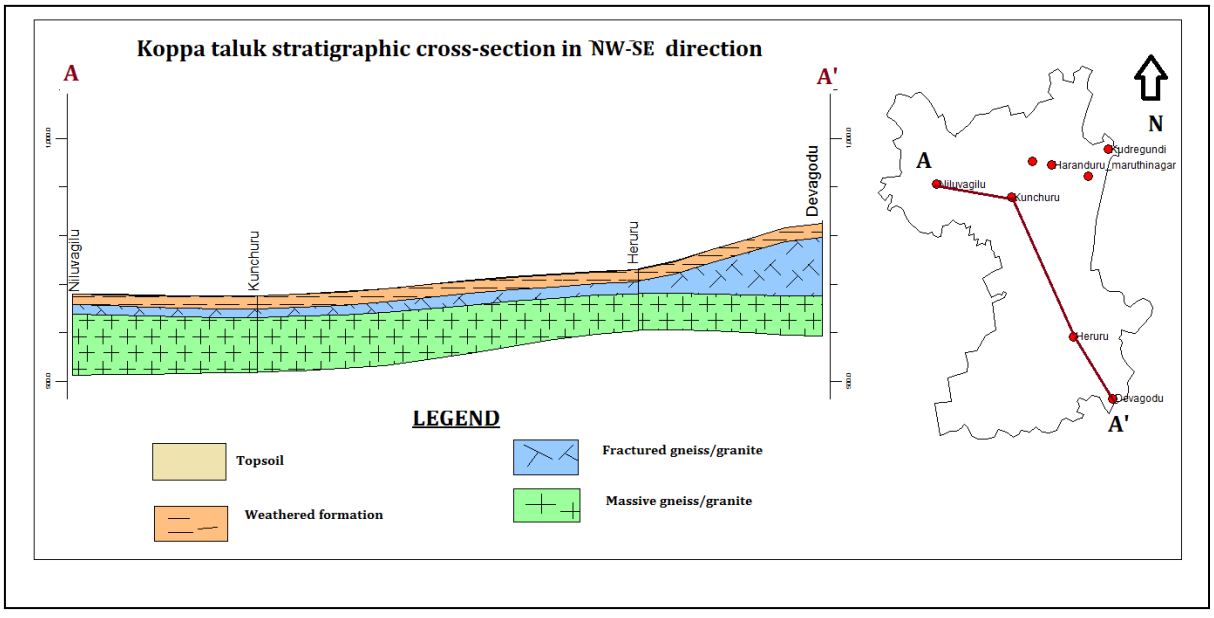
Figure 26: Map of fractured aquifer, Koppa taluk

Table 12: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	Heruru	75.3890	13.3794	98.46	25	25-30	1.5
2	Devagodu	75.4266	13.3220	123.07	31	31-50	1.5
3	Kunchuru	75.3305	13.5083	153.84	33	33-40	1.0
4	Harandurumaruthinagar	75.3683	13.5382	147.69	20	20-50	1.75
5	Niluvagilu	75.2587	13.5203	169	19.38	19.4-40	1.5
6	Nuggi	75.4030	13.5278	135	37	37-45	1.5
7	Koppa	75.3500	13.5417	202.55	22	22-55	2.0
8	Kudregundi	75.4222	13.5528	200.55	25	25-65	0.2

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

Figure 27: Stratigraphic cross-section of exploration wells drilled in Koppa taluk in NW-SE direction



