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

Chitapur Taluk, Kalaburagi District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

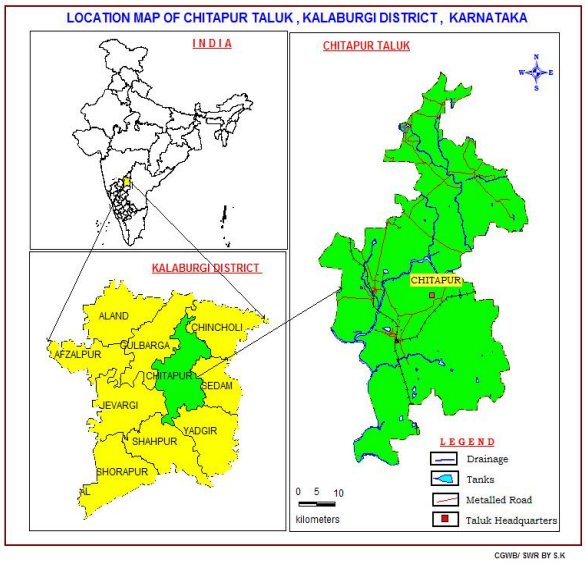
FOR OFFICIAL USE ONLY
No. SWR/RP/NQM/2022-23/60

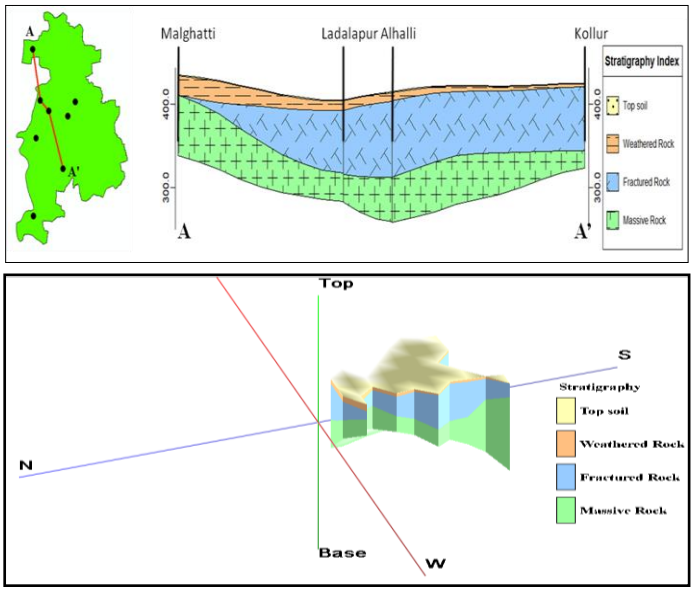
भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास
एवं गंगा संरक्षण विभाग
केन्द्रीय भूमिजल बोर्ड
दक्षिण पश्चिमी क्षेत्र,
बेंगलुरु

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, Chitapur Taluk, Kalaburagi District, Karnataka State

(AAP: – 2021-2022)





By

Bijimol Jose, Sc-C, CGWB, SWR, Bengaluru

OCTOBER 2022

Aquifer Maps and Management Plan, Chitapur Taluk, Kalaburagi District, Karnataka State

(AAP: – 2021-2022)

Contents

Aquifer Maps and Management Plan, Chitapur Taluk, Kalaburagi District, Karnataka State

1. INTRODUCTION

National Project on Aquifer Mapping (NAQUIM) initiated by Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India with a vision to identify and map the aquifers at the micro-level with their characteristics, to quantify the available groundwater resources, to propose plans appropriate to the scale of demand and institutional arrangements for participatory management in order to formulate a viable strategy for the sustainable development and management of the precious resource which is subjected to depletion and contamination due to indiscriminate development in the recent past.

Groundwater is being increasingly recognized as a dependable source of supply to meet the demands of domestic, irrigation and industrial sectors of the country. The development activities over the years have adversely affected the groundwater regime in many parts of the country. Hence, there is a need for scientific planning in development of groundwater under different hydrogeological situations and to evolve effective management practices with involvement of community for better groundwater governance.

Aquifer Mapping has been taken up in **Chitapur taluk**, Kalaburagi district in a view to formulate strategies for sustainable management plan for the aquifer system in accordance with thenature of the aquifer, the stress on the groundwater resource and prevailing groundwater quality which will help in drinking water security and improved irrigation facility. It will also result in better management of vulnerable areas.

Aquifer Mapping has been taken up in **Chitapur taluk,** Kalaburagi district in a view to formulate strategies for sustainable management plan for the aquifer system in accordance with thenature of the aquifer, the stress on the groundwater resource and prevailing groundwater quality. The studies will help in drinking water security and improved irrigation facility. It will also result in better management of vulnerable areas.

1.1 Objectives

The objectives of the aquifer mapping in Chitapur taluk, Kalaburagi district can broadly be stated as

- To define the aquifer geometry, type of aquifers and their lateral and vertical extent
- To determine the groundwater regime scenario
- To determine the hydro-geochemical characteristics of the aquifer units
- To define 2D and 3-D dispositions of the aquifer units
- To estimate the availability of groundwater resources in the aquifer system
- To develop a sustainable groundwater management plan for the aquifer system

1.2 Scope of the Study

The important aspect of the aquifer mapping programme is the synthesis of the large volume of data already generated during specific studies carried out by **Central Ground Water Board (CGWB)** and various Government organizations with a new data set generated that broadly describe the aquifer system. The available generated data are assembled, analyzed, examined, synthesized and interpreted from available sources. These sources are predominantly non-computerized data, which is to be converted into computer based GIS data sets.

Data gaps have been identified after proper synthesis and analysis of the available data collected from different state organizations like Ground Water Department (GWD), Watershed Department, etc. In order to bridge the data gap, data generation programme has been formulated in an organized way in the study area. Exploration work has been carried out in different segments of the regions and aquifer parameters have been estimated. Groundwater monitoring regime has been strengthened by establishing/adding State agencies additional monitoring wells. 2D and 3D sections have been prepared to bring out more realistic as the data points are more closure to the field.

1.3 Ground water Issues in the study area

The main issues pertaining to the Chitapur taluk are as follows:

- Declining groundwater Level trends in about 50% of the wells analyzed tapping phreatic aquifer during pre and post monsoon periods.
- Source Sustainability for drinking and irrigation, especially in lean periods
- Deeper fractures not getting recharge due to thick clay soil
- Contamination of Urban areas with municipal waste and sewage
- Poor yield of bore wells and drinking water scarcity in summer.
- Ground Water quality: High fluoride and Nitrate concentration in some pockets.
- Water logging and salinity in command areas

1.4 Approach & Methodology

Integrated multi-disciplinary approach involving geological, geophysical, hydrological and hydro-geological and hydro-geochemical components were taken up in 1:50000 scale to meet the objectives of study. Geological map of the study area has been generated based on the GSI maps, geophysical data have been generated through vertical electrical soundings and geo-electrical layers with different resistivity have been interpreted in corroboration with the litho-stratigraphy of the observation wells and exploratory wells. Hydrological and Hydro-meteorological data have been collected from Statistical department, Govt of Karnataka. Drainage, Soil and Geomorphology of the taluk were prepared based on the satellite data interpreted by KSRSAC.

Based on the data gap analysis data generation process has been scheduled through establishing key observation wells, integrating Ground Water Directorate observation wells, pinpointing exploratory sites for drilling through in-house and outsourcing, collecting geochemical samples in order to study groundwater regime, geometry of the aquifer and aquifer parameters, and quality of the groundwater respectively. Groundwater recharge and draft have been computed based on approved

guidelines and method to estimate the ground water resources of the aquifer system.

Based on the above studies Management strategies both on the supply side through augmentation of groundwater through artificial recharge and water conservation and on demand side through change in irrigation pattern have been formulated for sustainable management of the groundwater resource.

