Draft Report

केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report on

AQUIFER MAPPING AND MANAGEMENT PLAN

Chikballapur Taluk, Chikballapur District,Karnataka

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region,Bengaluru

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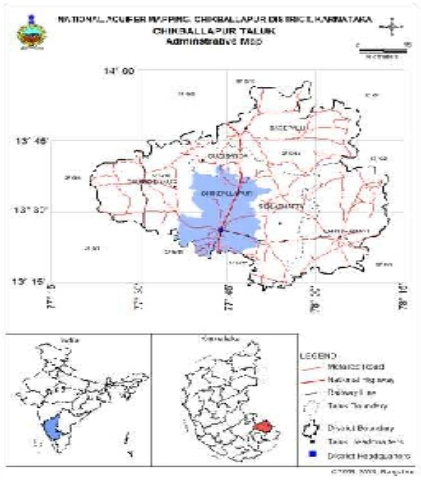
Government of India
Ministry of Water Resources, River Development & Ganga Rejuvenation
Central Ground Water Board

CHIKBALLAPUR TALUK AQUIFER MAPS AND MANAGEMENT PLANS CHIKBALLAPUR DISTRICT, KARNATAKA STATE



By
Dr.A.Asokan
Scientist 'D'

Central Ground Water Board
South Western Region
Bangalore
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CHIKBALLAPUR TALUK AQUIFER MAPS AND MANAGEMENT PLANS,

CHIKBALLAPUR DISTRICT, KARNATAKA STATE

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

1. SALIENT INFORMATION

Name of the taluk : **CHIKBALLAPUR**
District : Chikballapur;
State : Karnataka
Area : 637 sq.km.
Population : 2,12,536
Annual Normal Rainfall : 769 mm

1.1 Aquifer management study area

Aquifer mapping studies was carried out in Chikballapur taluk, Chikballapur district of Karnataka, covering an area of 637 sq.kms under National Aquifer Mapping Project. Chikballapur taluk of Chikballapur district is located between north latitude $13^0$20'10.7" and $13^0$39'59.4" & east longitude $77^0$36'04.7" and $77^0$52'20.2", and is covered in parts of Survey of India Toposheet Nos. 57G/10, 57G/11, 57G/14 and 57G/15. Chikballapur taluk is bounded by Gudibanda taluk on north, Devanahalli taluk of Bangalore Rural district on south, Sidlaghatta taluk on east and Gauribidanur taluk on western side. Location map of Chikballapur taluk of Chikballapur district is presented in Figure-1**.**

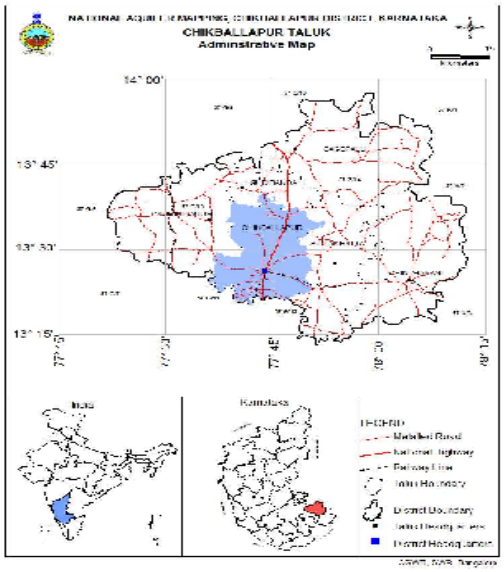

Fig 1: Location Map of Chikballapur taluk, Chikballapur district

Taluk administration of Chikballapur taluk is divided into 3 Hoblies and Chikballapur is only one town, which is also the taluk head quarter. There are 222 inhabited and 29 uninhabited villages in Chikballapur taluk (Table-1).

Table 1: Administrative divisions of Chikballapur taluk, Chikballapur district

No. of Villages		VA circles	Hoblies	Gram Panchayats	Municip alities	Cities / Towns / Urban Agglomeration
Inhabited	Uninhabited					
222	29	35	3	22	1	1

Source: District at a glance 2013-14, Govt. of Karnataka

1.2 Population

According to 2011 census, the population in Chikballapur taluk is 212536, in which 148884 constitute the rural population and 63652 is the urban population, which works out to 70% (rural) and 30% (urban) of the total population of taluk. The taluk has an overall population density of 333 persons per sq.km. The decadal variation in population from 2001-2011 is 10.1 % in Chikballapur taluk.

1.3 Rainfall

Chikballapur taluk enjoys semiarid to arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Eastern dry agro-climatic zone of Karnataka state and is categorized as drought prone. The normal annual rainfall in Chikballapur taluk for the period 1901 to 2014 is 769 mm. Seasonal rainfall pattern indicates that, major amount of (444.6 mm) rainfall was recorded during South-West Monsoon seasons, which contributes about 58% of the annual normal rainfall, followed by North-East Monsoon season (203.7 mm) constituting 26% and remaining (121 mm) 16% in Pre-Monsoon season (Table-2).