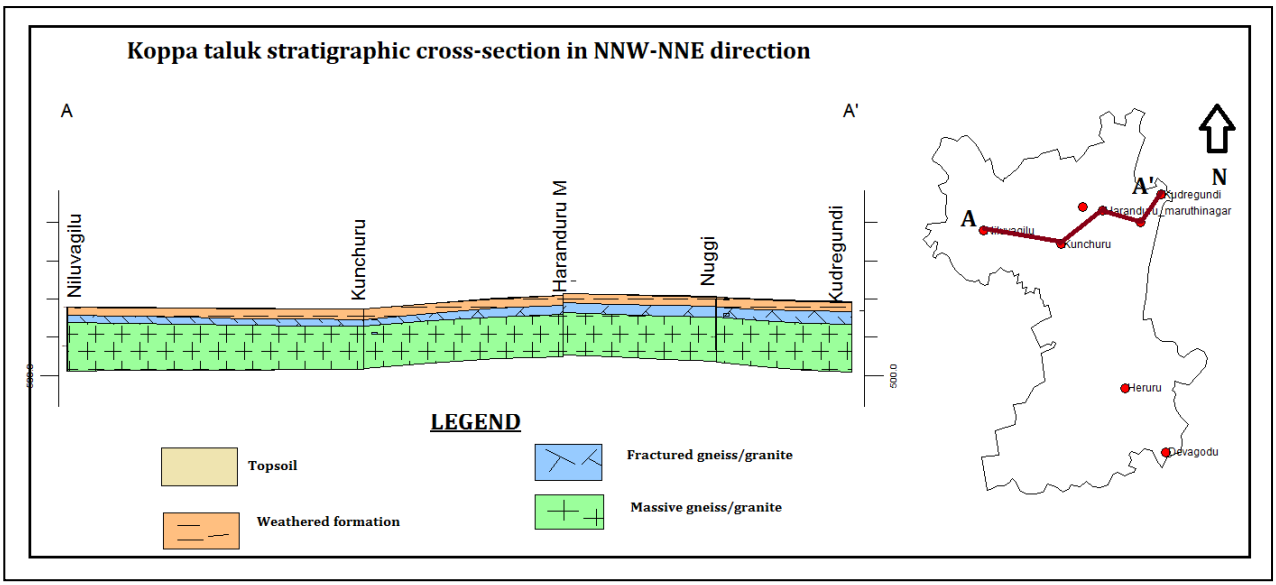


Figure 28: Stratigraphic cross-section of exploration wells drilled in Koppa taluk in NW-NE direction

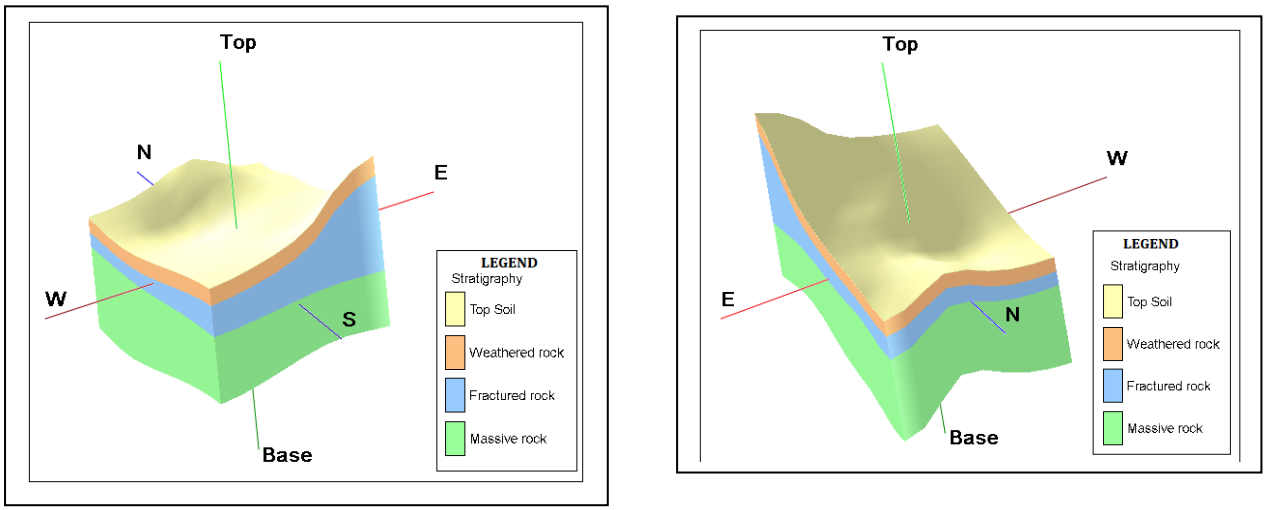


Figure 29a,b:3D aquifer disposition

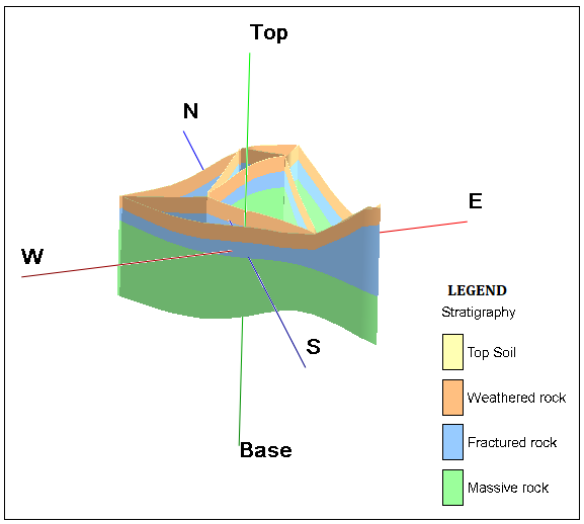


Figure 30: Fence diagram of wells drilled in Koppa taluk

3. WATER QUALITY AND GROUNDWATER ISSUES IN THE STUDY AREA

3.1 Water Quality

Interpretation from Chemical Analysis of Aquifer - I results in Koppa taluk **(Table 13)** shows that the pH varies from 6.23 to 7.79, Electrical Conductivity ranges from 100 to 520 µ/mhos/cm in the aquifer-I at 25^{o}C, while Total Hardness concentration ranges from 35 to 172 mg/L. The Nitrate value ranges from 1.33 to 37.62 mg/l and Fluoride concentration in groundwater ranges between 0.018 – 0.2 mg/l.