2. SALIENT INFORMATION

Name of the taluk: Chitapur

District: Kalaburagi

State: Karnataka

Area: 1750 sq.km

Population: 404188 of which 202354 are males and 201834 are females

Annual Normal Rainfall: 860 mm

2.1 Aquifer mapping study area

Aquifer mapping studies have been carried out in Chitapur taluk, Kalaburagi district of Karnataka, covering an area of 1750 sq.km under NAQUIM project. Chitapur taluk is located between North Latitudes 16°48'25" and 17°19'14" and East Longitudes between 76°54'01" to 77°13'45" and is falling in parts of Survey of India Topo sheets No: 56C/15,16, 56G/3, 4, 56H/1, 56D/13. The study area is bounded on the East by Chincholi and Sedam taluks, on the North by Bidar district, on the South by Yadgir district, on the West by Jewargi & Kalaburagi taluks of Kalaburagi district.

Location map of Chitapur taluk of Kalaburagi district is presented in **Fig.1**. Chitapur is the taluk head quarter (77.08 E - 17.12" N) at an Altitude of 741.5

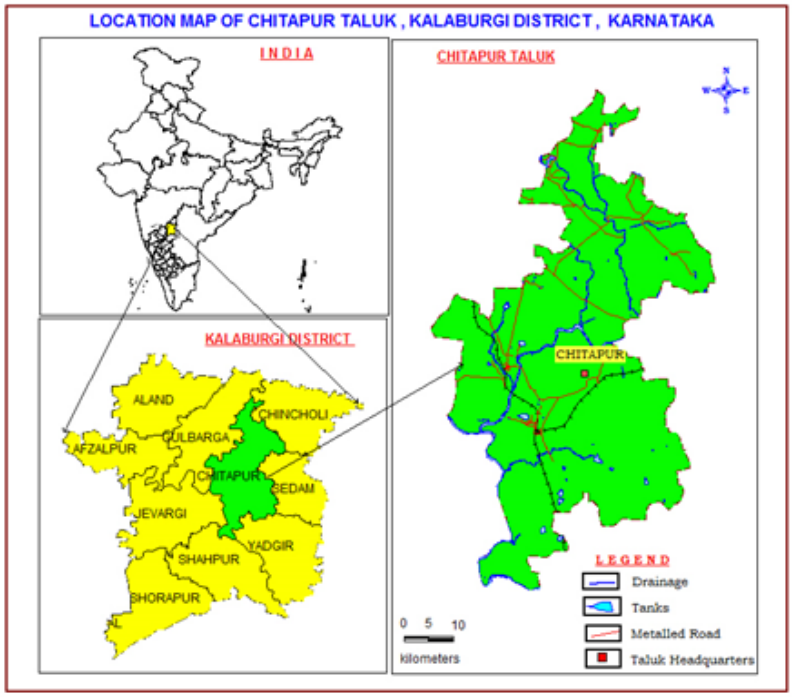


Fig 1: Location Map

2.2 Population

As per the Census India 2011, Chitapur Taluk has 73171 households. The population of the taluk is 404188 of which 202354 are males and 201834 are females. The population of children between age 0-6 is 59705 which is 14.77% of total population. The sex-ratio of Chitapur Taluk is around 997 compared to 973 which is average of Karnataka state. The literacy rate of Chitapur Taluk is 49.96% out of which 58.02% males are literate and 41.88% females are literate. The total area of Chitapur is 1750 sq.km with population density of 231 per sq.km. Out of total population, 67.7% of population lives in urban area and 32.3% lives in rural area. There are 31.73% Scheduled Caste (SC) and 1.83% Scheduled Tribe (ST) of total population in Chitapur Taluk.

2.3 Rainfall

Semi-arid climate prevails in Chitapur Taluk. The area falls under Northern Eastern Transitional agro-climatic zone of Karnataka state. The normal annual rainfall in Chitapur taluk for the period 1981 to 2010 is 860 mm. The pre-monsoon (Mar- May) rainfall constitutes over 6 percent to 8 percent of the annual. The summer monsoon (Jun-Sep) accounts for over 74 percent to 78 percent of the annual and the winter monsoon (Oct-Dec) accounts for nearly 15 percent to 17 percent of the annual, bulk of it occurring in the month of October. The seasonal distribution of rainfall, in the district, indicates that the rainfall increases from east to western parts. August is the wettest month in the district with rainfall over 200 mm. The driest month is February.

Computations were carried out for the 30 years blocks of 1981-2010, the mean monthly rainfall at Chitapur taluk is ranging between 2 mm during February to 223 mm during August. The coefficient of variation percent for pre-monsoon, monsoon and post-monsoon season is 65, 41 & 67 percent respectively. Annual Co-efficient Variation at this station works out to be 33 percent (**Table.1**).

Table.1: Rainfall details of Chitapur taluk

Item	JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
NRM	7	2	13	20	32	74	128	175	223	198	724	104	18	4	126	923
STDEV	16	5	30	20	31	48	67	115	137	135	300	76	38	10	84	302
CV%	215	295	233	101	99	65	53	65	61	68	41	73	214	228	67	33

2.4 Assessment of Drought

Rainfall data of Chitapur taluk has been analyzed for 56 years to assess the drought condition in the taluk. The results of the classification are listed in the **Table.2**. It is observed that the taluk has experienced alternating “no drought” to “severe drought” conditions over the years.

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

% Deviation (Di)		>0	0 to -25	-25 to -50	50 to 75	<-75	Probability of drought occurrences
Category		No drought	Mild (Normal)	Moderate	Severe	Acute	
		Years					
Taluk	Chitapur	11	37	5	3	0	**Once in 4 years**

The details of the drought assessment are discussed as herein under. Out of 56 years of analysis

in Chitapur taluk, “No Drought” condition is experienced in 11 years, “Mild Drought” condition is experienced in 37 years and “Moderate Drought” condition experienced in 5 years. Further it is observed that “Severe Drought” condition is experienced in 3 years. 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** in Chitapur taluk.

2.5 Agriculture & Irrigation

Agriculture is the main occupation in Chitapur taluk. Chitapur is famous as the land of Tuar dal (Pulses) and finest quality Tuar dal is being produced and exported from Chitapur similar to other taluks of Kalaburagi district. Major Kharif crops are Maize, Bajara, Jowar, Tur and Vegetables. Main crops of Rabi season are Jowar, Maize and Bajra (**Table.3**).

Water intensive crops like sugarcane is are grown in 5% of total crop area. Jowar is grown in 21 % and oil seeds in 5% of total crop area of taluk. Bajra & Maize account 2% of total crop area.

Table.3: Cropping pattern in Chitapur taluk 2016-2017 (Ha)

Year	Paddy	Wheat	Maize	Bajara	Jowar	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
		Area under cultivation (in ha)									
2016-2017	200	61	61	1755	26327	99507	669	909	2395	333	1093
	Total food grains										
	127911										
	Net sown area(in ha)										
	108513										
	Gross sown area(in ha)										
	129489										

It is observed that net sown area accounts 62 % of the total area of the taluk and area sown more than once is 15% of total geographical area in Chitapur taluk. Area not available for cultivation and Fallow land cover 8% & 21% of total geographical area respectively. 48% of net area irrigated is only from bore wells and 28 % from lift irrigation (**Table.4**) Major part of irrigated agriculture is through ground water sources.

Table-4: Irrigation details in Chitapur taluk (in ha)

Source of Irrigation	No.'s	Net area irrigated	Gross area irrigated
Canals	1	-	1664.50*
Tanks	25	101	113
Wells	895	800	901
Bore wells	777	1858	3086
Lift Irrigation	8	1071	89
Other Sources	NA	61	82
Total		**3891**	**4271**

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

* Canal command area of IPZ, Kalaburgi as per CADA in March 2021.