On Computations were carried out for the 114 year blocks of 1901- 2014, the mean monthly rainfall at Chikballapur taluk is ranging between 4.7mm during January to 156.1 mm during September (Table-2).

Table 2: Normals of Monthly, Seasonal and Annual Rainfall of Chikballapur Station (1901 to 2014)

JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
4.7	5.5	11.5	31.0	68.2	121.0	69.4	99.9	119.3	156.1	444.6	126.3	65.0	12.4	203.7	769.3

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Chikballapur taluk. Major Kharif crops are maize, ragi, tur and vegetables. Main crops of Rabi season are ragi, maize, horse gram, groundnut, sunflower

and fruits (Table-3). Ragi is grown in 25% and maize account 11% of total crop area. Fruits and vegetables are grown in 20% of total crop area of taluk.

Table 3: Cropping pattern in Chikballapur taluk 2013-2014 (Ha)

Year	Paddy	Maize	Ragi	Jowar	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
	Area under cultivation (Ha)									
2013-2014	245	4830	10408	328	1716	5137	3487	843	0	0

It is observed that net sown area accounts 37% and area sown more than once is 12% of total geographical area in Chikballapur taluk (Table-4). 31% area falls under forest. Groundwater from bore wells forms the only source of irrigation.

Table 4: Details of land use in Chikballapur taluk 2013-2014 (Ha)

Item Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Chikballapur	63700	19720	8501	2544	23595	7335

Source: District at a glance 2013-14, Govt. of Karnataka

1.5 Geomorphology, Physiography & Drainage

The topography of the Chikballapur taluk is undulating to plain (Fig.-2). Hills & plateaus cover entire western part of taluk. The general elevation varies from 249 to 911 m above mean sea level.

There are no perennial rivers in Chikballapur taluk. The taluk is drained by three river basins namely Palar, Ponnaiyar, and Pennar. All these rivers and their tributaries are small and carry water only during rainy season. Palar originates at Ambajidurga hillocks in Chintamani taluk and flows NW-SE direction. The drainage is highly dendritic in nature (Fig-3). The Pennar river originates in Doddaballapura taluk of Bangalore Rural district and flows towards north covering parts of Chikballapur taluk. North Pinakani originates from Nandi hills in Chikballapur taluk and flows towards north. South Pinakani originates from Nandi hills and flows in Chikballapur and Sidlaghatta taluks. Apart from these rivers, Arkavathi a tributary of Cauvery also originates in Nandi hills and flows only 2.8 kms in the Chiballapur taluk (Fig.-3).

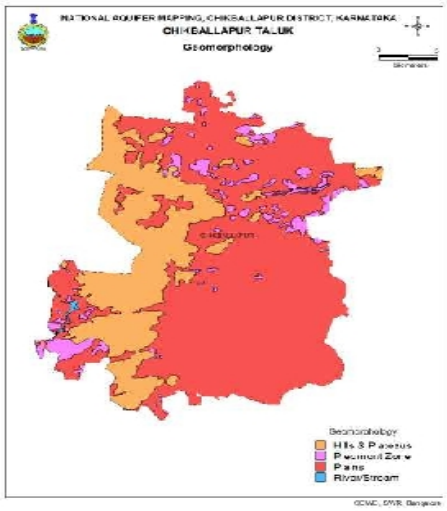

Fig 2: Geomorphology Map

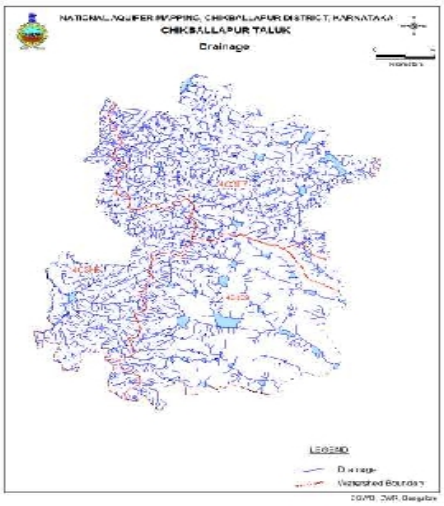

Fig 3: Drainage Map

1.6 Soil

Chikballapur taluk is covered red loamy soil to red sandy soil and lateritic soil.

1.7 Ground water resource availability and extraction

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

Table 5: Total GW Resources (2011) (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
Chikballapur	4600	0	1883	6483

1.8 Existing and future water demands (as per GEC-2011)

- Net ground water availability for future irrigation development : Nil
- Domestic (Industrial sector) demand for next 25 years : 6.10 MCM

1.9 Water level behavior

(a) Depth to water level

Aquifer – I : The dug wells in the taluk are dried up, hence there is no water level.

Aquifer – II : Pre-monsoon & Post-monsoon water level are given in Table 6 and shown in Figures 4 & 5 respectively.

