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

Hiriyur Taluk, Chitradurga District,Karnataka

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region,Bengaluru

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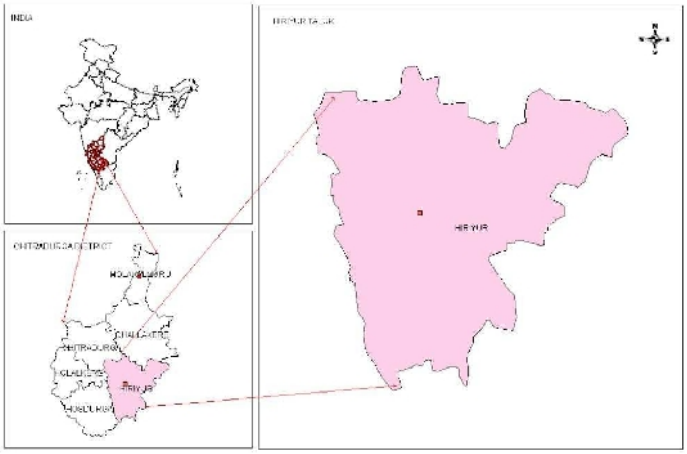
Government of India
Ministry of Water Resources, River Development & Ganga Rejuvenation
Central Ground Water Board

HIRIYUR TALUK AQUIFER MAPS AND MANAGEMENT PLANS, CHITRADURGA DISTRICT, KARNATAKA STATE



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HIRIYUR TALUK AQUIFER MAPS AND MANAGEMENT PLANS, CHITRADURGA DISTRICT, KARNATAKA STATE

CONTENTS

HIRIYUR TALUK AQUIFER MAPS AND MANAGEMENT PLANS,
CHITRADURGA DISTRICT, KARNATAKA STATE

1. SALIENT FEATURES

Name of the taluk : **HIRIYUR**
District : Chitradurga
State : Karnataka
Area : 1,717 sq.km.
Population : 2,86,494
Annual Normal Rainfall : 593 mm

Hiriyur taluk, Chitradurga district, Karnataka state covering an area of 1717 Sq. Kms and is a part of Krishna river basin located at longitudes 13^0 40' 59" : 14^0 12' 12" and east latitude of 76^0 26' 6.7" : 76^0 57'15.5" falling in survey of india toposheet numbers 57 C/9, C/10 and 57 B/12 and B/16 and is bounded by Chitradurga and Chellakere taluks of Chitradurga district in the North, Tumkur district in the South, Holalkere and Hosadurga taluks of chitradurga district in west and in the East it is bounded by Andrapradesh. Location map of the taluk is in Figure-1.

The Hiriyur taluk is a part of Chitradurga revenue sub-division with Hiriyur as taluk head quarter. There are four revenue hoblies - Hiriyur, Javanagondanahalli, Aimangala and Dharmapur which covers 154 Inhabitated and 4 un inhabitated villages. The taluk is well connected with good network of roads with NH-4 – Bangalore to Mumbai passing through the taluk.

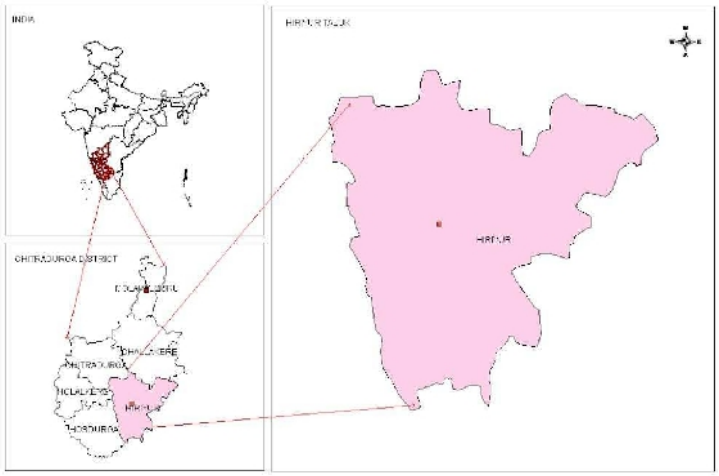

Fig 1: Location Map of Hiriyur taluk, Chitradurga district

1.2 Population

As per 2011 census, the total population in Hiriyur taluk is 286494 (1,45,241 males and 1,41,253 Females) of which about 2.3 lacs (80%) constitutes the rural population. The study area has an overall population density of 168 persons per sq.km. The decadal variation in population from 2001-2011 is 8.23 % with projected population of 314017 in 2021.

1.3 Rainfall

Hiriyur taluk enjoys arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Central Dry agro-climatic zone of Karnataka state and is categorized as drought prone.

The climate of the 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 annual normal rain fall (30 years RF data) 593 mm and the statistical analysis of rain fall data is in table -1.

Table-1 The Rain fall data analysis for the period 1981 to 2010 (Hiriyur Station)

	JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
NRM	1	3	13	32	67	117	58	53	71	121	303	123	43	7	173	593
STDEV	4	8	25	29	54	75	52	43	61	76	119	85	49	12	92	173
CV%	344	253	191	91	81	64	88	80	87	63	39	69	113	174	53	29

Assessment of Drought

Rainfall data of Hiriyur taluk has been analysed for 105 years using IMD method to assess the drought condition in the taluk. The results of the classification are listed in the Table -2.

