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

Aurad Taluk, Bidar District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु
South Western Region, Bengaluru

FOR OFFICIAL USE ONLY
No. SWR/RP/NQM/2022-23/20

भारत सरकार

जल शक्ति मंत्रालय

जल संसाधन, नदी विकास एवं गंगा संरक्षण विभाग

केन्द्रीय भूमिजल बोर्ड

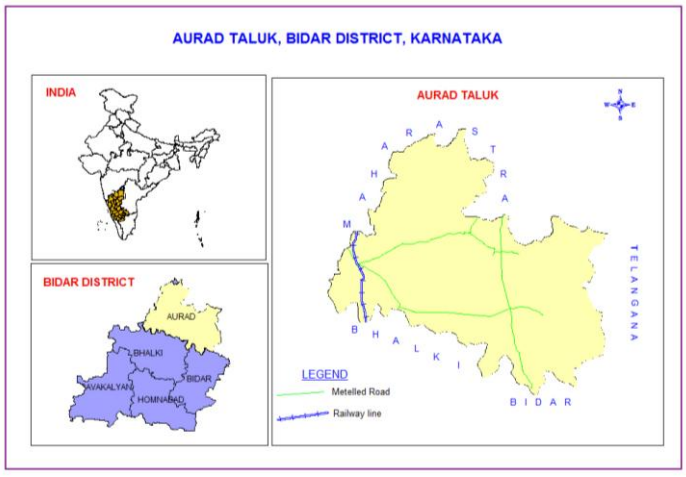
दक्षिण पश्चिमी क्षेत्र,

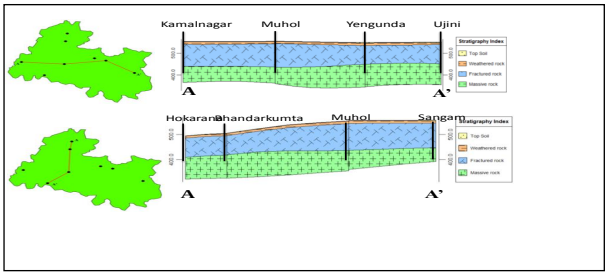
बेंगलुरु

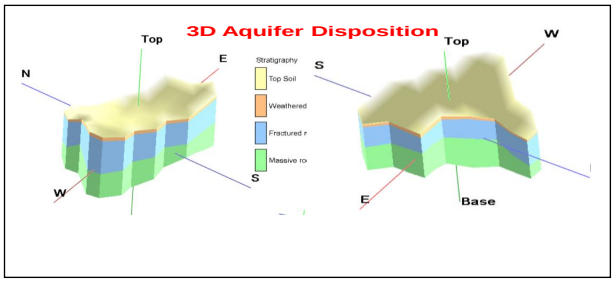
Government of India
Ministry of Jal Shakti
Department of Water Resources, River Development &
Ganga Rejuvenation
Central Ground Water Board
South Western Region, Bengaluru

AQUIFER MAPS AND MANAGEMENT PLAN, AURAD TALUK, BIDAR DISTRICT, KARNATAKA STATE

(AAP: – 2021-2022)







By

Dr J Davithuraj, Scientist 'B', CGWB, SWR, Bengaluru

AUGUST 2022

AQUIFER MAPS AND MANAGEMENT PLAN, AURAD TALUK, BIDAR DISTRICT, KARNATAKA STATE

(AAP: – 2021-2022)

Contents

AQUIFER MANAGEMENT PLAN OF AURAD TALUK, BIDAR DISTRICT, KARNATAKA STATE

1 SALIENT INFORMATION

Name of the taluk: **AURAD**

District: **BIDAR**

State: Karnataka

Area: 1233 sq.km.(Including the area of newly formed Kamalanagar taluk)

Population: 2,78,400

Annual Normal Rainfall: 867 mm

1.1 Study Area

Aquifer Mapping Studies have been carried out in Aurad taluk, Bidar district of Karnataka, covering an area of 1233 sq.kms under National Aquifer Mapping. The Aurad taluk is located between North Latitudes 18°10'44.4'' and 18°27'18" and East Longitudes between 77° 19' 12" to 77°36'18" and is falling in Survey of India Toposheets No forms parts of 56F/3 ,56F/4, 56F/7 56F/8 and 56F/12. The study area is bounded by Maharashtra on the North-west, Bhalki taluka on the south and Andhra Pradesh in the east. Location map of Aurad taluk of Bidar district is presented in **Fig-1.** Aurad is taluk head quarter . There are 151 villages and 39 gram panchayats in this taluk.