Table 6: Ground Water levels (2011) (Ham)

Taluk	Pre-monsoon Water Level (mbgl)			Post-monsoon Water level (mbgl)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Chikballapur	11.83	133.90	37.48	10.41	110.73	37.84

(b) Water level fluctuation

Aquifer-II (Fig.-6)

A. Seasonal Fluctuation: Rise ranges between 0.07 to 23.17 m;
Fall ranges between 0.20 to 22.73 m.

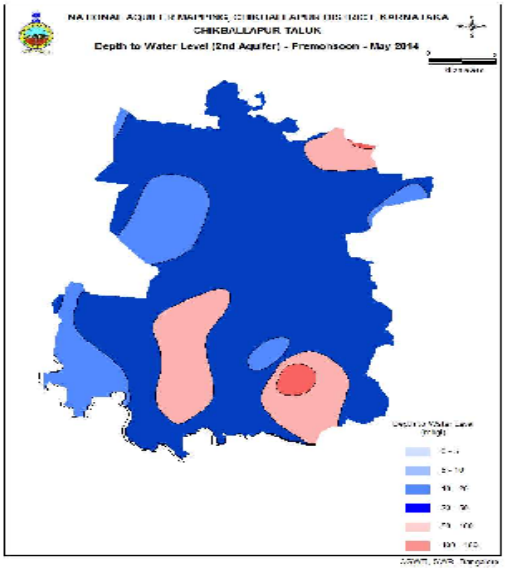

Fig 4. Pre-monsoon Depth to Water Level (Aq-II)

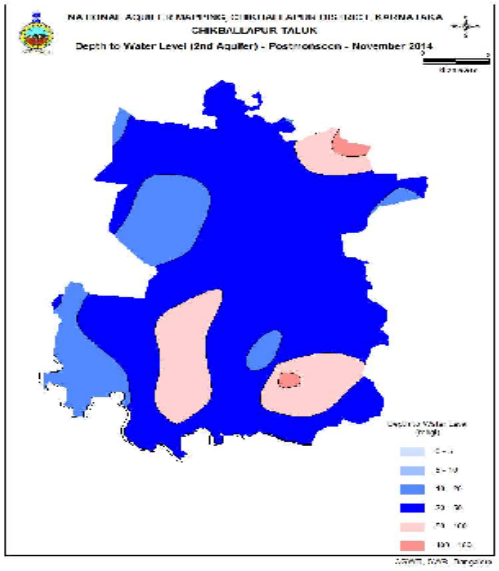

Fig 5. Post-monsoon Depth to Water Level (Aq-I**I)**

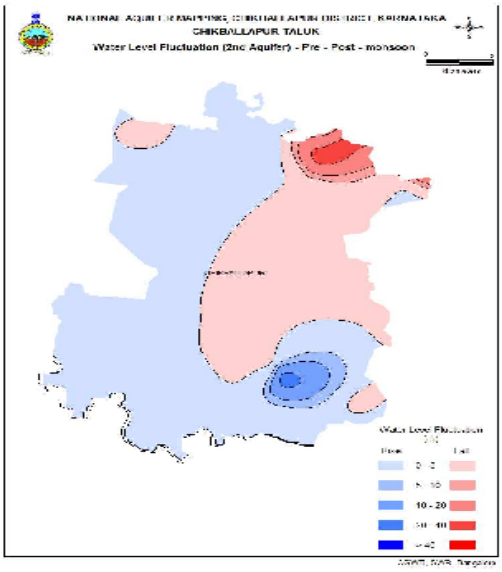

Fig 6. Water Level Fluctuation (Aq-II)

2. AQUIFER DISPOSITION

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

i. **Aquifer-I (Phreatic aquifer)** comprising Weathered Banded Gneissic Complex

ii. **Aquifer-II (Fractured aquifer)** comprising Fractured Banded Gneissic Complex

In Chikballapur taluk, fractured Banded Gneissic Complex / gneisses and laterite are the main water bearing formations (Figure-7). Ground water occurs within the weathered and fractured gneisses and laterite under water table condition and semi-confined condition. In Chikballapur taluk bore wells were drilled from a minimum depth of 100 mbgl to a maximum of 500 mbgl (Table-7). Depth of weathered zone (Aquifer-I) ranges from 10.2 mbgl to 49.0 mbgl (Figure-8). Ground water exploration reveals that aquifer-II fractured formation was encountered between the depth of 30 to 381 mbgl. Yeild ranges from 0.1 to 5.4 lps. The most productive granular zones with good discharge encountered are in between 100 to 200 m. Transmissivity ranges from 2.0 to 19.8 m^2/day. The basic characteristics of each aquifer are summarized in Table-8.