Interpretation from Chemical Analysis of Aquifer - II results in Koppa taluk **(Table 13)** shows that the pH varies from 6.01 to 6.90, Electrical Conductivity ranges from 60 to 390 µ/mhos/cm in the aquifer-I at 25^{o}C, while Total Hardness concentration ranges from 20 to 125 mg/L. The Nitrate value ranges from 0 to 13.0 mg/l and Fluoride concentration in groundwater ranges between 0 – 1.0 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	CO_3	HCO_3	Cl (1000)	SO_4 (400)	NO_3 (45)	F (1.5)	TDS (2000)
1	Seegodu	DW	7.29	410	106	18	15	33.05	18.38	0	74	71	9	37.62	0.04	201
2	Heruru	DW	7.39	200	81	16	10	4.68	4.58	0	61	18	20	1.95	0.03	103
3	Jayapura	DW	6.91	120	45	12	4	4.58	0.63	0	43	7	2	11.24	0.03	51
4	Agalagandi	DW	6.91	120	40	14	1	3.98	4.93	0	37	11	5	2.58	0.10	58
5	Shanuvalli	DW	6.76	140	51	10	6	6.33	2.55	0	25	14	19	3.24	0.02	70
6	Hariharapura	DW	6.23	100	45	6	7	3.12	2.41	0	31	14	6	1.33	0.02	54
7	Narve	DW	6.9	160	56	12	6	7.01	5.64	0	43	18	12	6.05	0.02	82
8	Koppa	DW	7.06	120	35	8	4	8.13	2.78	0	18	14	17	9.74	0.06	63
9	Kudregundi	DW	7.79	520	172	59	6	30.23	5.43	0	252	21	21	4.26	0.20	266
10	**Seegodu**	**BW**	**6.80**	**390**	**125**	**34**	**2**	**21**	**5.6**	**0**	**153**	**35**	**8**	**0**	**0.72**	**223**
11	**Heruru**	**BW**	**6.76**	**170**	**60**	**10**	**9**	**13**	**2.3**	**0**	**31**	**35**	**4**	**12**	**0.25**	**137**
12	**Jayapura**	**BW**	**6.70**	**300**	**70**	**10**	**11**	**30**	**4.9**	**0**	**140**	**11**	**6**	**13**	**0.34**	**197**
13	**Guddethota**	**BW**	**6.90**	**60**	**25**	**4**	**4**	**3**	**0.8**	**0**	**12**	**11**	**3**	**5**	**0.18**	**54**
14	**Agalagandi**	**BW**	**6.30**	**160**	**60**	**16**	**7**	**7**	**5.5**	**0**	**79**	**7**	**6**	**0**	**0.36**	**139**
15	**Shanuvalli**	**BW**	**6.57**	**200**	**80**	**18**	**9**	**9**	**2.2**	**0**	**92**	**14**	**4**	**0**	**0.34**	**155**
16	**Hariharapura**	**BW**	**6.60**	**240**	**90**	**26**	**6**	**15**	**2.0**	**0**	**116**	**14**	**6**	**0**	**0.25**	**195**
17	**Narve**	**BW**	**6.37**	**80**	**20**	**6**	**1**	**6**	**2.0**	**0**	**18**	**14**	**2**	**0**	**0.10**	**69**
18	**Koppa**	**BW**	**6.01**	**200**	**60**	**10**	**9**	**12**	**3.5**	**0**	**61**	**21**	**10**	**0**	**0.11**	**127**