2.6 Geomorphology, Physiography & Drainage

The area is characterized by undulatory topography. Geomorphologically, Chitapur taluk is a plateau region formed by basaltic lava flows, which represents "Deccan peneplain". The central and southern parts exhibit moderate to gently "undulating terrain" having sparsely distributed knolls and tors. The elevation in the plains varies from 741 m in the North western part to 480 m amsl in the Southern part of the taluk (**Fig.2**). This has its bearing on the regional slope which is towards south. The differential altitude is significant because, it is likely to cause irregular ground water flow patterns on the micro scale. Topography is dominantly controlled by geological structures.

The entire Chitapur taluk falls in Lower Bhima Basin which is a subbasin of Krishna river. Tributary of Lower Bhima- Kagna, Wadi flows through Chitapur taluk (**Fig.3**)

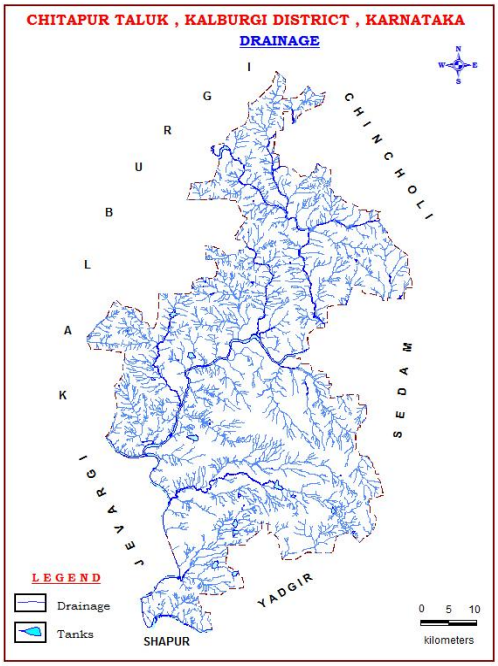


Fig.2: Geomorphology Map

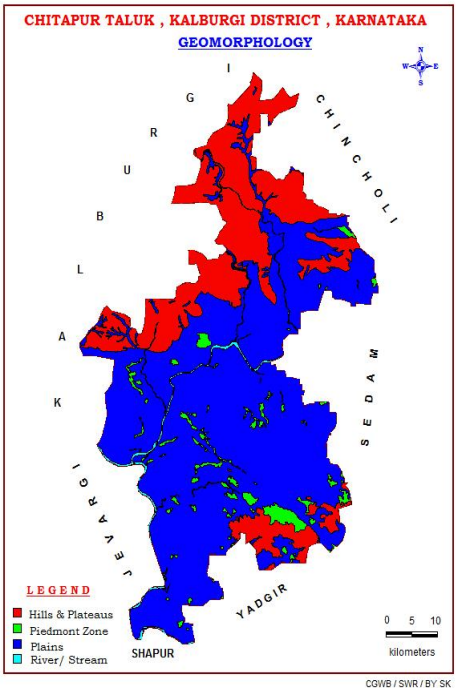


Fig.3: Drainage Map

2.7 Geology

Geologically, the area is a part of Lower Bhima basin, which is one of the Proterozoic basins in India. The basement formations of BGC & Granites are unconformably overlain by sedimentary sequence of Bhima series viz Limestone, Shale, Sandstones/conglomerates with a cover of Vesicular and massive Deccan trap Basalts, Laterites **(Fig.4).**

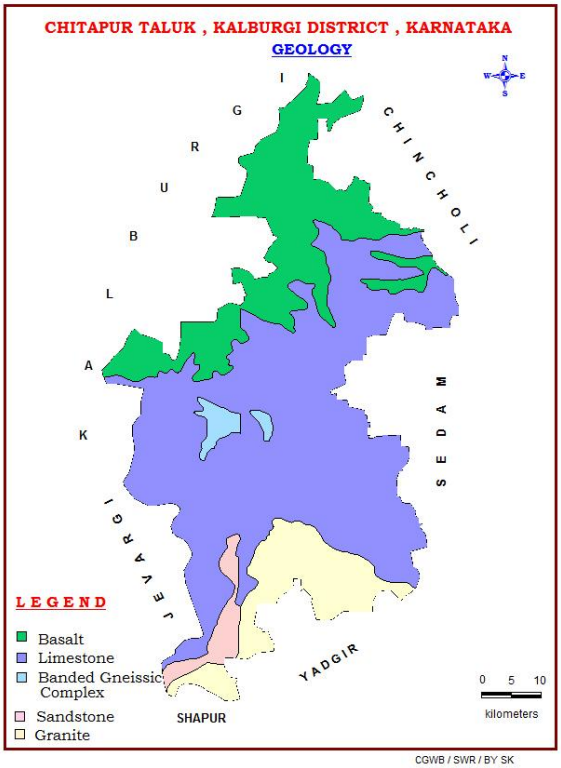


Fig 4. Geology

The Deccan traps of Eocene to Upper Cretaceous age comprise numerous flows, each of which erupted separately. Intertrappean beds of clayey red bole and green bole formations occur as horizontal bands in basaltic formations varying in thickness from two meters to six meters in the taluk. The Deccan trap flows show considerable lateral variation in the area. Weathered products of basaltic flows, lateritic capping is found on uplands and hill tops.

2.8 Soil

The Deep black cotton - clay rich soils cover major part of the taluk. Black cotton soils are mature soils with high humus and are mildly alkaline in nature. Black cotton soil derived from Deccan trap basils are clayey in nature and often form clay layers in the phreatic zone which hinders the recharge and return seepage. **Red soils and Lateritic soil form other types of soils** These soils vary in depth and texture, depending on the parent rock type, physiographic settings and climatic conditions (**Fig.5)**. The land use map of the study area is shown in **Fig.6**. Major part of the study area is covered by Agriculture land. Details of the landuse is presented in **Table.5.**

Table-5: Details of land use in Chitapur taluk (Ha)

Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Cultivable waste	Net sown area	Area sown more than once
175000	**4123**	**12847**	**70256**	**4467**	**112537**	**12134**

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

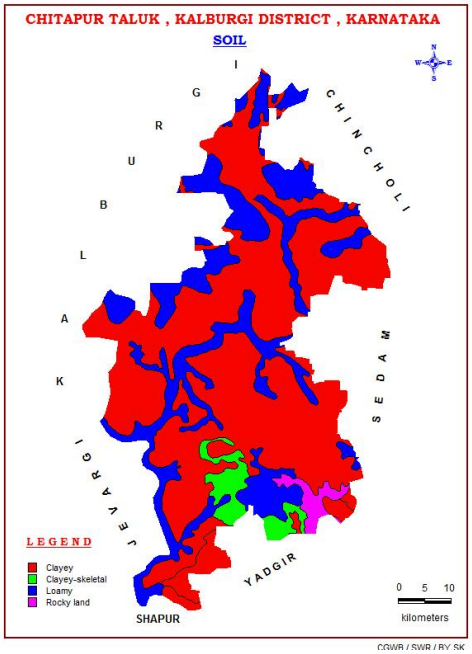


Fig.5: Soil Map

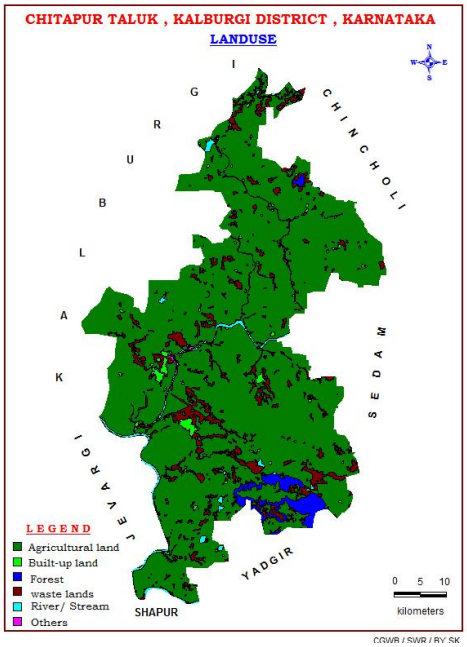


Fig.6: Land use Map

3. AQUIFER CHARACTERISATION

3.1 Aquifer types

Two aquifer types have been mapped namely,

- Aquifer I: Weathered aquifer down to the depth of 15.50 m bgl
- Aquifer II: Fractured aquifer down to the depth of 201 m bgl

Aquifer system in Chitapur taluk is divided into shallow weathered and deeper fractured aquifers. Limestones, Sandstones, shales, Basement granites/gneisses and Basalts constitute the yielding aquifer in the study area.