Table-2: Classification of drought and its periodicity (IMD, 1971)

% Deviation (Di)	> 0	0 to -25	-25 to -50	-50 to -75	Probability of drought occurrences
Category	No drought	Mild (Normal)	Moderate	Severe	
	Years				
Period/Duration	50	30	22	3	Once in 4 years

The details of the drought assessment indicates that out of 105 years of analysis, "No Drought" condition is experienced in 50 years, "Mild Drought" condition is 30 years and "Moderate Drought" condition experienced in 22 years. Further it is observed that "Severe Drought" condition is experienced in 3 years ie, during 1965, 1976 and 1994 in Hiriyur Taluk. Based on occurrence and frequency of past drought events, the probability of occurrence of various intensities of drought at each station has been studied. It has been observed that the frequency of occurrence of drought is **once in 4 years** at Hiriyur taluk.

1.4 Agriculture & Irrigation: Hiriyur taluk having 2.3 lacs (80%) of rural population wholly dependent on the rain fall for their agricultural activities. The land use pattern of the taluk is presented in the table-3.

Table 3: Landuse pattern of in Hiriyur taluk

Geographical area (Ha)	Area under forest (Ha)	Area not available for cultivation (Ha)	Uncultivable land (Ha)	Fallow land (Ha)	Area sown (Ha)		
					Net sown area	Area sown more than once	Total sown/cropped area
137423	11358	8219	35882	29979	51985	8203	60188

Source: District at a glance 2011-2012

1.4.1 Principal crops

The principal crops of the taluk are Jower - 11561 ha (19.20% to the total cropped area), Sun flower with 6771 ha(11.24%) and Ground nuts-4421 ha (7.34%). Overall food grains are the major crops comprising of cereals and pulses grown in an area of 23331ha (38.76%) and oil seeds with an area of 11782ha (19.57%) grown during Rabi season. Vegetables and paddy crops are the Kharif crops. The principle crops and area grown are in the below table-4.

Table-4 Principal crops in Hiriyur taluk

Table 4: Cropping pattern of in Hiriyur taluk

Crops	Cereals (Area in Ha)			Pulses (Area in Ha)			Fruits (Area in Ha)	Vegetables (Area in Ha)	Oil seeds (Area in Ha)		
	Jowar	Ragi	Others	Bengal gram	Horse gram	Others			Sun Flower	Ground nuts	others
	11561	1448	2300	6055	1482	485	1433	1215	**6771**	4421	590
Total	15309			8022			1433	1215	11782		
	Food Grains (23331 ha)						**Fruits**	**Vegetables**	**Oilseeds**		

Source: District at a glance 2011-2012

1.4.2 Irrigation Practices: In Hiriyur taluk the ground water is being developed through 574 dug wells and 8499 number of shallow tube wells (Report on 4th census of Minor Irrigation Schemes 2006-2007) for irrigation purposes. The ground water thus developed from these

structures were managed through water distribution irrigation practices by adopting- open channel (5402 bore wells & 454 dug wells), underground pipe (1971 bore wells & 94 dug wells), surface pipe (681 bore wells & 1 dug well), drip irrigation (376 bore wells & 20 dug wells) sprinklers (61 bore wells & 5 dug wells) and others (8 bore wells).

1.4.3 Ground water and surface water Irrigation: Ground water is the main source of irrigation in Hiriyur taluk. The details of surface water and ground water irrigation are in the table-5.

Table 5: Details of irrigation in Hiriyur taluk

Sl. No.	Source	No. / Length	Net area irrigated	Gross area irrigated
1	Canals	114	700	790
2	Tanks	57	0	0
3	Wells	2102	0	0
4	Bore wells	8519	7929	23894
5	Lift Irrigation	0	0	0
6	Others	0	0	0
7	Total	10792	8629	24684

1.5 Geomorphology, Physiography & Drainage

Geomorphologically, Hiriyur taluk is charectarised by huge undulating plains and is part of Eastern Ghats and lies in the valley of Vedavathi river (Hagari). Eastern Ghats runs from the west of Hiriyur continue up to Chitradurga. Prominent hill ranges are Uttare chain of hills with an altitude of 3675 feet near Mari Kanive and the other one is Hiduskatte chain of hills with an altitude of 2904 feet. The average elevation of Hiriyur taluk is 630m a msl.

Drainage: Hiriyur taluk is the part of Krishna river basin drained by Vedavathi (Hagari) river and its tributaries. Vedavathi is of two streams – Veda and Avathi united together near Kadur and forms joint stream of Vedavathy and after penetrating the central belt of the hills enters the taluk near Marikanive where the renowned reservoir Vanivilas sagar has been built. The general drainage pattern is of sub-rectangular due to marked influence of geologic structures in the basin Figure-3.

1.6 Geology

Hiriyur taluk is occupied by crystalline Schist constituting Chitradurga schist belt and banded gneissic complex as major rock formations (figure 2).