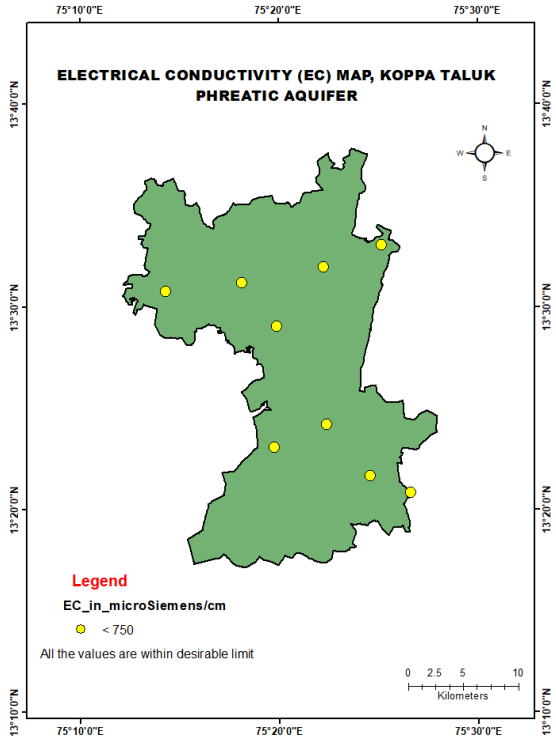


Figure 31: EC map of phreatic aquifer, Koppa taluk

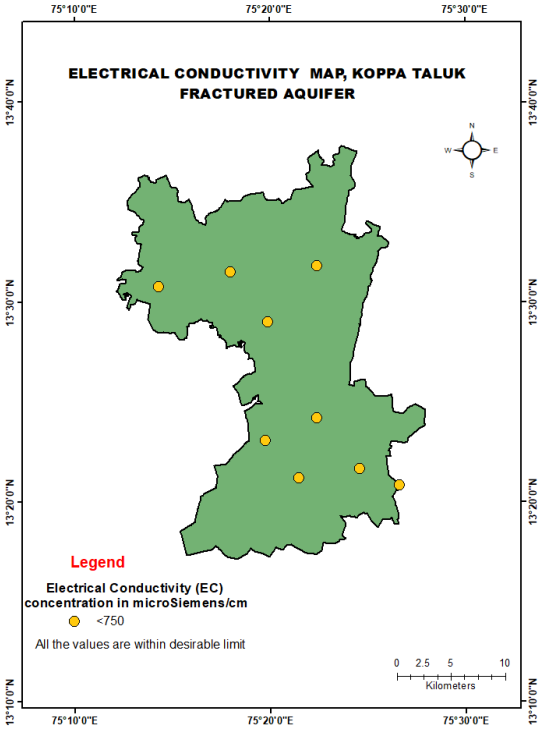


Figure 32 : EC map of fractured aquifer, Koppa taluk

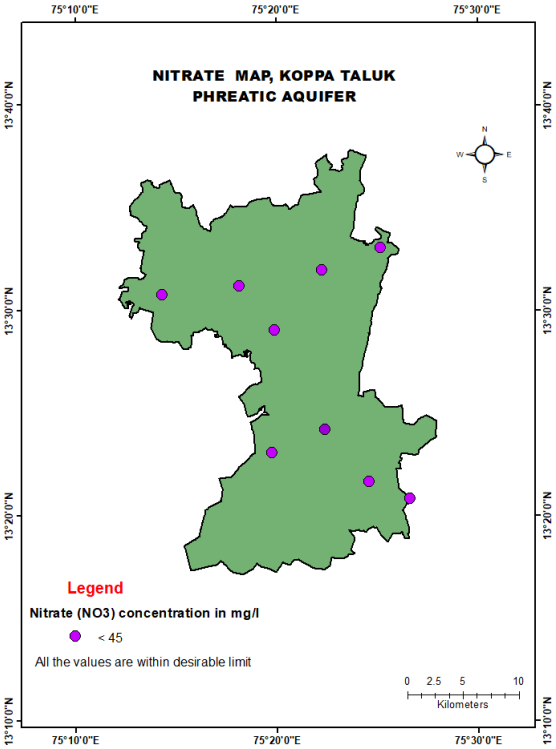


Figure 33: Nitrate map of phreatic aquifer, Koppa taluk

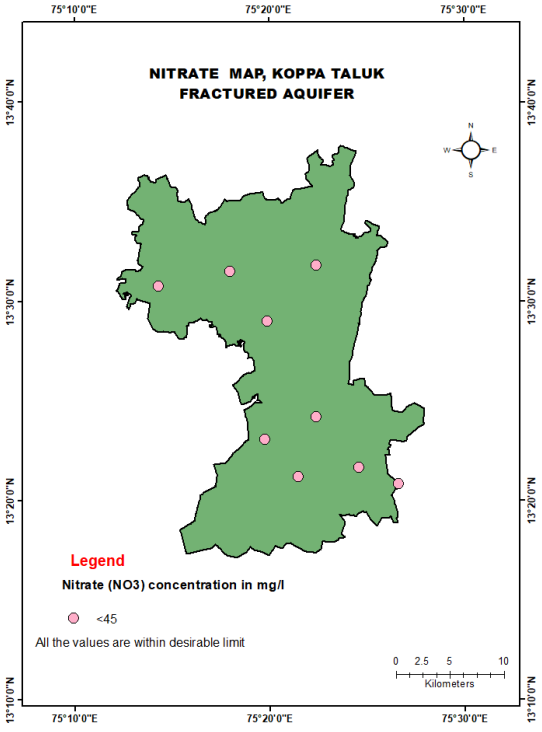


Figure 34: Nitrate map of fractured aquifer, Koppa taluk

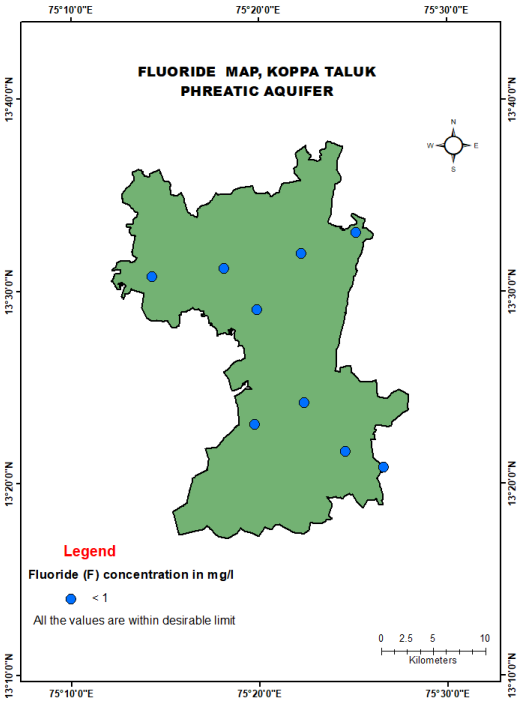


Figure 35: Fluoride map of phreatic aquifer, Koppa taluk

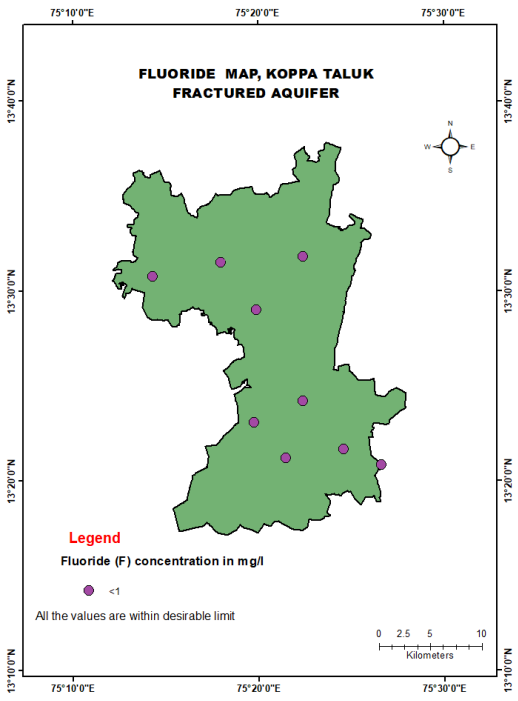


Figure 36: Fluoride map of fractured aquifer, Koppa taluk

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 31 to 36**.

3.2 Groundwater Issues:

- Low stage of groundwater extraction (27.72%).
- All most all areas in Koppa, are hilly and the rain 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.

3.3 Status of Ground Water Development:

Groundwater development in the taluk is very low (27.72%) 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 5.55 to 20.70 mbgl and 50 to 150mbgl 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 27.72% as per GEC 2022. The area feasible for recharge in the taluk is 443sq.kmas per Master Plan for artificial recharge, Karnataka and Goa,2020(Figure 27). However, out of 443 sq.km area,296.12 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 4966.4 ham, which is considered for planning of structures. For this, a one (1) subsurface dyke, 41 percolation tanks and 230 check dams /vented dams are proposed. The volume of water expected to be conserved/recharged @75% efficiency is 3724.8ham through these AR structures. The approximate cost estimate for construction of

these structures is Rs. 3139.167 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 Koppa taluk, Chikmagalur district have been carried out and given in below Tables 14a.