3.2 Weathered Aquifer (Aquifer I)

The weathered formations of Basalts, Limestone, Sandstone, Shale, Basement Gneisses/Granites forms the phreatic aquifer with a minimum thickness of 1.97 m and maximum thickness of 15.50 m bgl with average thickness of 7 m. Groundwater occurs in unconfined condition. Yield of this weathered aquifer unit ranges from less than 1 lps to 3 lps. During monsoon period, the wells tapping this aquifer unit sustains for one to 3 hrs/day of pumping, while during non-monsoon period (May to July) wells sustains for less than 1 hour/day of pumping.

3.3 Fractured Aquifer (Aquifer II)

Fractured limestone, Shale, Sandstone, Basement granites/Gneiss and Basalt and vesicular basalt comprise the deeper aquifer II occurs from 13 to beyond 200 m bgl. Based on the analysis of the 18 bore wells and 58 Vertical electrical sounding data it is inferred that of the productive fractures are encountered from 50 m- 187 m bgl. About 42% of the fractures encountered are in the depth range of 100 to 200 m and the remaining is found to be within the depth of 100 m. The yieldof this aquifer unit II ranges from <1 – 10.2 lps and is observed to be desaturated in some parts of the taluk. During monsoon period, the wells tapping this aquifer unit sustains for 2 to 6 hrs /day of pumping, while during non-monsoon period (May to July) sustains for 1 to 3 hour/day of pumping**.** In general ground water in fractured aquifer is potable. Groundwater occurs under semi confined conditions in Aquifer system II. Salient features of the aquifers are given in **Table.6.**

Table.6: Summary of Aquifer Characteristics

Aquifer Characteristics:	**Particulars**	**Exploratory wells**
	• Depth range (mbgl)	39 - 302
	• Weathering range (mbgl)	2 – 14.5
	• Yield range (lps)	<1 – 10.2
	• Fractures (mbgl)	13 – 187 (Most of the fractures are encountered beyond the depth ranges of 50 m bgl)
	• Transmissivity (m^2/day)	2.4 – 61
	• Static Water Level (mbgl)	2.1 – 6.1

3.4 Aquifer Disposition & Geometry

2D & 3D models showing Aquifer Disposition

Aquifer Disposition (Vertical & Lateral) aquifer characterization has been brought mainly by analyzing the data collected from Bore well lithologs ***(17 EW & 02 OW)*** and Vertical Electrical Sounding conducted in the taluk. Details of Exploratory wells are given in **Table 7.** The 2D & 3D aquifer disposition models of the aquifer system have been deciphered by using ROCKWORKSsoftware and 2D cross section have been generated along different directions of Chitapur taluk. All such 2D cross sections were verified and the model was calibrated to bring out the 3D aquifer disposition of the aquifer system. The type cross sections generated in different direction of the aquifer system is given in **Fig.7** (2D Cross Section)**, Fig.8** (3D Section), 3D aquifer disposition (Fence diagram) in **Fig.9.**