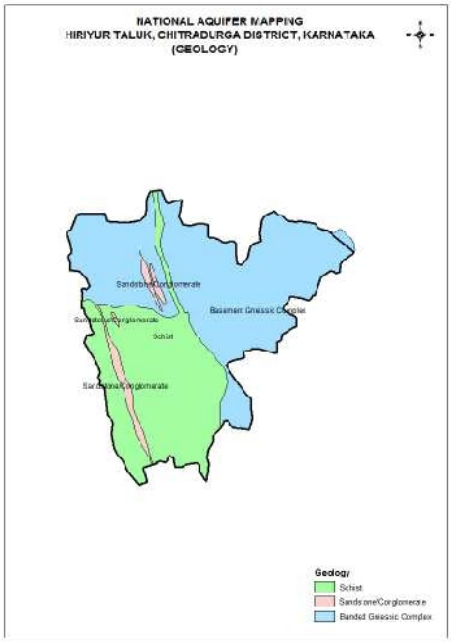

Fig 2 : Geology map

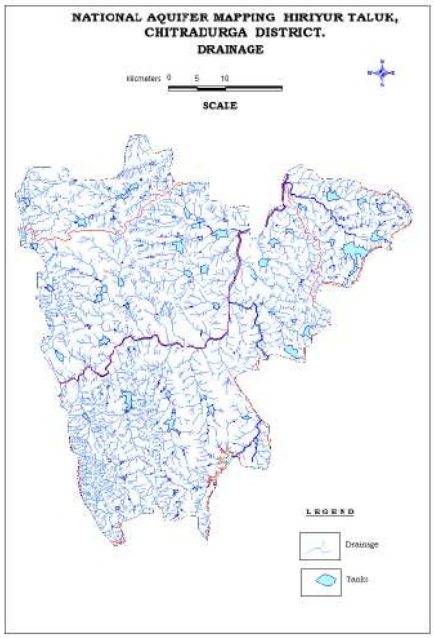

Fig 3: Drainage map

1.7 Soil

The soils of the area are derived from Schist / Gneiss. The soils are clayey, clayey missed, clayey skeletal, Loamy and rocky land.

1.8 Ground water resource availability and extraction:

The Ground water availability as per Resource Estimation 2009 is as in the table-6.

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
HAM	11460	21386	4367	37214

As per the estimation (GEC 2013) the ground water draft (extraction) for irrigation worked out to be **11898 ham** with stage of ground water development of 109% .

1.9 Existing and future water demands

As per GEC (2013) existing ground water draft for irrigation, industrial & domestic (all use) is **12468 ham** and availability for future demands with judicious utilization since the stage of ground water development is already reached up to **109** % having less scope it is **2303 ham** of which **642 ham** is for domestic and industrial use and **1661ham** is for future irrigation purposes.

1.10 Water level behavior

Depth water level during pre and postmonsoon period of the taluk as in table 7.

Table 7: Depth to Water levels in Hiriyur taluk

Item	Depth to Water levels, mbgl					
	Pre- monsoon		Post- monsoon		Water level fluctuation	
	Aquifer I	Aquifer II	Aquifer I	Aquifer II	Aquifer I	Aquifer II
Range	5.05 to 14.80	57.30	4.90 to 12.35	30.00	0.00 to 2.45	27.30
Average	10.75	57.30	9.99	30.00	0.86	27.30