Table 14a: 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	Koppa taluk
Area Feasible for Artificial Recharge	443 sq km
Non-committed monsoon runoff available (Ham)	4966.4
Number of CheckDams/Vented dams	230
Number of Percolation Tanks	41
Number of subsurface dykes	1
Tentative total cost of the project (Rs.In lakhs)	3139.167
Expected recharge (Ham)	3724.8
Additional irrigation potential (lakh hectares)	0.045

As per NAQUIM study, the area feasible for artificial recharge is about 147 sq.km excluding the hilly area with slope >20° and high drainage density which causes intense runoff. 84 numbers of check dams/vented dams and 19 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 37** shows the area feasible for artificial recharge in Koppa 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 Tables 14b.

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

Artificial Recharge Structures	Koppa taluk
Area Feasible for Artificial Recharge	147 sq km
Number of Check Dams/Vented dams	84
Number of Percolation Tanks	19
Expected recharge	16.14 mcm/1614 ham
Tentative total cost of the project (Rs.In lakhs)	1220

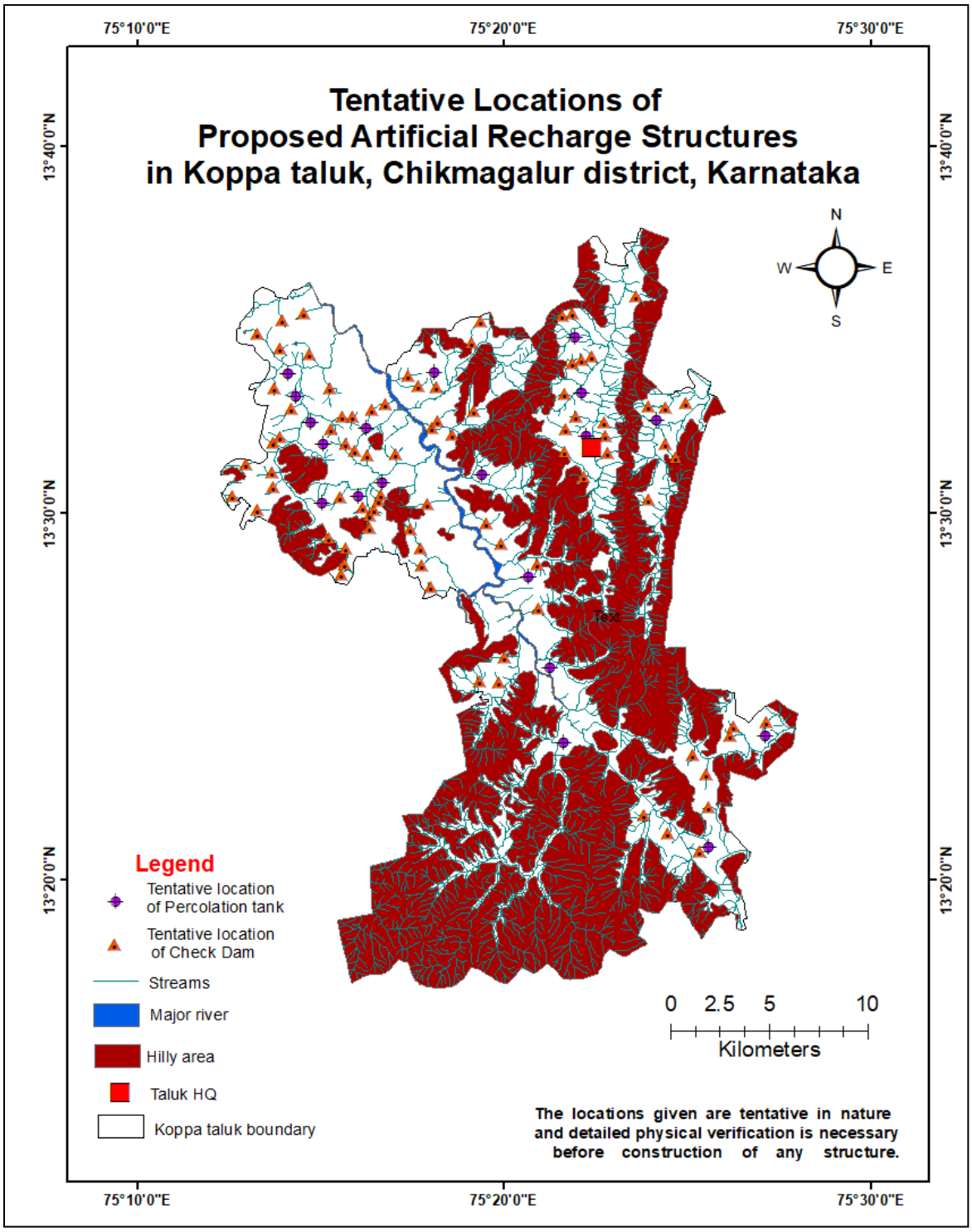


Figure 37: Area feasible for artificial recharge in Koppa taluk as per NAQUIM study.