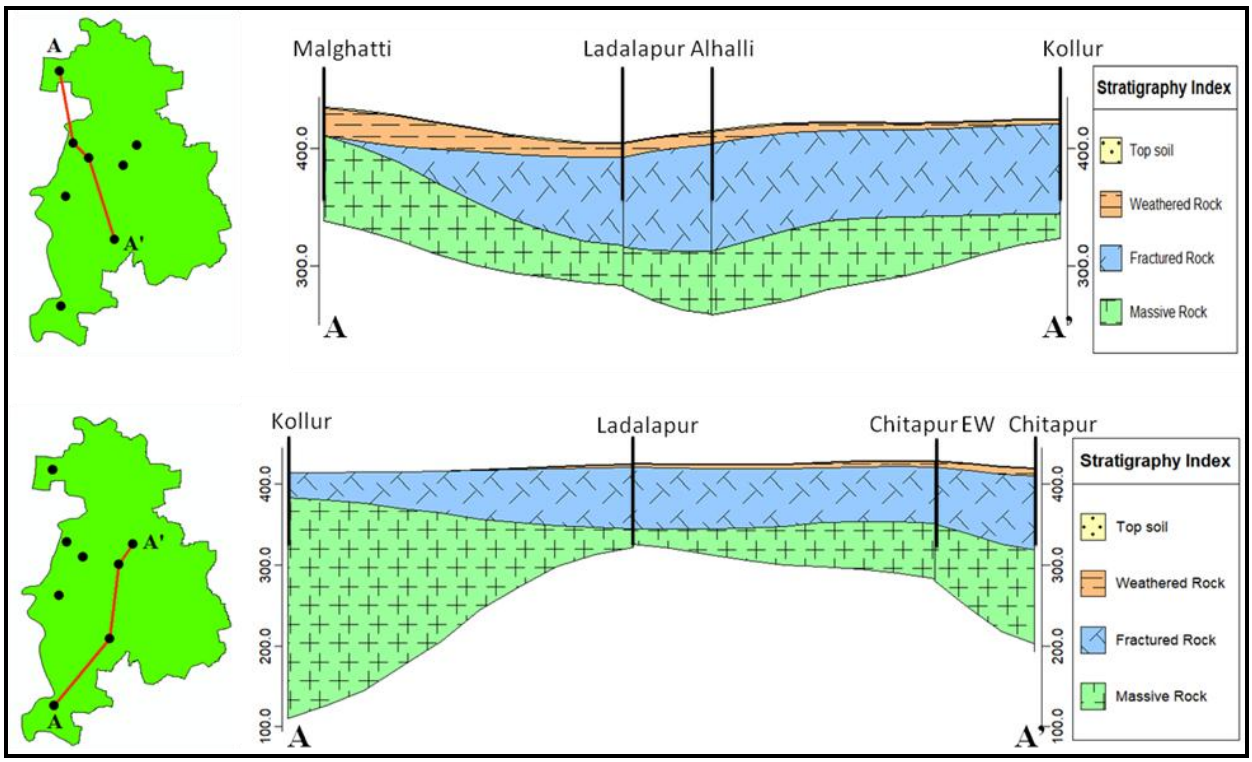


Fig.7. 2D cross section of aquifer in Chitapur taluk

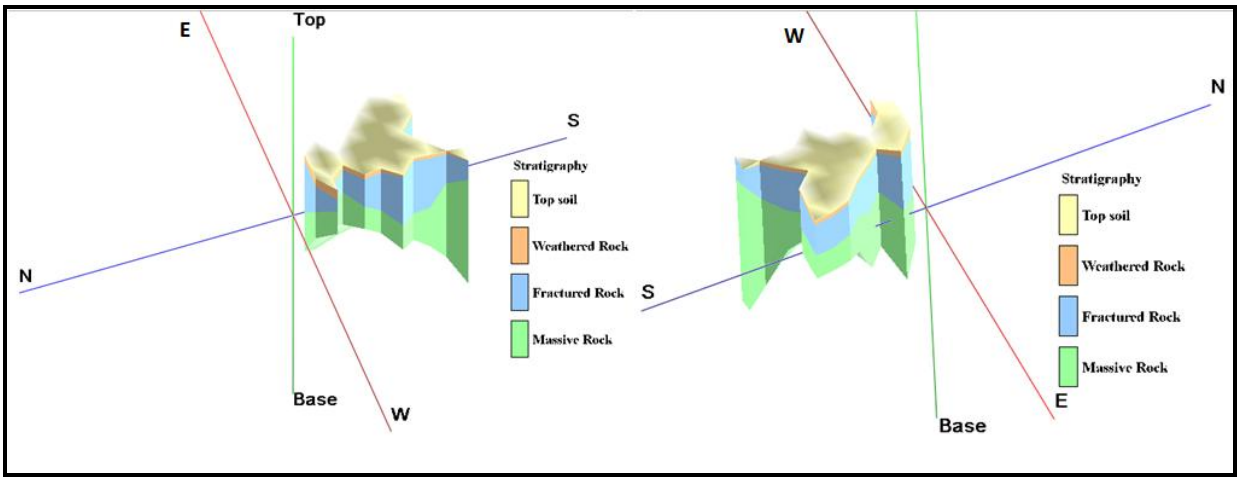


Fig.8. 3D cross section of aquifer in Chitapur taluk

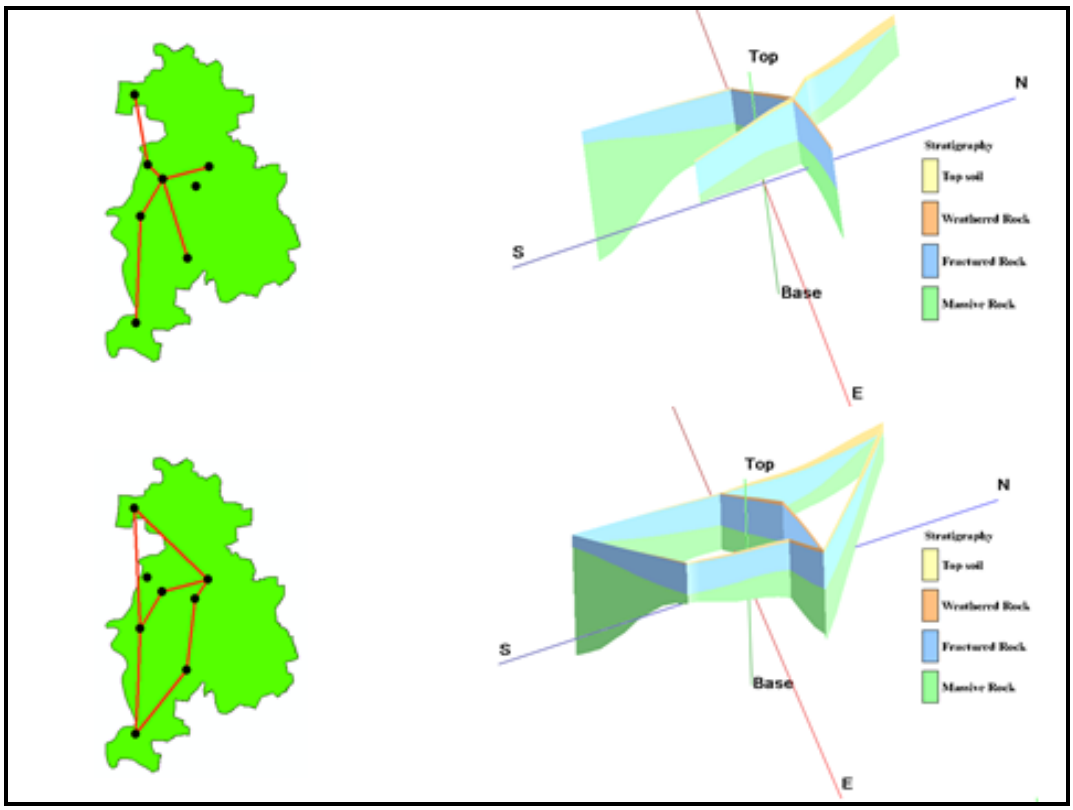


Fig.9. 3D Fence Diagram of aquifer in Chitapur taluk

Table.7: Details of Exploratory wells

Borewell Location	**Longitude**	**Latitude**	**Easting**	**Northing**	**Elevation** (m amsl)	**Total depth** (m bgl)	**Fracture Zones** (m bgl)	**Casing** (m)	**T** (m^2/d)
Alhalli EW	77.00000	17.10139	712807.8	1891864	423	210.8	62.3-63.3, 78.6-79.6	13.5	
Alhalli OW	77.00000	17.10139	712807.8	1891864	423	206	29.8-30.8, 41-42, 125.4-126.4, 135.5-136.5, 186.4-187.7	14.5	
Chitapur	77.07778	17.12083	721063.9	1894102	409	302.3	50.10- 51.10, 128.4-129.4	12.1	
CHITTAPUR EW (Chittapur Tq)	77.05556	17.08889	718736.3	1890542	445	80.9	32.0-33.0, 45.0-45.05	5.5	3.94
Kollur	76.95278	16.87083	708035.9	1866295	394	302.3		6.1	
LADALAPUR	77.04028	16.97361	717242.9	1877765	428	85.85	13, 18.75, 83.9	5.1	2.4
MALGHATTI	76.97500	17.12500	710120.3	1894450	391	75.55	16.95, 73.55	10.5	61
MUGHALGAON	76.95417	17.23750	707778	1906879	438	90	Dry	17	
WADI EW	76.96250	17.04167	708882.8	1885214	410	92	92	1.5	

3.5 GROUNDWATER LEVEL

During Aquifer Mapping studies in Chitapur taluk, 11 groundwater monitoring wells which were monitoring regularly in phreatic and fractured aquifers in order to know the behavior of the groundwater regime. The water levels were monitored from May 2018 to January 2019 (four times in a year). The summary of the ground water levels are presented in **Table.8**.

Table. 8: Summary of Ground Water levels

GW Monitoring	Particulars	Dug wells	Piezometers
	Water level range (mbgl)	10.4 (May 2019)	6.3 to 16.2 (May 2019)
		6.15 (Nov 2019)	1.0 to 18.0 (Nov 2019)

3.5.1 Depth to Water level for (May 2019)

Major part of the taluk shows water level in the range of 5 to 16 m bgl. Isolated Patches were recorded water level in the range of 2 to 4 m bgl. Water level ranging more than 20 m bgl is observed in the Eastern part as a small isolated patch. The depth to water level during pre-monsoon (May 2019) is shown in **Fig. 10.** The depth to water level in the major part of the taluk is observed to be in the range of 5 to 20 mbgl. The piezometric head during May 2019 (Pre-monsoon) varied from 6.3 to 16.2 m bgl for fractured aquifer (Aquifer II).

3.5.2 Depth to Water level (November 2019)

The water level in the range of less than 2 to 5 m bgl is observed in the taluk (**Fig.11**). The comparison of pre and post monsoon water levels shows that rise in water levels throughout the taluk and thephreatic aquifer is responding to the rainfall and recharging the aquifers. The piezometric head during November 2019 (post-monsoon) varied from 1 to 18 mbgl in fractured aquifer.