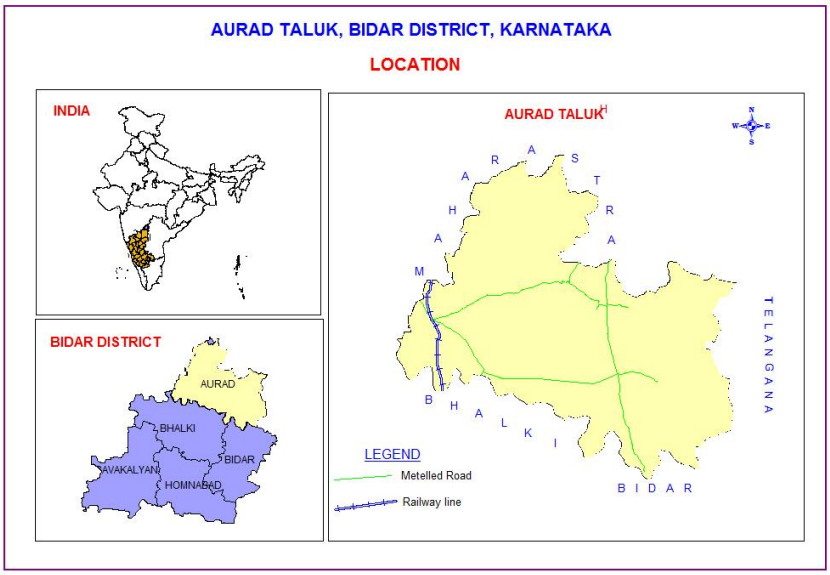


Fig-1: Location map

1.2 Population

According to 2011 census, the population in Aurad taluk is 2,78,400.(Combined population of Aurad and Kamalanagara taluks). Out of which 1,42,309 are males while 1,36,091 are females. The average sex ratio of Aurad taluk is 956. The Aurad taluk has an overall population density of 227 persons per sq.km. The decadal variation in population from 2001-2011 is 10.84% in Aurad taluk. Details of Population of Aurad taluk is given in **Table-1.**

Table-1. Details of Population

Male	Female	SC	ST	TOTAL	No. of Villages	No. of GPs	Literacy %	Density
142309	136091	79534	29150	27400	151	39	67.34	277

1.3 Rainfall

Aurad taluk experiences semi-arid climate with extreme summer and falls under North-Eastern Transitional Agro-Climatic Zone. The dust storms and severe heat waves are common in the taluk between April and May. The normal annual rainfall in Aurad taluk for the period 1981 to 2010 is 867 mm. Seasonal rainfall pattern indicates that, major amount of (695 mm) rainfall was recorded during South-West Monsoon seasons, which contributes about 80% of the annual normal rainfall, followed by North-East Monsoon season (109 mm) constituting 13% and remaining (64 mm) 7% in Pre-Monsoon season **(Table-2).**

As per the rainfall analysis and computations carried out for the 30 year blocks of 1981-2010, the mean monthly rainfall at Aurad taluk is ranging between 3 mm during Feburary to 222 mm during August. The coefficient of variation for pre-monsoon, monsoon and post-monsoon season is 82, 32 & 63 percent respectively. Annual Co-efficient Variation for the taluk works out to be 28 percent (**Table-2**).