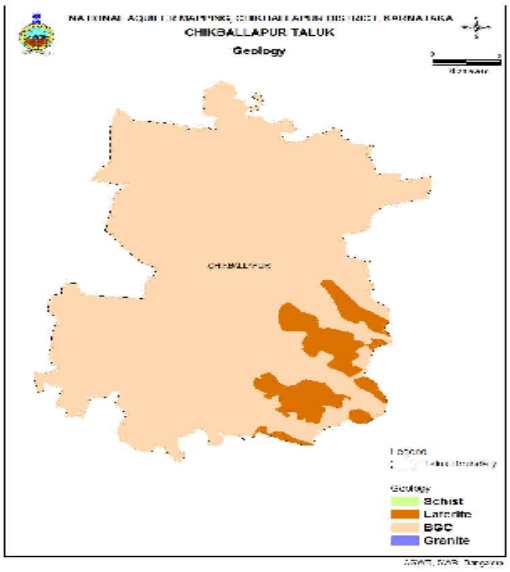

Fig 7. Geology Map

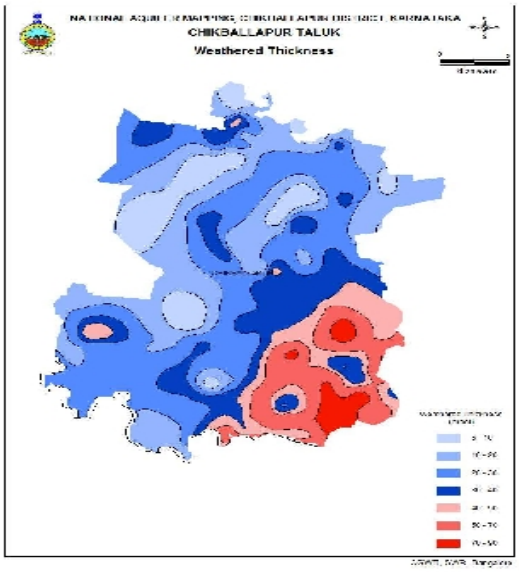

Fig 8. Weathered thickness map (Aq-I disposition)

Table 7: Details of Ground water Exploration

S.No.	Location	Latitude	Longitude	Depth Drilled (mbgl)	Casing Depth (m)	Fracture Zones (mbgl)	SWL (mbgl)	Q (lps)	DD (m)	T (m2/ day)
1	Gandalavarapalli	13°36'50"	77°44'10"	180.41		12.77, 60.49	19.5	0.21	-	
2	Jatavara Hosahalli	13°25'15"	77°48'15"	260.61		22.86	30.08	0.01	-	
3	K.Narayanapura	13°23'55"	77°39'55"	149.93		15-28.39	39.03	0.01	-	
4	Kottur Ew	13°31'0"	77°43'45"	144.31		12-50.87, 83-85	8.4	5.41	14.97	18.2
5	Kottur Ow	13°31'0"	77°43'45"	100		7.15-35.63	3.25	1.79	36.9	2
6	Korlaparti	13°29'15"	77°57'29"	150		14.77, 26-27.96, 49.50, 92-94	8.435	2.75	19.53	19.8
7	Ganganahalli	13°36'45"	77°48'60"	200		12-77, 28-30, 34-35, 37-39, 60-62	11.3	1.75	24.2	2.6
8	Hosahudya	13°7'31"	78°7'55"	345.6	46	105 – 108;233-235:253-255	92.57	11.75	3.36	
9	Hosahudya Ow	13°7'31"	78°7'55"	184	49	56-57: 90.5-91.5	29.7	1.75	7.37	-
10	Haleperesandra	13°35'60"	77°47'45"	500.7	25.6	29-30; 208-214; 218-220; 379-381	27.22	1.2		
11	Chikballapur Ew	13°30'10"	77°45'30"	367	34.5	36-38: 75-80: 257-260: 336-340: 360-367	5.22	4.5	15.78	
12	Chikballapur Ow	13°30'10"	77°45'30"	257.2	41	72-74: 133-135: 255-256	>100	9		
13	Rangasthala	13°27'25"	77°42'3"	275.4	10.2	79.0-79.5, 124.5-125.5, 259.0-259.5	70.4	0.014		
14	Dibbur	13°28'50"	77°47'30"	184.6	38	36.0-37.0, 147.5-148.5, 182.0-183.0	38.07	0.44		
15	Chikballapur	13°24'34"	77°43'44"	305.9	35	275.0-276.0	173.6	0.44		
16	Mandikal	13°36'1"	77°44'6"	200	16.8	152.5-153.5	3.72	0.014		

Table 8: Basic characteristics of each aquifer

Aquifers	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Weathered gneisses and laterite	Fractured / Jointed gneisses and laterite
Thickness range (mbgl)	30	Fractures extends upto 300 mbgl
Depth range of occurrence of fractures (mbgl)	-	30 – 300 65% between 30 - 200
Range of yield potential (lps)	Mostly Dry	< 1 - 5
Specific Yield	2%	0.2%
T (m^2/day)	-	2 – 19.8
Quality Suitability for Irrigation	Yes	Yes
Suitability for Domestic purposes	Yes	Yes
Remarks	Over exploited	Ground water in hard rocks exists within the fractures & 1 to 3 sets of fractures are likely to be encountered up to the depth of 500 m bgl.