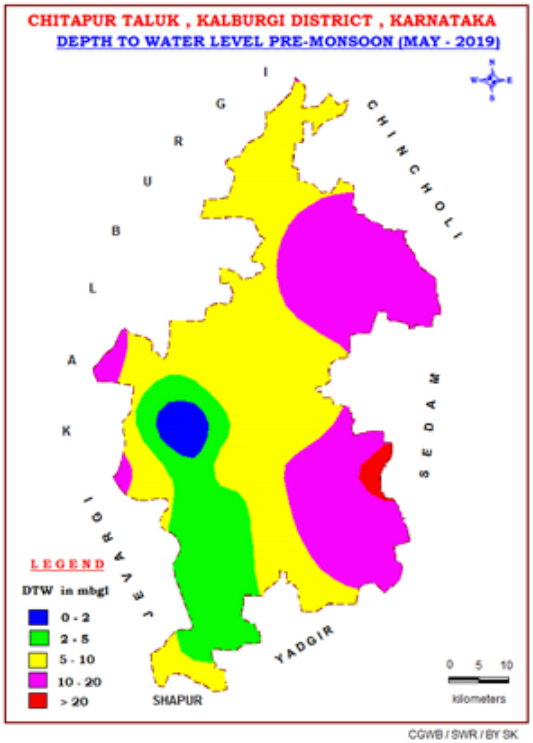


Fig 10: Pre-monsoon Depth to Water Level

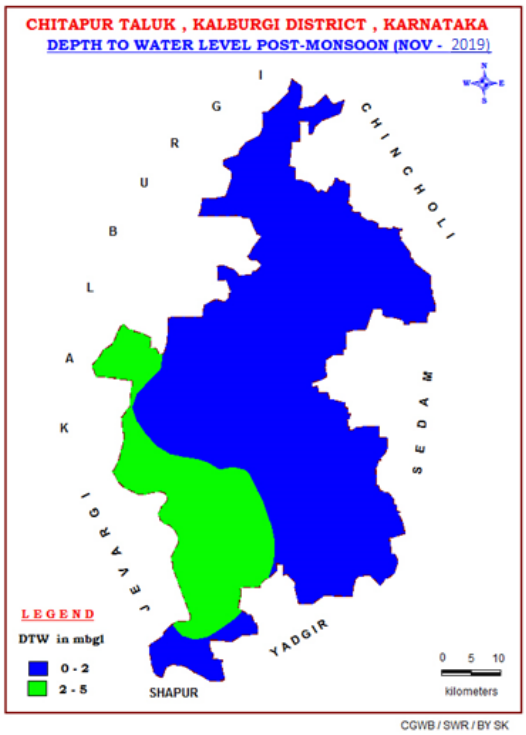


Fig 11: Post-monsoon Depth to Water Level

3.6 Ground water Quality

The water in phreatic aquifer zones found to be in potable form whereas it is alkaline to saline in the deeper zones in part of d Chitapur Taluk. The electrical conductivity (EC) is observed in the range of 900 to 2600 µm/cm at 25°C (**Fig.12**).

The higher concentration of Nitrate (NO3), i.e., more than permissible limit of 45 mg/litre occur in many localities as indicated in **Fig.13.** The Nitrate content is less than 45mg/l in about 20 % of the sample analyzed and 80 % of sample shows more than 45 mg/l.

The fluoride presence in some pockets of the central part of the taluk is within 1.5 mg/l. It is greater than the permissible limit in some pockets as depicted in **Fig.14.** The rest of the area have acceptable limit of 0.2 to 1.0 mg/lit. About 50% of the groundwater samples of phreatic aquifer have recorded the desirable limit of fluoride content, less than 1 mg/l. Remaining 50 % of wells have recorded beyond permissible limit of more than 1.5 mg/l.

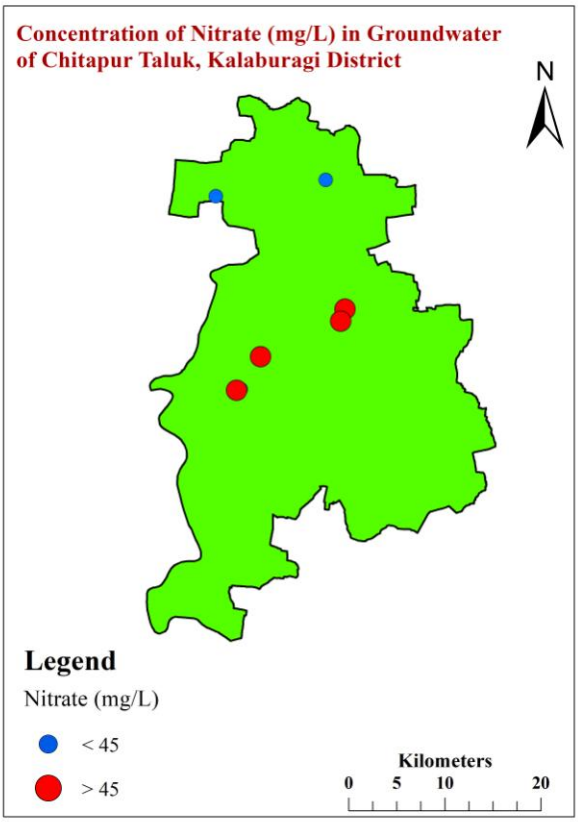


Fig.12. EC distribution map

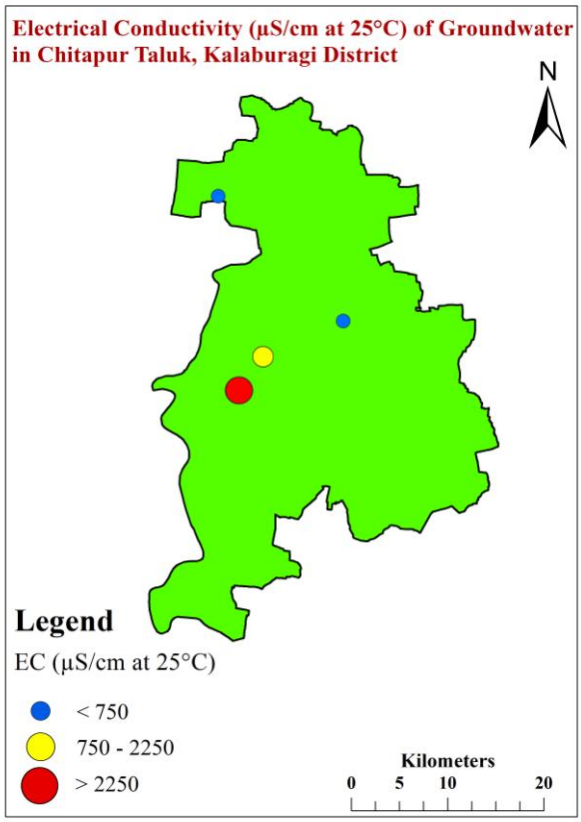


Fig.13. Nitrate distribution map

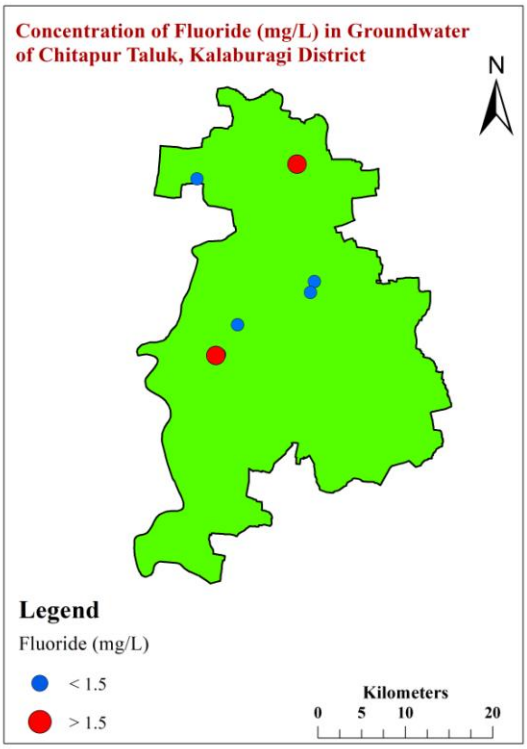


Fig.14. Fluoride distribution map

All the groundwater samples of phreatic aquifer have recorded the chloride concentration less than 250 mg/l which is the desirable limit. Summarized results of aquifer wise (Phreatic and semi confined) Ground water quality of Chitapur taluk as on May-2019 is given in **Table.9.** Details of water quality from monitoring stations are furnished in **Table 10**.