Table-2: Statistical Analysis of Rainfall Data of Aurad taluk, Bidar district (1981 to 2010)

STATION		JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
AURAD	NRM	8	1	14	12	28	64	127	190	222	156	695	84	18	6	109	867
	STDEV	17	3	23	12	41	52	67	108	124	108	224	61	36	14	68	241
	CV%	211	271	161	103	146	82	53	57	56	69	32	72	197	224	63	28

The annual rainfall data from 2009 to 2018 of the Aurad taluk is collected from the District statistical office, Bidar and is given in **Table.3**. The rainfall trend for the period from 2009 to 2018 and probability occurrence of rainfall of the taluk are shown in **Fig.2** & **Fig-3** respectively.

Table-3 Actual Annual Rainfall of Aurad taluk from 2009 to 2018

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall (mm)	640	1000	857	767	1034	546	604	1216	778	540

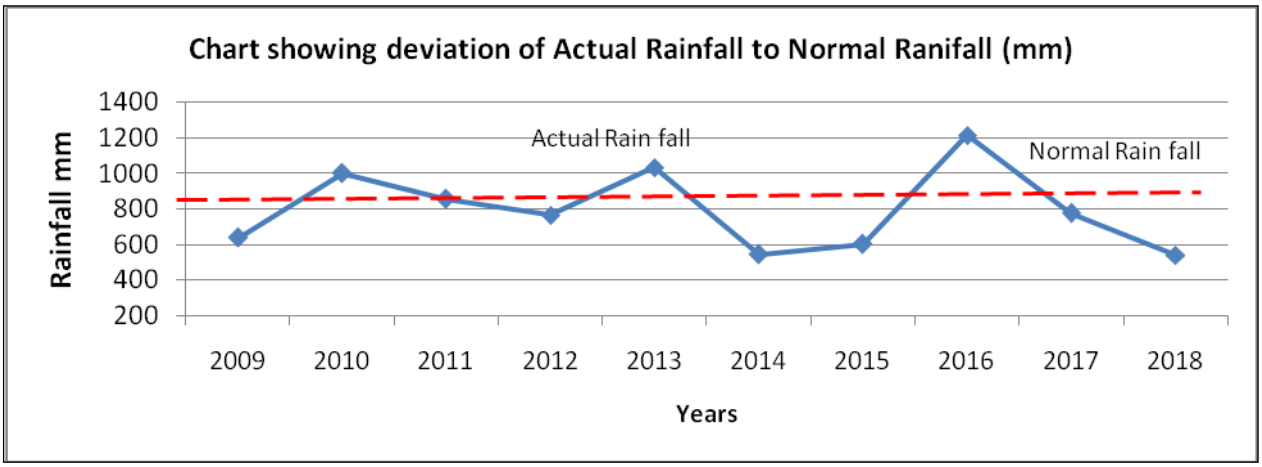


Fig-2. Rainfall trend in Aurad taluk, Bidar district

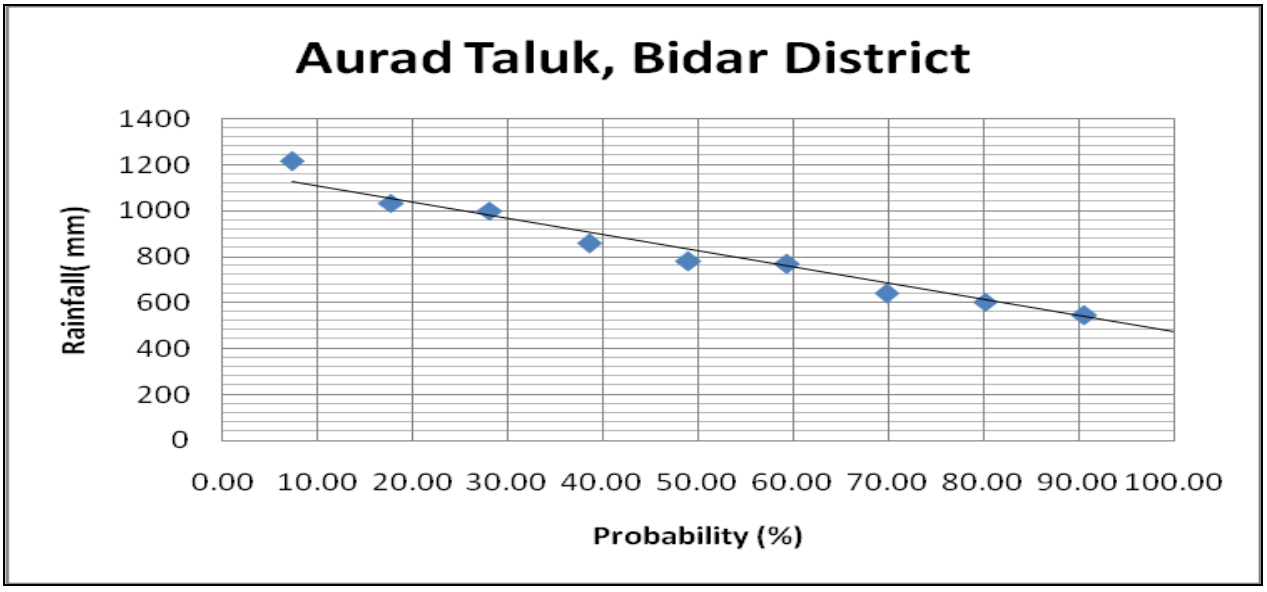


Fig-3. Probability occurrences of Rainfall in Aurad taluk of Bidar district

The rainfall pattern in the Aurad taluk reveals the irregularity of rainfall behavior (Fig-2) and the rainfall varies from 540 mm to 1216 mm (Table-3). The normal annual rainfall of Aurad taluk is 867mm. Aurad taluk received rainfall above normal during the years 2010, 2013 and 2016.

Probability analysis of rainfall for the years from 2009 to 2018 (Fig-3), indicate that the probability of occurrence of 650 mm rainfall is 70% in the taluk. The dependable rainfall of 650 mm can be used for construction of any ground water recharge structures in this taluk area.