4.2 Ground Water Development Plan

In Koppa taluka, the present stage of ground water extraction (2022) is 27.72 % with annual extractable resource of 4434.49ham and total extraction of 1229.63 ham. The ground water draft for irrigation purpose is 1069.88 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 27.72% to 60% in a systematic way by adopting scientific approach. About 1193dugwells (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. 35.8 Cr. 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 2022 availability

Balance GWR available to make SOE 60%	DW unit draft	BW unit draft	No. of DW feasible @ 50% 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
2660.69	0.6	0.9	1193	622.0197	357,900,000	124403933.3

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 0.045 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 (2022)	27.72 %, Safe
Annual Extractable GW Resource (Ham)	4434.49
Total Extraction (Ham)	1229.63
Ground Water Draft for Irrigation (Ham)	1069.88
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	 1 19 230
Expected Additional Recharge to GW due to AR (Ham)	3724.8
Additional Irrigation Potential that can be created (lakh Ha)	0.045
Total Estimated Expenditure (Rs. in lakhs)	3139.167
Ground Water Resource Enhancement as per NAQUIM study	
Number of Check Dams/Vented dams	84
Number of Percolation Tanks	19

Expected recharge	16.14 mcm/1614 ham
Tentative total cost of the project (Rs.In lakhs)	1220
Ground Water Resource Development Plan	
Balance GWR available to enhance SOE 60% (Ham)	2660.69
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	 1193 622
Total Estimated Expenditure (Rs. in Cr.)	48
Increase in Stage of GW Extraction (%)	27.72 to 60

As per the resource estimation – 2022, Koppa taluk falls under safe category with the stage of ground water extraction is 27.72 %. 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 Koppa taluka, the present stage of ground water extraction (2022) is 27.72 % with annual extractable resource of 4434.49 ham and total extraction of 1229.63 ham. In view of above, the focus of proposed ground water development plan is to up the ante of ground water development from the present 27.72% to 60% in a systematic way by adopting scientific approach. About 1193dug wells (15-30 m depth; 3 to 5 m diameter @ Rs. 3.00 lakh/dug well) are recommended to be constructed in feasible areas. Further 622 borewells (40-100 m depth; 150 mm dia @ Rs. 2.00 lakh/borewell) are also recommended to be drilled in feasible areas.

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 Koppa taluk

Sl.no.	Longitude	Latitude	Village name
1	75.4221	13.3466	Devagodu
2	75.4081	13.3549	Hallikere
3	75.3970	13.3631	Yalemadalu
4	75.4264	13.3667	Adigebylu
5	75.4253	13.3814	Adigebylu
6	75.4193	13.3900	Adigebylu
7	75.4364	13.3992	Adigebylu
8	75.4379	13.4031	Adigebylu
9	75.4528	13.4050	Adigebylu
10	75.3314	13.4234	Belavina Kodige
11	75.3225	13.4237	Belavina Kodige
12	75.3336	13.4346	Belavina Kodige
13	75.3493	13.4565	Thuluvinakoppa
14	75.3002	13.4662	Thammadavalli
15	75.2594	13.4721	Bilagaddhe
16	75.2962	13.4764	Asagodu
17	75.2609	13.4767	Bilagaddhe
18	75.3489	13.4768	Udana
19	75.2617	13.4837	Bilagaddhe
20	75.2954	13.4837	Asagodu
21	75.3319	13.4858	Narasipura
22	75.2538	13.4888	Bilagaddhe
23	75.2912	13.4930	Asagodu
24	75.2723	13.4932	Melubilre
25	75.3254	13.4954	Narasipura
26	75.2722	13.4988	Melubilre
27	75.2215	13.5013	Nilandhuru
28	75.2746	13.5014	Melubilre
29	75.2692	13.5024	Melubilre
30	75.2986	13.5043	Hariharapura
31	75.2763	13.5058	Melubilre
32	75.3993	13.5059	Nuggi
33	75.2588	13.5074	Niluvagilu
34	75.2102	13.5076	Koduru
35	75.2778	13.5082	Melubilre
36	75.2285	13.5116	Koduru
37	75.3698	13.5166	Somalapura
38	75.2279	13.5184	Koduru
39	75.2165	13.5223	Shankarapura
40	75.4116	13.5254	Nuggi
41	75.2712	13.5260	Niluvagilu
42	75.2840	13.5268	Yadadhante
43	75.3806	13.5273	Bintharavalli
44	75.3612	13.5277	Koppa
45	75.2655	13.5283	Niluvagilu
46	75.4067	13.5312	Nuggi
47	75.2614	13.5316	Niluvagilu
48	75.2284	13.5318	Heggaru
49	75.2317	13.5343	Heggaru
50	75.3796	13.5347	Melina Harandhuru
51	75.3099	13.5353	Bomlapura
52	75.2548	13.5380	Heggaru