A. Depth to water level – pre monsoon

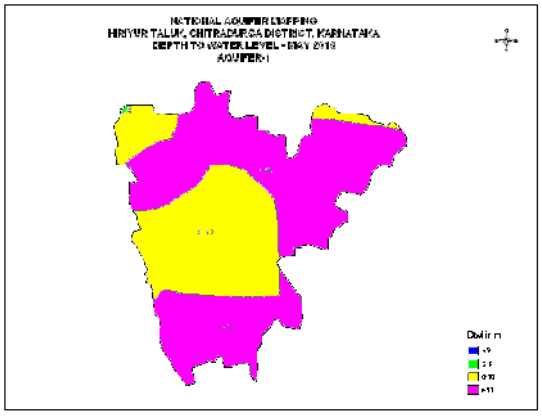

Fig 4: Pre- monsoon DTW Map Aquifer- I

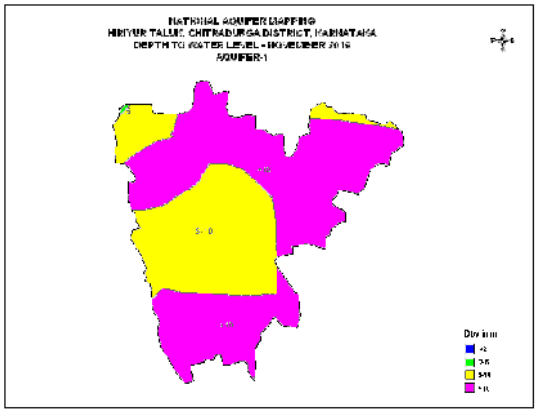

Fig 5: Post-monsoon DTW map Aquifer-I

B. Depth to water level – post monsoon

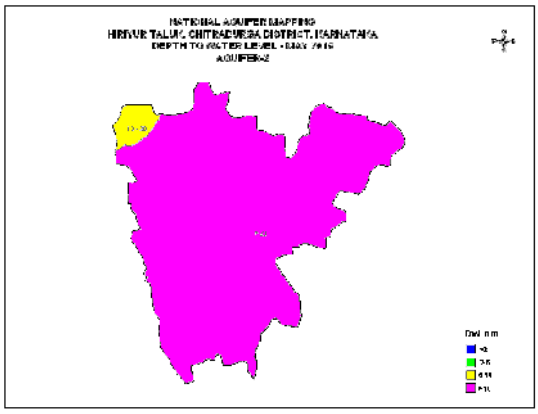

Fig 6: Post- monsoon DTW Map Aquifer- II

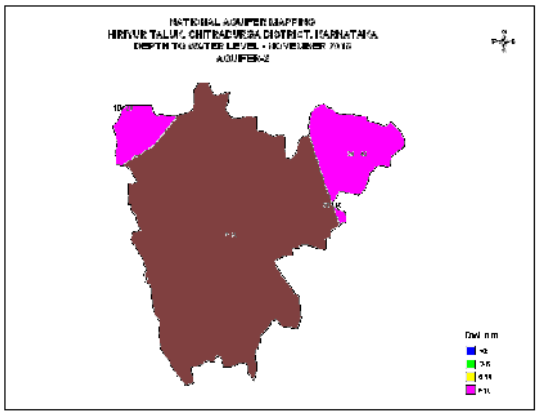

Fig 7: Post- monsoon DTW map Aquifer- II

C.Water level fluctuation

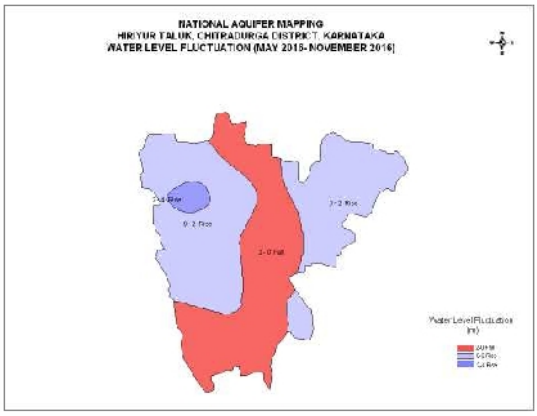

Fig 8: Water level fluctuation Aquifer I

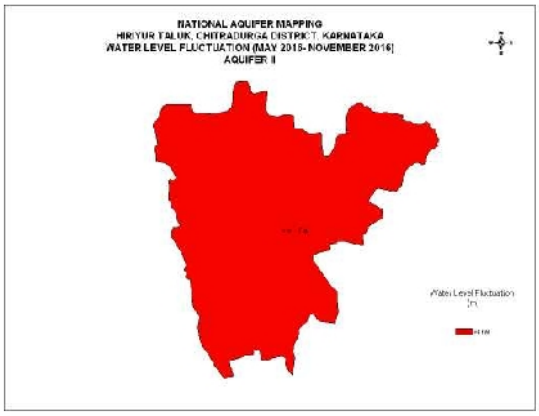

Fig 9: W/L fluctuation Aquifer II

The analysis of long term water level trend in aquifer-I indicates that the falling trend of 0.0755 m/y during pre-monsoon and 0.1055m/y during post-monsoon with overall falling trend of 0.086m/y. Similarly, in aquifer-II it is falling trend of 0.8265 m/y during pre- monsoon and 0.939 m/y during post-monsoon with overall raising trend of 0.0.9475m/y.

2. AQUIFER DISPOSITION

The data collected during Geophysical investigation, Ground water exploration **(Table- 8)** were made use to delineate the aquifer system, Geometry and the extension of aquifer in terms of both lateral and vertical extent.

Table 8: Details of Ground water Exploration in Hiriyur taluk

Sl. No.	Details	No/Range
1	No of wells drilled	20
2	Depth range in 'm'	60 to 200
3	Depth of Casing in 'm'	5 to 24
4	Discharge in LPS	0.71 to 8.40
5	S.W.L. in mbgl	3.57 to 20.60
6	Sp. Capacity, lpm/m dd	2.90 to 96.31
7	Transmissivity, m^2/day	1.03 to 91.76

The fracture analysis from the above wells indicates about 30% of the fractures are encountered at the depth of 0 to 30.00m, 54% are in between the depth of 30 to 100m and 17% are in between 100 to 200m depth. The yield analysis indicated that 55% of the wells showed 1 to 5 lps discharge followed by 305 above 5 lps discharge.

2.1 Number of aquifers: Based on the Ground water exploration data In Hiriyur taluk, there are mainly two types of aquifer systems;

i. **Aquifer-I- (Phreatic aquifer)** comprising Weathered Gneiss / Granite which is dry.

ii. Aquifer-II- (Fractured multi-aquifer system) comprising Fractured Gneiss / Granite.

2.2 3 D aquifer disposition and basic characteristics of each aquifer:

The Exploration drilling data utilised for generating aquifer disposition maps through Rock works software.