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Aurad taluk nearly 70% of working population is engaged in agriculture. Two cropping seasons namely, Kharif (June to September) and Rabi (October to March). Sugar Cane (water intensive crop) is the main commercial crop of the taluk and nearly 5 % of the net area sown is covered. Other principal crops are Jowar, soya beans, red gram, , Black gram, Green gram, Bengal gram, wheat, horse gram etc (**Table-4**). Jowar is grown in 10 % and oil seeds in 45% of total crop area of the taluk.

Table-4: Cropping pattern in Aurad taluk 2018-2019 (Ha)

Year	Paddy	Jowar	Bajara	Total cereals and minor milletes	Wheat	Pulses	Fruits	Oil seeds	Sugarcane	Cotton
	Area under cultivation (in ha)									
2018-2019	3.0	8554	-	9419	860	50945	33	49193	2473	466

(Source: District at a glance 2018-19, Govt. of Karnataka)

It is observed that net sown area accounts 76% and area sown more than once is 30% of total geographical area in Aurad taluk (**Table-5**). Area not available for cultivation and Fallow land covers 5% & 6% of total geographical area respectively. 95% of net area irrigated is from bore wells and dug wells (**Table-6**).

Table-5: Details of land use in Aurad taluk 2018-2019 (Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Net Land Utilization	Fallow land	Net sown area	Area sown more than once
Aurad	121622	2311	6055	90134	15272	90134	22982

(Source: District at a glance 2018-19, Govt. of Karnataka)

Table-6: Irrigation details in Aurad taluk

Source of Irrigation	Net area irrigated (Ha)
Canals	-
Tanks	123
Wells	1371
Bore wells	2961
Lift Irrigation	100
Other Sources	-
Total	**4555**

(Source: District at a glance 2018-19, Govt. of Karnataka)

1.5 Geomorphology, Physiography & Drainage

The geomorphology of the Aurad is formed by the dissected Deccan plateau. The ground altitudes are varying from 640 to 440 meter above MSL. The ground surface is flat, gently sloping forming broad valleys and flat topped hills. Flat topped hills with step like sides exhibit the terraced landscape(**Fig.4**).