Table.9: Summarized results of Ground water quality of Chitapur taluk (May-2019)

Particulars	Phreatic Aquifer (Aquifer-I)	Fractured Aquifer (Aquifer-II)
Electrical Conductivity (µS/cm at 25°C) (Most frequent range)	755 - 1520	-
Fluoride , F (mg/l)	0.38 – 1.9	0.4 – 2.2
Nitrate, NO_3 (mg/l)	14 - 243	9 -168
Chloride (Most frequent range)	25- 600	-

Table 10:Details of water quality from monitoring, Chitapur taluk

S. No	Location	LATITUDE	LONGITUDE	EC	N03	F
1	Chitapur A	17.10830	77.08333	460	47	0.2
2	Haldihal	17.22500	76.96667	700	38	1.4
3	Ravur	17.07500	77.00833	1000	192	1.5
4	Wadi A	17.04360	76.98583	2600	81	2.2
5	Gundagurti	17.24028	77.06944	-	40	1.6
6	Chittapur	17.11944	77.08750	-	49	1.4

4. GROUNDWATER RESOURCES

The dynamic groundwater resources have been estimated as on 2020 based on the methodology suggested by Ground Water Estimation Committee (GEC) 2015.

The groundwater recharge is calculated both by groundwater fluctuation-specific yield method and by rainfall infiltration method. The annual replenishable groundwater recharge is the summation of four components viz.,

i) Monsoon recharge due to rainfall
ii) Monsoon recharge from other sources
iii) Non-monsoon recharge due to rainfall
iv) Non-monsoon recharge due to other sources

Taluk wise dynamic groundwater resources have been taken from the approved resources estimation done as on March 2020, jointly by Ground Water Directorate of Karnataka and CGWB, to arrive at the total resources available in Chitapur taluk.

4.1 Ground water resource availability and extraction

The net groundwater availability refers to the available annual recharge after allowing for natural discharge in the monsoon season in terms of base flow and subsurface inflow/outflow. This annual groundwater potential includes the existing groundwater withdrawal, natural discharge due to base flow and subsurface inflow/ outflow in the monsoon season and availability for future development. As the groundwater development progresses the natural discharge gets suitably modified and comes down to negligible quantities due to interception by different groundwater structures. Hence, natural discharges in the monsoon season may not be considered and the total annual groundwater recharge may be taken as net groundwater availability.

4.1.1 Ground water resources as on March 2017

As per ground water estimation 2017, in Chitapur taluk, the net annual ground water availability is 2803 Ham. The existing gross ground water draft for irrigation is 1051 Ham and draft for domestic is 514 Ham. Thus, the total ground water draft for all uses amounts to 1565 Ham **(Table.11).** Allocation for domestic and industrial water supply for next 25 years is 568 Ham. The net ground water availability for future irrigation development is 1183 Ham. The stage of ground water development is 56 % and is categorized as 'Safe'.

Table.11. Dynamic Ground Water Resources of Chitapur taluk (ham) (March 2017)

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 Extraction	Category
2803	1051	514	1565	568	1183	56	SAFE

4.1.2 Ground water resources as on March 2020

As per ground water estimation 2020, in Chitapur taluk, the net annual ground water availability is 2595.02 Ham. The existing gross ground water draft for irrigation is 1219.58 Ham and draft for domestic is 474.09 Ham and the industrial draft is 0 Ham. Thus, the total ground water draft for all uses amounts to 1693.67 Ham **(Table.12).**

Allocation for domestic and industrial water supply for next 25 years is 514.9 Ham. The net ground water availability for future irrigation development is 860.54 Ham. The stage of ground water development is 65.27 % and the taluk falls under **'Safe'** category.

Table.12. Dynamic Ground Water Resources of Chitapur taluk (March 2020 in ham)

Net Annual Ground Water Availability	Existing Gross Ground Water Draft For Irrigation	Ground Water Extraction for Industrial Use (Ham)	Existing Gross Ground Water Draft for Domestic usey	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 Extraction	Category
2595	**1220**	**0**	**474**	**1694**	**515**	**861**	**65**	**SAFE**

4.1.3 Total ground water resources as on 2017

The total ground water resources estimated earlier up to 200 m depth as on 2017 is summarized in **Table.13.** The fresh in-storage resource in the phreatic zone is estimated as Nil for the taluk where as in the fractured zone, the same is estimated as 1284 ham. The total availability of ground water resource (Dynamic +phreatic in-storage + fractured in-storage) is estimated as 4087 ham for the taluk.

Table. 13 Total Ground Water Resource (as on 2017 in ham)

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
2803	**0**	**1284**	**4087**

4.2 Comparison of groundwater availability between 2017 and 2020

The comparison of groundwater availability and draft scenario between 2017 and 2020 is presented in **Table.14.** It is seen that ground water availability is found to be marginally decreased during 2020 in comparison with 2017. In tune with this, the total ground water extraction is increased during 2020 in comparision with 2017. The stage of ground water extraction is found to be 56 % and 65 % respectively during 2017 and during 2020, showing an increase during 2020.

Table.14. Comparison of ground water availability and draft scenario (in Ham), Chitapur taluk

2017			2020		
GW Availability	**GW Extraction**	**Stage of GW Extraction (%)**	**GW Availability**	**GW Extraction**	**Stage of GW Extraction (%)**
2803	**1565**	**56**	**2595**	**1694**	**65**

5. GROUND WATER RESOURCE ENHANCEMENT

5 .1 Resource Enhancement by Supply Side Interventions

The Master Plan for Artificial recharge to ground water prepared by CGWB (2020) recommended to replenish the de-saturated aquifer system, both phreatic & deeper **(Aquifer I & II)** through construction of artificial recharge structures, viz; check dams, percolation tanks & Sub surface dykes. As per the Master Plan additional structures for artificial recharge are not proposed in view of the present activities in this direction by Govt. of Karnataka. As of now, recharging dried-up phreatic aquifer in the taluk, through construction of artificial recharge and watershed treatment structures has already been taken up by state Government agencies and is being implemented under MGNREGA. As per the data collected from Govt. of Karnataka, 197 Check dams, 11 Percolation tanks and 66 bore well recharge structures were implemented as on 2020.

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. Scientific site selection of AR structures is a prerequisite to improve the efficacy of Managed Aquifer Recharge. Even though additional structures for artificial recharge are not proposed in in the Master Plan of CGWB, in view of the available non-committed source water, some tentative locations for the construction of Percolations tanks (2 locations) and Check dams (10 locations) are identified and shown in **Fig.15.** The details of the non-committed surface run-off and expected recharge through artificial recharge structures are detailed in **Table.15.** The locations of the proposed Percolation tanks and Check dams are listed in **Annexure 1.**

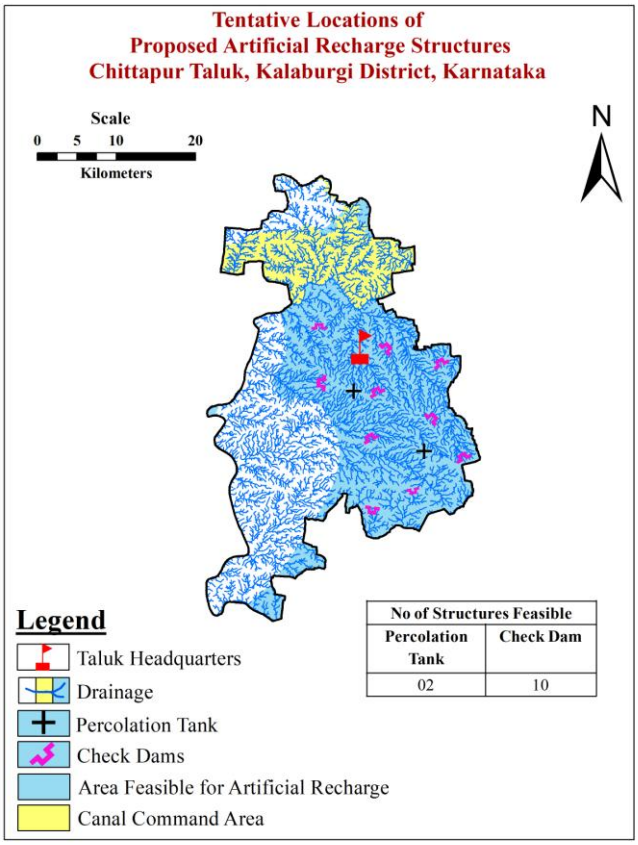


Fig.15 Tentative Locations of AR Structures

Table-15: Quantity of non-committed surface runoff & expected recharge through AR structures