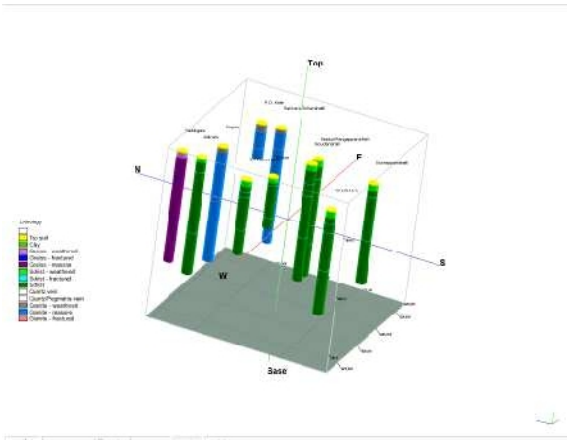

Fig 10: Log diagram of Exploratory wells

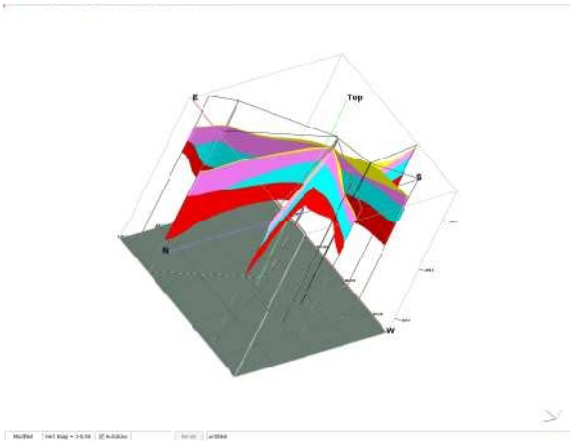

Fig 11: 3 D Stratigraphy Fense diagram

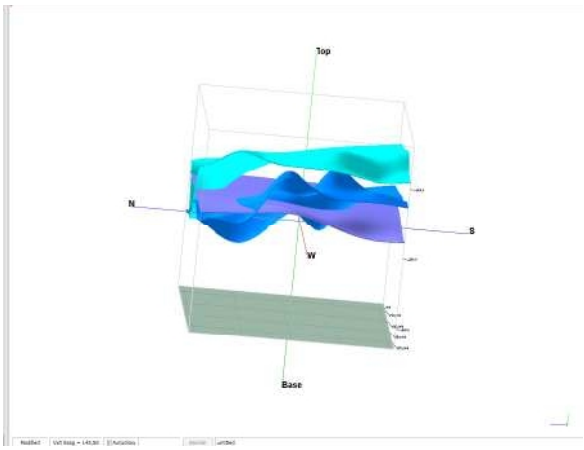

Fig 12: 3 D Aquifer Model

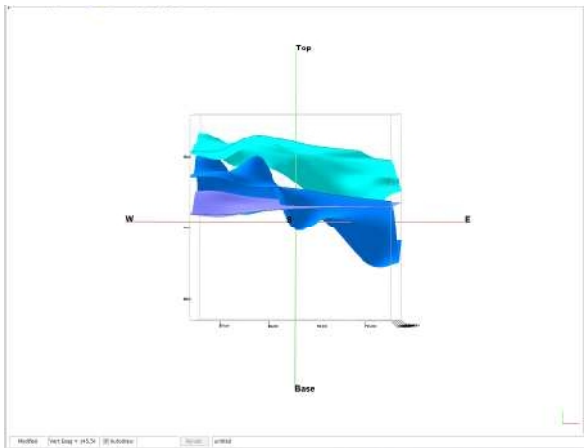

Fig 13: 3 D Aquifer Model (different directions)

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION

3.1 Aquifer wise resource availability and extraction

Aquifer wise ground water resource (2011) has already been discussed in above chapter (1.8 & 1.9). However overall Groundwater resource estimation in Hiriyur tluk as on 2011 & 2013 indicating present and future scenario (2025), Stage of ground water development and categorization is presented in the below table-9.

Table 9: Ground water resource

Sl. No.	Resource details	2Estimation-2011	Estimation-2013
1	Net Ground Water Availability in HAM	11494.84	11442
2	Existing Gross Ground Water Draft for Irrigation in HAM	11664.61	11898
3	Existing Gross Ground Water Draft for Domestic and Industrial Water Supply in HAM	498.41	570
4	Existing Gross Ground Water Draft for all use in HAM	12163.03	12468
5	Allocation for Domestic And Industrial Use for next 25 years in HAM	801.75	642
6	Net Ground Water Availability for future Irrigation Development in HAM	1343.45	1661
7	Existing Stage Of Ground Water Development in percentage	106	109
8	Categorization	OE	OE

3.2 Chemical quality of ground water and contamination

The chemical quality of ground water in Hiriyur taluk is assessed from the analysis results of 9 samples from dug wells (Aquifer-I) and 14 from bore wells (Aquifer-II). The variation range and average of the different chemical constituents are presented in the table-7.

Table 10: Variation range and average of chemical constituents in Ground water

→ Chemical consitituents in PPM	pH	EC in m/mhos/cm at 25 ^{0} c	Total hardness asCaCo$_3$	Ca	Mg	Na^{++}	K^+	Hco_3	Cl	So_3	No_3	F
Aquifer I (Dug wells)												
Range	7.95 to 8.15	926 to 2883	90 to 500	16 to 92	15 to 95	88 to 455	0.37 to 73	244 to 793	121 to 461	40 to 215	3.2 to 265	0.3 to 1.3
Average	8.0	211.44	311.11	32.8	57.1	304.78	12.8	451.3	253	120.5	83.0	0.65
Aquifer II (Bore wells)												
Range	7.5 to 8.2	1020 to 2440	140 to 500	32 to 80	7 to 92	99 to 327	0.1 to 67	244 to 671	92 to 447	32 to 100	7 to 170	0.5 to 2.8
Average	7.9	1420.9	279.6	47.7	38.7	191.4	9.0	417.9	184.1	56.3	47.8	1.9

3.2.1. Suitability of ground water for **drinking purposes** is assessed as per Indian Standard Drinking water specification (IS 10500:1991) which indicates water is potable and all the required chemical constituents is within the desirable/permissible limits. The distribution of major chemical constituents like Chloride and Nitrate is presented in the figures-14 & 15.