2.2 3 D aquifer disposition and Cross-Sections

A. Aquifer disposition – Rockworks output (Fig.-9 & Fig.-10)

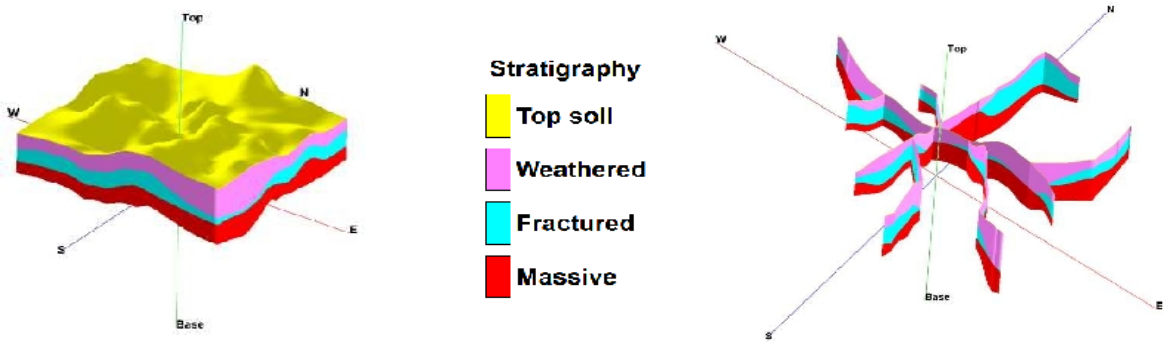

Fig 9. 3D aquifer Disposition and Fence Diagram

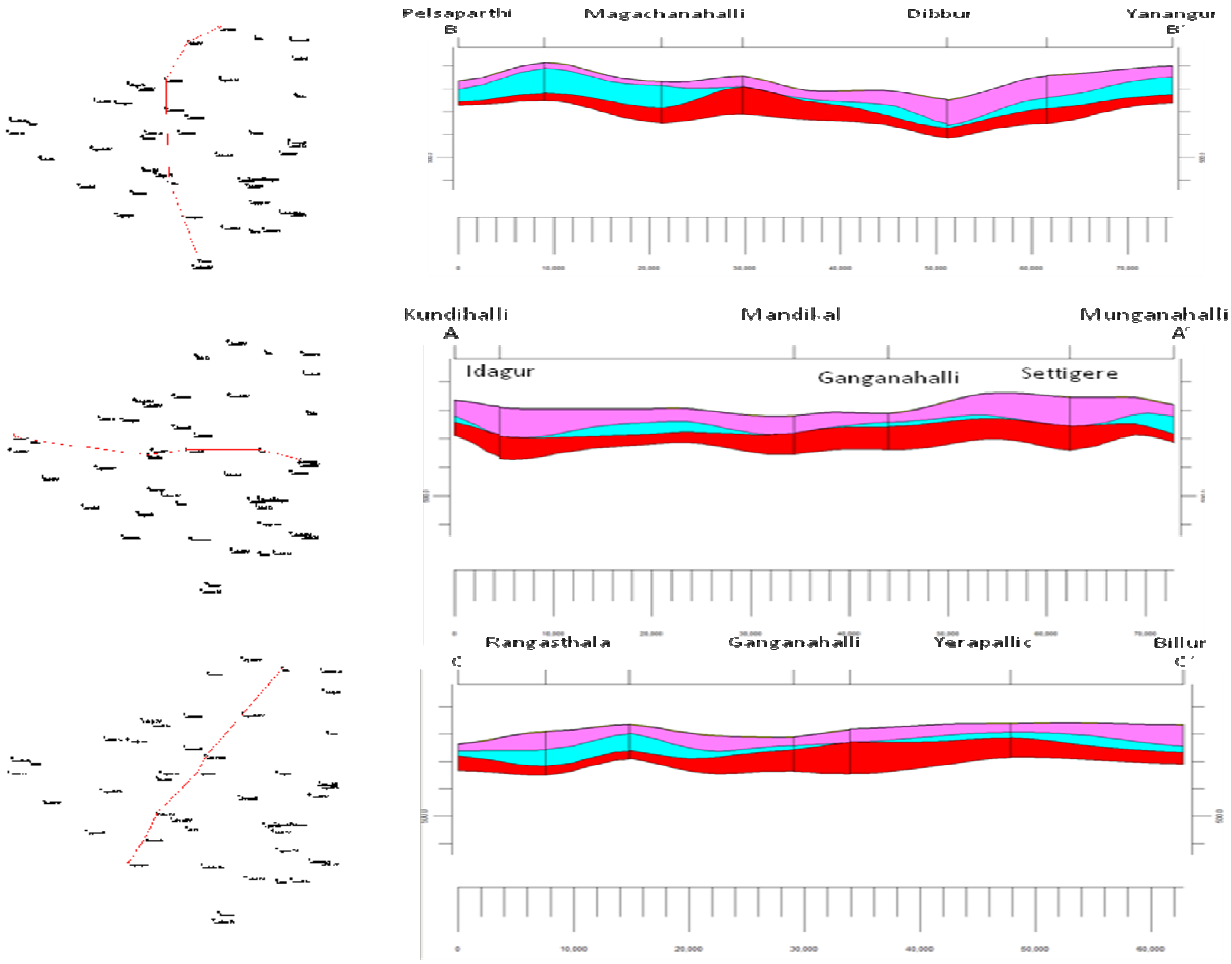

Fig 10. Cross sections of aquifers in different directions

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

a. Aquifer wise resource availability and extraction

(a) Present Dynamic Ground Water Resource (2011)

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
Chikballapur	4600	6051	610	6661	610	0	145	OVER-EXPLOITED

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

Taluk	Annual replenishable GW resources (in ham)	Fresh In-storage GW resources (in ham)		Total availability of GW resource, (in ham)
		Phreatic	Fractured	Dynamic + phreatic in-storage + fractured in-storage
Chikballapur	4600	0	1883	6483

(c) Comparison of ground water availability and draft scenario in Chikballapur taluk

Taluk	GW availability (in ham)	GW draft (in ham)	Stage of GW development	GW availability (in ham)	GW draft (in ham)	Stage of GW development	GW availability (in ham)	GW draft (in ham)	Stage of GW development
	2009			**2011**			**2013**		
Chikballapur	4319	6921	160	4600	6661	145	4448	6482	146

b. Chemical quality of ground water and contamination

Range of chemical constituents from analytical results of 19 samples in Chikballapur taluk is presented in Table 8 below:

Table-8: Range of chemical constituents in ground water – Chikballapur taluk

Chemical constituents in PPM →	pH	EC in m/mhos/cm at 25 ^{0} c	Total hardness as $CaCo_3$	Ca	Mg	Na	K	HCO_3	CO_3	Cl	So_4	No_3	F	B
Aquifer I (Dug wells)														
Range	7	1600	560	176	29	102	12.1	281	0	305	44	102	0.49	0.25
Aquifer II (Bore wells)														
Range	7.2 to 8.3	260 to 1360	60 to 380	8 to 64	7 to 68	26 to 129	1.7 to 79.4	49 To 262	0 to 12	21 to 263	10 to 90	15 to 65	0.3 to 1.6	0.001 to 0.25

Electrical Conductivity: Out of 19 samples, EC values ranges from 260 to 1360 µ/mhos/cm at 25^{o}C which indicates ground water has EC value within the permissible limit in both the aquifers (Fgure-11).

Fluoride: Fluoride concentration in ground water is of geogenic origin in areas underlain by younger granites/ gneisses containing minerals like Flurospar & fluroapatite F value ranges between 0.3 – 1.6 mg/l. Out of 19 samples, 1 sample indicate fluoride greater than the permissible limit of 1.5 mg/l (Fgure-12).

Nitrate: Nitrate value ranges between 15 to 65 mg/l. Out of 19 samples, 3 samples indicate nitrate greater than the permissible limit of 45 mg/l, which constitutes 16% of the samples analyzed. Nitrate contamination is due to extensive use of fertilizers, hence is anthropogenic in origin (Fgure-13).