The taluk falls within Godavari river basin with two minor sub-basins. The important rivers are Manjara and Deoni. The river Manjara flows in the southern part of the taluk and forms the natural boundary of the taluk also. This river flows towards eastern direction with meandering course. Deoni *nala*, another important stream flowing in the western part of the taluk joins Manjra river near Sangam in the south-western part of the taluk. Beside these, there are various minor non-perennial *nalas*. The drainage pattern in the taluk varies from sub-dendritic to dendritic pattern (**Fig.-5**). This has its bearing on the regional slope which is towards North and 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.

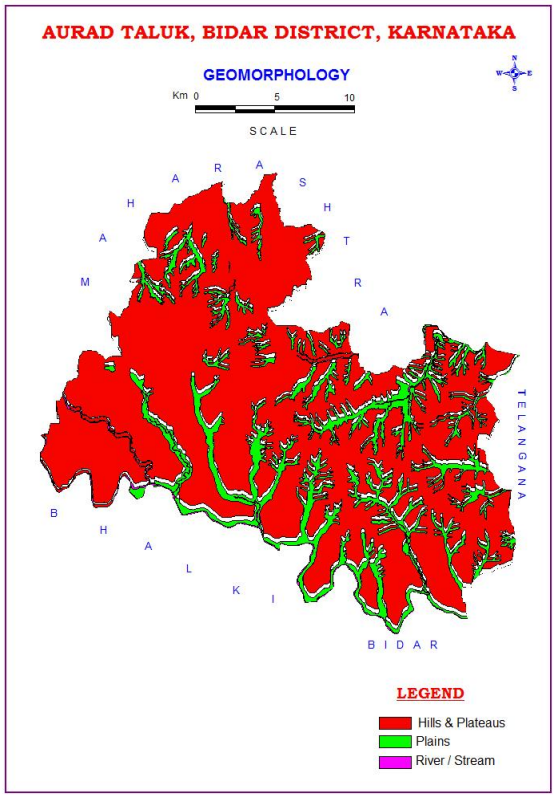


Fig-4: Geomorphology Map

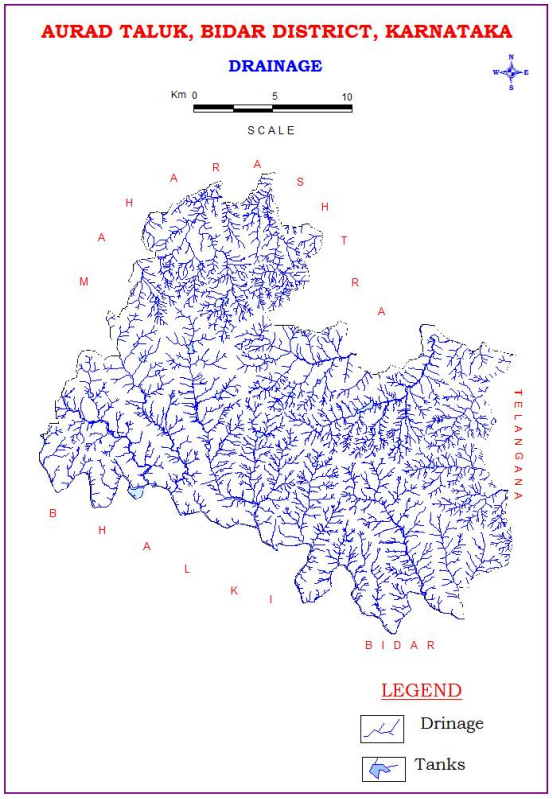


Fig-5: Drainage Map

1.6 Soil

Two types of soils are noticed in the taluk which are loamy and clayey soils. Major parts of the taluk are made up of loamy (black soils) derived from Deccan traps. These are deep black in colour and their texture varies. Their infiltration characteristics are poor to moderate. Red soils are pale to bright red in colour and clay to clayey in nature. This soil has moderate to good infiltration characteristics. (**Fig-6**).