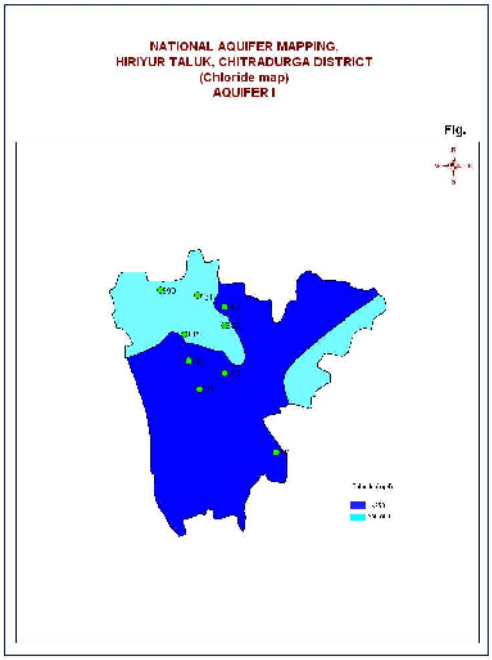

Fig 14: Chloride distribution

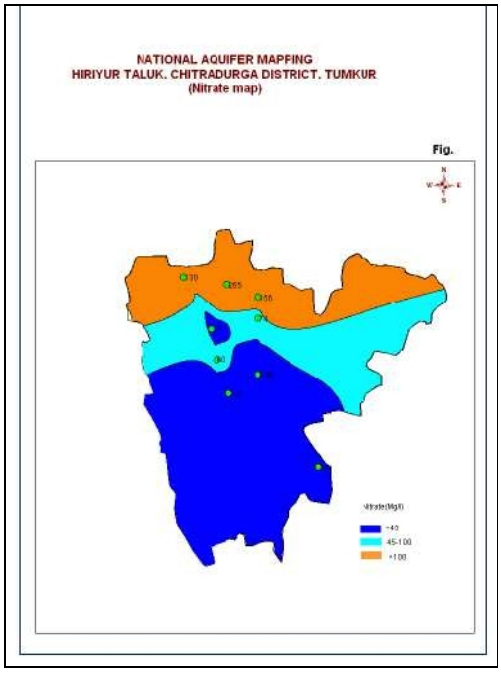

Fig 15: Nitrate distribution

3.2.2. Similarly the utilisation of ground water for **irrigation purposes** was assessed and the classification of ground water in to different class is presented in the below table-8.

Table 8. Suitability of Ground water for irrigation purposes

Sl. No.	Chemical parameter	Class	Limits/Required standard	No. of samples falling in the category	Percentage	Remarks
1	EC in Micro mhos/cm at 25^0C (after wilcox)	Excellent	< 250	-	-	92 % percent of the area falls in permissbilbe class of ground water for irrigation purposes.
		Good	250 to 750	0	-	
		Permissible	750 to 2000	13	92.85 %	
		Doubtful	2000 to 3000	1	7.14 %	
2	Chgloride (after Scofield)	I	< 700	14	100 %	Ground water is class I for irrigation purposes
		II	700 to 2000	-	-	
		III	> 2000	-	-	
3	Percent Sodium (after Wilcox)	Excellent	< 20	0	-	56.25% the taluk is falling under doubtful class for irrigation purpooses.
		Good	20 to 40	2	12.5 %	
		Permissible	40 to 60	5	31.25 %	
		Doubtful	60 to 80	9	56.25	
4	Sodium Absorption Ratio	Excellent	< 10	16	100 %	Low Sodium type of ground water over the area and excellent for irrigation purposes
		Good	10 to 18	-	-	
		Fair	18 to 26	-	-	
		Poor	> 26	-	-	
5	Residual Sodium Corbonate	I	< 1.25	9	56.25%	Maximumarea falls under class I followed by class III
		II	1.25 to 2.00	0	0	
		III	> 2.00	7	43.75%	

Based on the above chemical data/classification the distribution of chemical constituents like EC, percent sodium, residual sodium carbonate over Hiriyur tluk is presented in the following figures-16,17 & 18.