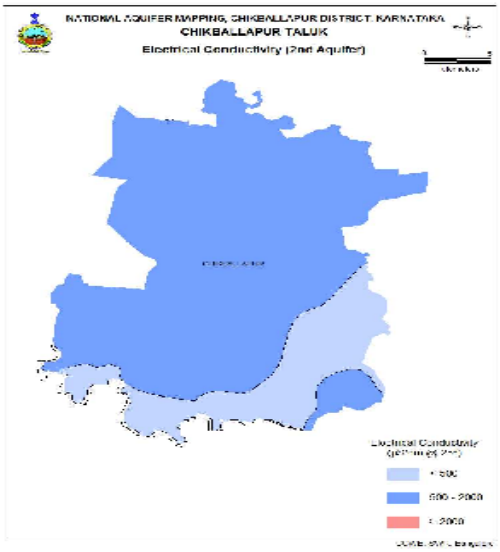

Fig 11. Electrical Conductivity Map

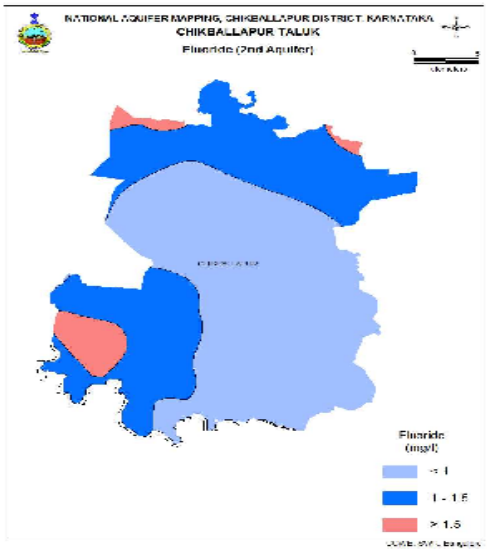

Fig 12. Fluoride Map

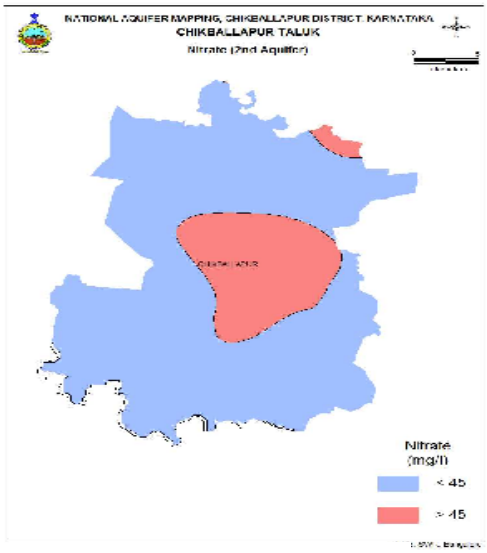

Fig 13. Nitrate Map

In general ground water quality in Chikballapur taluk is good for drinking purpose except in some areas as depicted in above illustrated maps, where nitrate & fluoride is found to be greater than the permissible limit as per “Indian Standard Drinking Water Specification 2009”. Ground water samples have also been tested and found suitable for agriculture & irrigation purposes.

4. GROUND WATER RESOURCE ENHANCEMENT

a. Aquifer wise space available for recharge and proposed interventions

Recharge dry phreatic aquifer (Aq-I) in the taluk through construction of artificial recharge structures, viz; check dams, percolation tanks & point recharge structures (Table-9). 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 (Figure-14). Tentative location of proposed artificial recharge structures is shown in Figure-15.

Table 9: Quantity of non-committed surface runoff & expected recharge through AR structures

Artificial Recharge Structures Proposed	Chikballapur taluk
Non committed monsoon runoff available (MCM)	9.20
Number of Check Dams	57
Number of Percolation Tanks	4
Number of Point Recharge structures	6
Tentative total cost of the project (Rs. in lakhs)	222.67
Excepted recharge (MCM)	6.63
Expected rise in water level (m)	0.7
Cost Benefit Ratio (Rupees/ cu.m. of water harvested)	3.37

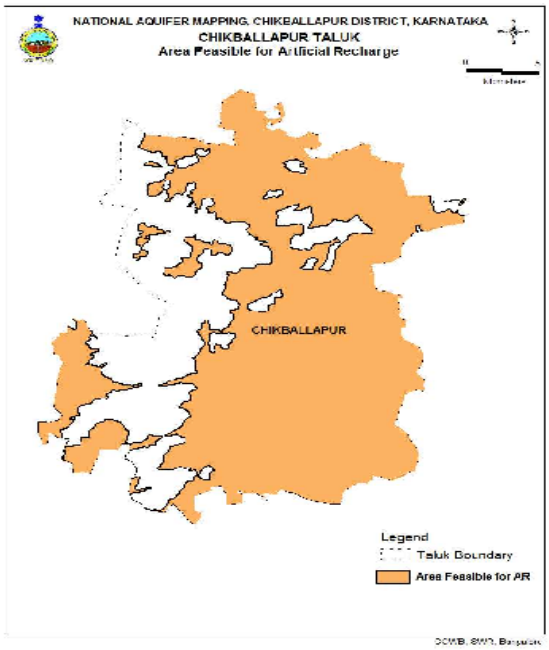

Fig14. Area feasible for AR structures

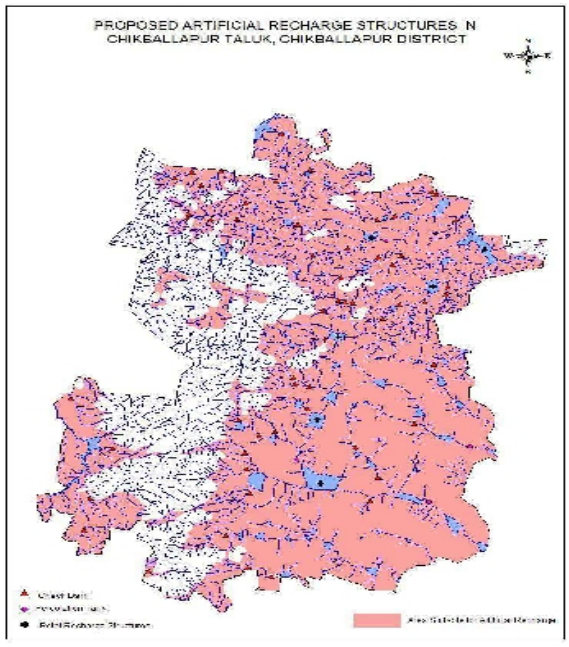

Fig 15. Tentative location of AR structures

b. Proposed Yettinahole Project

Yettinahole project is a drinking water supply scheme which neither proposes irrigation use nor development of any command areas.