Artificial Recharge Structures Proposed	Chitapur taluk
Non committed monsoon runoff available (MCM)	1.16
Total no. of existing Artificial Recharge Structures	274
Number of Check Dams proposed	10
Number of Percolation Tanks proposed	2
Tentative total cost of the project (Rs. in lakhs)	120 Lakhs
Excepted recharge (MCM)	0.72 MCM

5.2 Resource Savings by Demand Side Interventions

The important crops grown are Paddy, Jowar, Wheat, Bajra, Maize, Pulses, Fruits, Vegetables and Sugarcane etc. Ground water is the major source for irrigation. In view of this, Water Use Efficiency (**WUE**) practices like Drip needs to be strengthened to save irrigation water by way of precision farming mechanism. This ultimately enhances the area under irrigation potential.

Efficient irrigation practices like Drip irrigation and sprinkler had to be adopted by the farmers in the existing 3891 ha of net irrigated area. It is proposed to adopt micro irrigation (drip) techniques in fruits and vegetables (1578 ha) and in Sugarcane (333 ha). It is assumed that 50% of this area i.e., 789 ha and 166.5 ha is irrigated by ground water. Implementation of efficient irrigation techniques will contribute in saving ground water by 182 ham. The details of the resource enhancement through

artificial recharge in the taluk and also through Water Efficiency practices in Irrigation are shown in **Table.16.**

Table.16: Improvement in GW availability due to Recharge & WUE

Sl. No.	Resource Details	As per 2020 Estimation
1	Net Ground Water Availability in Ham	2595
2	Existing ground water draft for all uses in Ham	1694
3	Existing Stage of Ground Water Development in percentage %	65%
4	Expected Recharge from Artificial Recharge sources in Ham	72
5	Cumulative Ground water availability in Ham	2667
6	Expected improvement in stage of ground water development %	63.5% from 65%
8	Saving due to adopting Water Use Efficiency in Ham	182
9	Ground water availability after AR & WUE in Ham	2849
10	Expected improvement in stage of ground water development after implementation of AR & WUE %	**59.5% from 65%**

5.3 Regulation and Control

As per the resource estimation – 2020, Chitapur taluk falls under "**Safe"** category with the stage of ground water extraction of 65 **%**. However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority needs to be strictly implemented in the taluk, so that quality of ground water will improve in due course of time.

5.4 Other interventions proposed

- The ground water worthy areas such as topographic lows, valley portions low fluctuations zones should be developed with adequate soil conservation measures to prevent the soil erosions.
- Roof top rain water harvesting, Insitu Rainwater harvesting and dilution of contaminated water.
- Dilution of nitrate rich ground water through artificial recharge & water conservation.
- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Excess nitrate & fluoride concentration is found in ground water samples require remedial measures viz RO treatment and Dilution with Treated harvested Rainwater/surface water sources.

6. SUMMARY OF MANAGEMENT PLANS

- **Ground Water resource**: As per the resource estimation – 2020, Chitapur taluk falls under "**Safe**" category with the stage of ground water extraction of 65 %. However, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk during the summer and scarcity of water during the future days.
- **Ground water resource enhancement**: Increase in agricultural activity, excessive ground water withdrawal, depletion of ground water levels, reduction in yield and ground water quality related issues etc., suggests the need for scientific ground water management, enhancement of storage capacity of the aquifers and protection of ground water quality.
- **Supply side Interventions:** The surplus non-committed monsoon run off is estimated to be approximately 1.16 MCM. As of now, recharging dried-up phreatic aquifer in the taluk, through construction of artificial recharge and watershed treatment structures has already been taken up by state Government agencies and is being implemented under MGNREGA.As per the data collected from Govt. of Karnataka, 197 Check dams, 11 Percolation tanks and 66 bore well recharge structures were implemented as on 2020. Even though additional structures for artificial recharge are not proposed in in the Master Plan of CGWB, in view of the available non-committed source water of 1.16 MCM, construction of Percolations Tanks (2 locations) and Check Dams (10 locations) are proposed which will be able to recharge 72 ham to ground water.
- **Demand Side Interventions:** In view of the ground water dependent irrigation in the major part of the taluk, Water Use Efficiency (WUE) practices like Drip needs to be strengthened to save irrigation water by way of precision farming mechanism. It is proposed to adopt micro irrigation (drip) techniques in fruits and vegetables (1578 ha) and in Sugarcane (333 ha). It is assumed that 50% of this area i.e., 789 ha and 166.5 ha is irrigated by ground water. Implementation of efficient irrigation techniques will contribute in saving ground water by 182 ham. This ultimately enhances the area under irrigation potential.
- **Probable Benefits:** Due to implementation of supply side and demand side interventions, it is proposed to reduce the stage of ground water extraction from 65% to 59.50%. The supply and demand side intervention will also improve the ground water sustainability of the taluk.
- **Conjunctive use plan in water logged area:** An area of 2841 ha is water logged, out of which 1574 ha is reclaimed and 1267 ha is yet to be reclaimed (Source: CADA as on March 2021). In addition to this reclamation, as mentioned above, conjunctive use plan is also recommended to benefit the water deficit and tail end areas of the irrigation command.

- **Change in cropping pattern**: Water intensive crops such as paddy and sugarcane are grown in only 200 ha and 330 ha respectively, whereas major crops are Jowar and pulses, thus the change in cropping pattern is not recommended.
- **Drinking water Supply**: In view of ground water contamination with mainly higher concentration EC, Nitrate and Fluoride, drinking water supply from surface water needs to be explored/ ensured.
- **Participatory management**: Awareness programmes and practice of participatory approach needs to be strengthened with the involvement of all the stake holders for sustainable management.
- **Other Management Options proposed:**
    - Scientific disposal of sewage water by the concerned agency
    - Periodical maintenance of artificial recharge structures is recommended for better recharge and long life of the structure
    - RTRWH from each building and in-situ storage and use /mixing with surface water supply or groundwater in urban areas.
    - Priority to promote recycle and reuse of grey water effectively in urban pockets.
    - **Water Linkages with other Activities:** Water sector has strong linkages with other developmental activities. Hence, the proposed management plans cannot be considered as static and needs to be reviewed and improved from time to time.

Annexure 1:

A. Tentative Locations of Proposed Percolation Tanks, Chitapur taluk

Sl.No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	77.16228	17.00185	Allura .K	Allur (B)	Chittapur
2	77.07958	17.07107	Chitthapura .K	Chittapur	Chittapur

(It is likely that the number of structures proposed may vary depending upon the ground truth verification and feasibility criteria)

B. Tentative Locations of Proposed Check dams, Chitapur taluk

Sl.No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	77.09928	16.93220	Yagapura	Yagapur	Chittapur
2	77.14796	16.95464	Allura .B	Allur (B)	Chittapur
3	77.20656	16.99596	Rachola .B	Dhongaon	Chittapur
4	77.09689	17.01899	Karadhala	Kardal	Chittapur
5	77.17354	17.04042	Donagaov	Dhongaon	Chittapur
6	77.10593	17.07152	Chitthapura .K	Chittapur	Chittapur
7	77.03805	17.07995	Ravura	Ravoor	Chittapur
8	77.18174	17.10478	Dhiggaov	Diggaon	Chittapur
9	77.11904	17.12107	Chitapur	Chittapur	Chittapur
10	77.03913	17.14484	Kaddharagi	Bhagodi	Chittapur

(It is likely that the number of structures proposed may vary depending upon the ground truth verification and feasibility criteria)