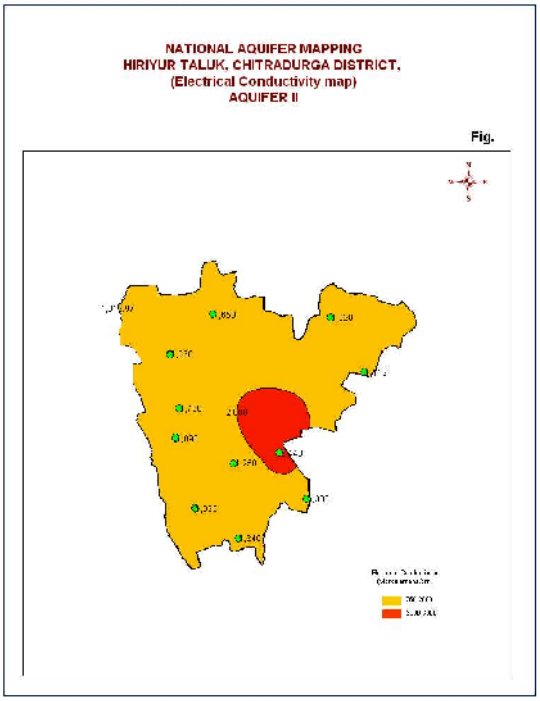

Fig 16: Distribution of EC

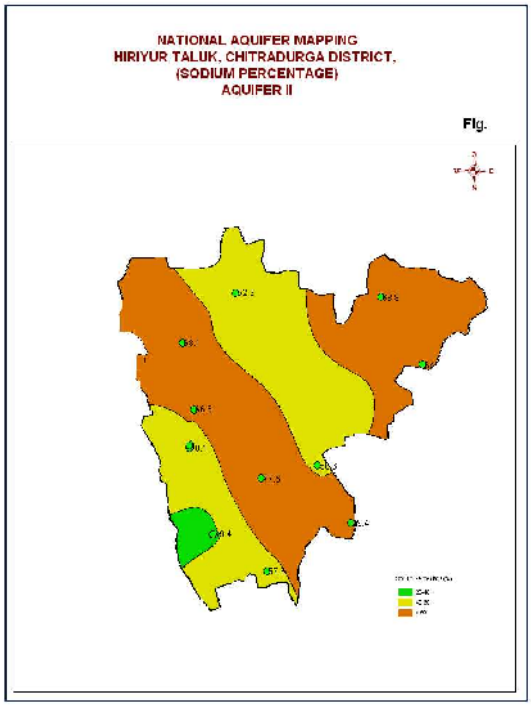

Fig 17: Distribution of percent Sodium

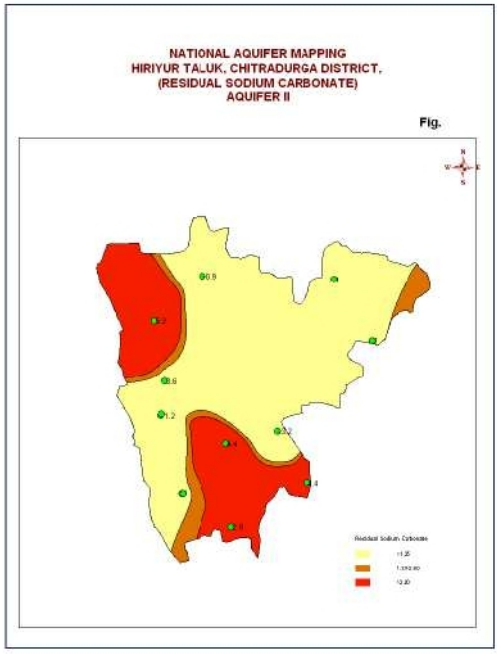

Fig 18: Distribution of Residual Sodium Carbonate

3.3.Ground water contamination

Fluoride is the major ground water contamination for drinking purpooses over entire Hiriyur taluk. This is a quite an intriguing situation as Aq-I is almost dried up and Aq-II is facing quality problem. About 71.42% of the samples collected are with Fluoride beyond 1.5 ppm details are as in the above table-10 and distribution is presented in figure-19.

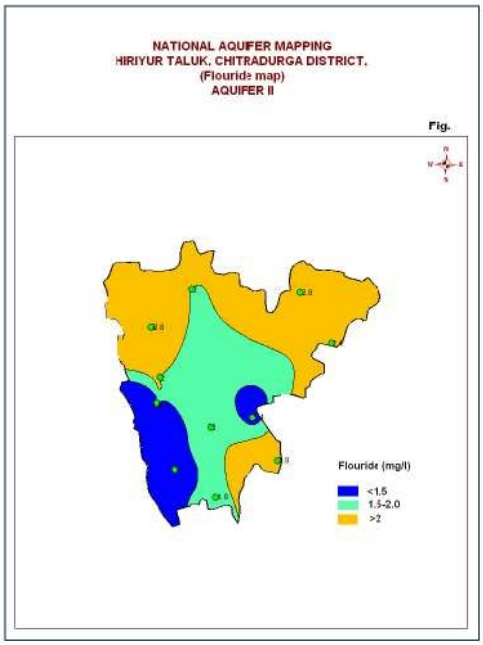

Fig 19: Distribution of Fluoride

4. GROUND WATER RESOURCE ENHANCEMENT

Continuous drought, increase in agricultural activity, subjected to excessive ground water withdrawal leading to depletion of ground water table, reduction in yield and deterioration of ground water quality etc., suggests a need for proper ground water management and enhancement of storage capacity of aquifers, protection of ground water quality and proper utilization of ground water.

To enhance the storage capacity of aquifers, the dewatered aquifers are to be recharged, for which the artificial recharge structures like Check dams, percolation tanks, point recharge structures etc have to be constructed (Table-9).