The project envisages Drinking Water Supply Scheme to Chikballapur district along with other six districts ie. Kolar, Bangalore Rural, Ramnagaram, Tumkur, Hassan and Chickmagalur by Karnataka Neeravri Nigam Ltd, Government of Karnataka.

The project proposal comprises two components namely, drinking water and tank filling. In Chikballapur taluk, iImplementation of the project helps to recharge 565 Ham to groundwater by which there will be increase in the groundwater availability and the stage of GW development will come down (Table-10).

c. Urban Tertiary Treated Water

The Government of Karnataka is contemplating a scheme/project to replenish 32 tanks of Chikballapur district with the treated sewage water from Bangalore city lakes. Tanks in Chikballapur district would be replenished by processing of about 110 MLD (about 33 MCM/year, considering 300 days of treatment). The project will contribute 338 Ham of water for recharging the aquifer in Chikballapur taluk (Table-10).

Overall, recharge through AR structures, implementation of Yettinahole and urban tertiary treated waste water projects help to recharge 1566 Ham of water to groundwater by which there will be 37% increase in the groundwater availability and the stage of GW development will come down to 108 % from 145%.

The increase in groundwater availability on recharging the available water from different sources and consequent change in groundwater scenario is presented in the Table-10.

Table-10: Ground Water Availability and Draft Scenario in Chikballapur taluk and Expected Improvement in Stage of Ground Water Development

Taluk	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for all uses	Existing stage of Ground Water Development	Expected Recharge from Artificial Recharge Projects	Additional Potential from proposed Yettinahole Project	Proposed Tertiary Treated Waste Water of Bangalore City	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**	**Ham**		**%**
Chikballapur	4600	6661	145	663	565	338	6166	37	108

5. DEMAND SIDE INTERVENTIONS

a. Water use efficiency

Agriculture is the main occupation and source of livelihood of the rural population in Chikballapur taluk. As there are no other sources, groundwater is the only source for agriculture. Therefore, agriculture sector is major consumer of groundwater. Because of over-exploitation, dug wells are practically dry and yield of bore wells also is on declining trend. Hence, farmers are facing inadequacy of groundwater for agriculture and in the district about 70% of the farmers have adopted to change in cropping pattern and water economy irrigation practices like drip irrigation and sprinkler irrigation.

Heavy water consuming crops like paddy is grown in less than 1% of the net sown area and sugarcane is not grown. If, the remaining 30% farmers also adopt the water use efficient irrigation practices, there will be additional saving in water. Therefore, encouragement from government is essential for achieving full target of water use efficiency in the district.

b. Regulation and Control

- Chikballapur taluk has been categorized as Overexploited, since the Stage of ground water development has reached 145% (GEC-March 2011). Hence, stringent action has to be taken up through Karnataka Ground Water Authority to control further ground water exploitation in the taluk.
- Ground water recharge component needs to be made mandatory in the taluk.

c. Quality issue management options

The main quality issues in the Chikballapur taluk are fluoride and nitrate in both the aquifers. But, they are sporadic in nature. Fluoride is geogenic. Nitrate contamination is local in nature and is anthropogenic.

For remediation, the following management measures are suggested.

- Alternate source
- Removal technique
- Artificial recharge
- In-situ rainwater harvesting
- Centralized drinking water supply from Yettinahole Project
- Prevention of contamination

6. SUMMARY

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

Table 11. Summary of Management plan of Chikballapur taluk

Chikballapur taluk is over-exploited & present stage of GW Development (2011)	145%
Net Annual Ground Water Availability (MCM)	46.00
Existing Gross Ground Water Draft for all uses	66.61
Groundwater development feasibility	NIL
Total GW Resources (Dynamic & Static upto the depth of 200 mbgl) (MCM)	64.83
Expected additional recharge from monsoon surplus runoff (MCM)	6.63
Change in Stage of GW development, %	145 to 126
Expected additional recharge from Proposed Yettinahole project (50% live capacity of MI tank) (MCM)	5.65
Change in Stage of GW development, %	126 to 114
Expected additional recharge from Proposed project of filling MI tanks with Urban Tertiary treated water (MCM)	3.38
Change in Stage of GW development, %	114 to 108
Water Use efficiency measures	• 70 % farmers have adopted water use efficiency irrigations practices like dip & sprinkler irrigation • Water intensive crops (Paddy & Sugarcane) are not being cultivated and • Government to take initiative to encourage remaining 30% farmers to adopt water use efficiency irrigations practices
Groundwater quality aspects - Fluoride & Nitrate	• Alternate source • Removal technique • Artificial recharge • In-situ rainwater harvesting • Centralized drinking water supply from Yettinahole Project • Prevention of contamination