53	75.3613	13.5381	Koppa
54	75.3008	13.5384	Bomlapura
55	75.3791	13.5410	Melina Harandhuru
56	75.3033	13.5418	Bomlapura
57	75.2646	13.5435	Hosuru
58	75.2602	13.5437	Hosuru
59	75.3663	13.5438	Melina Harandhuru
60	75.3199	13.5463	Kagga
61	75.2732	13.5469	Bandigadi
62	75.2369	13.5475	Makkikoppa
63	75.4068	13.5477	Thalamakki
64	75.3989	13.5483	Thalamakki
65	75.2796	13.5496	Bandigadi
66	75.4161	13.5501	Thalamakki
67	75.3609	13.5540	Gunavanthe
68	75.2546	13.5567	Hosuru
69	75.2292	13.5567	Makkikoppa
70	75.3027	13.5570	Bomlapura
71	75.2943	13.5578	Bomlapura
72	75.2900	13.5624	Bomlapura
73	75.3645	13.5679	Gunavanthe
74	75.3688	13.5695	Gunavanthe
75	75.3733	13.5708	Gunavanthe
76	75.2452	13.5719	Halmatthuru
77	75.2319	13.5746	Chavalmane
78	75.3186	13.5771	Hirekodige
79	75.2212	13.5814	Inam Shirakaradi
80	75.3227	13.5871	Hirekodige
81	75.2325	13.5873	Chavalmane
82	75.3600	13.5898	Gunavanthe
83	75.3645	13.5907	Gunavanthe
84	75.2425	13.5907	Chavalmane

ANNEXURE-II

Tentative locations of proposed Check Dams in Koppa taluk

Sl.no.	Longitude	Latitude	Village name
1	75.4263	13.3485	Devagodu
2	75.3604	13.3961	Kooluru
3	75.4520	13.3989	Adigebylu
4	75.3544	13.4296	Lokanathapura
5	75.3447	13.4710	Belagola
6	75.2506	13.5045	Niluvagilu
7	75.2673	13.5074	Melubilre
8	75.2780	13.5141	Melubilre
9	75.3233	13.5177	Addhada
10	75.2514	13.5315	Heggaru
11	75.3708	13.5350	Koppa
12	75.2708	13.5384	Niluvagilu
13	75.2455	13.5412	Hosuru
14	75.4027	13.5424	Thalamakki
15	75.2388	13.5529	Makkikoppa
16	75.3689	13.5548	Gunavanthe
17	75.2352	13.5634	Halmatthuru
18	75.3016	13.5636	Bullapura
19	75.3656	13.5800	Gunavanthe

ANNEXURE-III

List of Keywells

Sl.no.	Longitude	Latitude	Village	Location	Total depth drilled(mbgl)	Depth of casing pipe lowered (mbgl)	Water tapped zones fractures	yield of well lps
1	75.4437	13.3472	Seegodu	BW located in Annapoorneshwari estate of Sh.Surendra Shetty,BW is used only during lean season, Coffee, silverwood and areca nut plantation	123	37	45	1.25
2	75.3728	13.4031	Jayapura	BW infront of Ahirvaad stationery store belonging to Sh.Ramakrishna H.S.	124.97	24.38	30.48, 115.82	0.05
3	75.3581	13.3534	Guddethota	BW located in G.S.Gowda and sons estate ,BW is used only during February/March to May, Coffee, silverwood and areca nut plantation	91.44	6.09	60.96	1.5
4	75.3294	13.3846	Agalagandi	BW located in the house of Sh.Mahesh	115.82	33.53	88.39	3
5	75.4096	13.3607	Heruru	BW located in the estate of Sh.Padmanabhan,BW water used via sprinkler for coffee plantation, Areca nut and black pepper also grown,BW used only during lean period	106.68	24.38	54.86	2
6	75.2996	13.5248	Hariharapura	BW located in H.S.Gowda and sons estate ,BW is used only during February/March to May, Coffee, silverwood and areca nut plantation	106.68	12.19	36.57	2.5
7	75.3313	13.4833	Narve	40 years old HP converted to BW.It is located in Sh.Ratnakar Bhatt's house at Narve trijunction	50	not known	not known	not known
8	75.2386	13.5128	Shanuvalli	BW located in the house of Sh.Satish Gowda	50	24.38	30.48	2