4.1 Aquifer wise space available for recharge and proposed interventions

4.1.1 Quantity of water available through non-committed surface runoff:

The surplus non-committed water from annual rainfall is calculated to be 1320 HAM this can be used to recharge the aquifer through suitable recharge structure which augments the net ground water availability in the taluk. The details of types of structure/number for recharge are presented in the table 9.

Table 9: Details of Artificial structures

Artificial Recharge Structures available/Proposed	Hiriyur tluk
Non committed monsoon runoff available (MCM)	9.8027
Number of Check Dams	60
Number of Percolation Tanks	4
Number of Point Recharge structures	7
Tentative total cost of the project (Rs. in lakhs)	236.31
Excepted recharge (MCM)	5.553
Expected rise in water level (m)	0.178
Cost Benefit Ratio (Rupees/ cu.m. of water harvested)	4.255

Thus, considering above source water for ground water recharge the volume of water expected to be conserved or in the ground water resource enhancement is as detailed in the below table-10.

Table 10: Details of resource enhancement after proposed artificial recharge

Sl. No.	Resource details	As per 2013 Estimation
1	Net Ground Water Availability in HAM	11442
2	Existing Gross Ground Water Draft for All use HAM	12468
3	Existing Stage Of Ground Water Development in percentage	109
4	Expected recharge from Artificial Recharge Projects HAM	555
5	Cumulative ground water Availability HAM	11997
6	Expected improvement in stage of ground water Development after implementation of the project in percentage	104
7	Expected improvement in overall Stage of Ground water development in percentage	5
8	Expected additional irrigational potential in hactares	638.302

5. DEMAND SIDE INTERVENTIONS

5.1 Advanced irrigation practices

Major crops of Hiriyur taluk is Jowar, Ragi, Ground nuts and Sunflower which are rain fed crops. Remaining crops like some of the pulses, Vegetables and fruits are depending upon the ground water source.

The ground water for irrigation is being developed through **574** irrigation dug wells and **8499** irrigation bore wells. The existing **advance irrigation practices** and the irrigation potential created over the taluk is as detailed in the below table-11.

Table 11: Details of Irrigation practices

Sl. No.	Advanced Irrigation practices	No. of Irrigation Dug wells and potential utilized area in hectares		No. of Irrigation Bore wells and potential utilized area in hectares		Total	
		No. Dug wells	potential utilized (hectares)	No. of Bore wells	potential utilized (hectares)	Total no of structures	Total potential utilised
1	Open water channel	454	610	5402	9035	5856	9645
2	Underground pipe	94	158	1971	4264	2065	4422
3	Surface pipe	1	2	681	1147	682	1149
4	Drip irrigation	20	66	376	1133	396	1199
5	Sprinklers	5	16	61	209	66	225
6	Others	-	-	8	8	8	8
	Total	**574**	**852**	**8499**	**15796**	**9073**	**16648**

Source: 4th Census of Minor Irrigation schemes, Department of Minor irrigation, Bangalore, March 2011

Perusal of the above table, the irrigation practices like Drip irrigation & sprinklers as water distribution system is comparatively very less with less irrigation potential utilized when compared to other distribution systems resulting in difficulty in maximum water conservation. If these methods of drip and sprinkler irrigation systems increased, maximum available ground water can be conserved. This ultimately enhances the area under irrigation potential.

5.2 Change in cropping pattern

Farmers are facing inadequacy of groundwater for agriculture so the farmers have to change their cropping pattern and water economy irrigation practices like drip irrigation and sprinkler irrigation which are negligible number. If they also adopt the water use efficient irrigation practices like **mulching**-plastic sheeting, spread on the ground around plants to prevent excessive evaporation or erosion, enrich the soil, etc., and there will be additional saving in

water. Therefore, encouragement from government is essential for achieving full target of water use efficiency in the district.

5.3. Alternate water sources

As per the resource estimation – 2013, Hiriyur taluk falls under OE category with the stage of ground water development of 109 % leading towards water scarcity problem. So there is need to formulate management strategy to tackle the water source scarcity in the taluk.

If the artificial recharge projects as proposed is implemented the Surplus non committed monsoon runoff water available-through artificial recharge structures about 9.8027 MCM of water will be conserved. This alternate water sources will cope up additional irrigational potential of 638.302 ha of agricultural land and there will be rise in water level of 0.178m (Table-10&11).

5.4. Regulation and control

Considering the current existing ground water draft for all use - 12468 HAM with the stage of ground water development up to 109%, it is mandatory to plan to augment the ground water through artificial recharge besides use of ground water judiciously.

Due to this grim situation of ground water resources in the taluk /district, state government has planned to conduct an intensive survey of ground water level and its quality and planning to impose a ban on sinking of new irrigation bore wells as per the provisions of the Karnataka Ground Water (Regulation and control of Development and Management) bill 2011.

5.5 Other Interventions proposed

The taluk is facing acute quality problem with fluoride contamination in ground water (table-7). To mitigate this critical issue of safe drinking water and control Fluorosis, construction of rain water harvesting units at the family level are must. The Government of Karnataka along with number of NGOs (Arghyam Foundation) has already taken up the program of Roof Top Rain Water harvesting. This program of roof top rain water harvesting, direct aquifer recharge, excavation of farm ponds, bore well recharge and timely water quality analysis etc will reduce the Fluoride level in water.