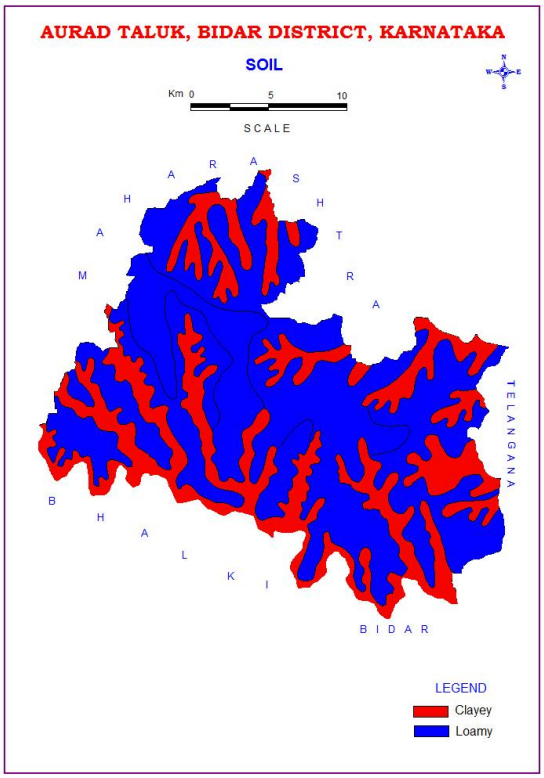


Fig-6: Soil Map

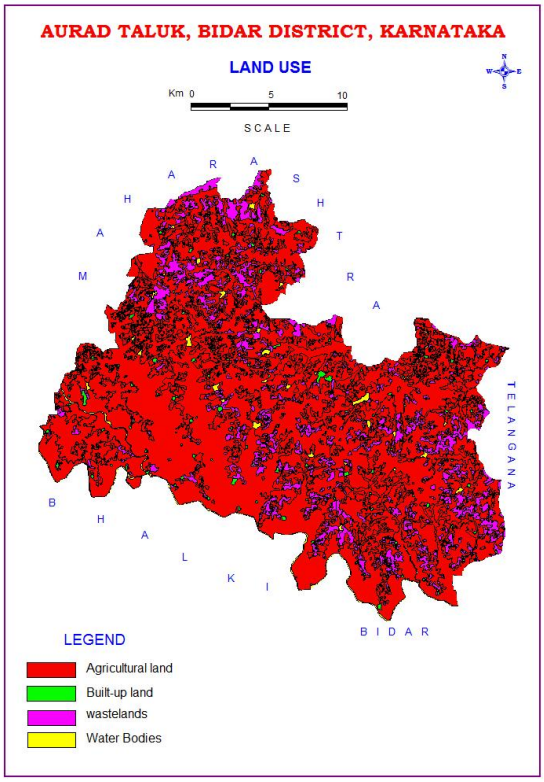


Fig-7: Land use Map

1.7 Ground water resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth is given in **Table-7** below.

Table-7: Total Ground Water Resources (2017) (Ham)

Taluk	Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
AURAD	7700	Phreatic	Fractured (Down to 200m)	Dynamic + phreatic in-storage + fractured
		7427	3008	18137

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

- Net ground water availability for future irrigation development : 53.49 MCM

- Domestic (Industrial sector) demand for next 25 years : 1.63 MCM

1.9 Water level behavior

***(a) Depth to water level* (Table-8)**

Aquifer-I

- Pre-monsoon: 3.85 – 9.43 mbgl (**Fig.-8**)
- Post-monsoon: 0.33 – 4.30 mbgl (**Fig.-9**)

Aquifer-II

- Pre-monsoon: 5.80 – 67.75 mbgl
- Post-monsoon: 0.95-47.00 mbgl

(b) Water level fluctuation

Aquifer-I

- Seasonal Fluctuation: Rise ranges 1.92 – 7.85 m (**Fig.-10**).

Aquifer-II

- Seasonal Fluctuation: Rise ranges 0.40-19.00 m.

(c) Long-Term Water level trend (Table-9)

- Pre-monsoon: Falling ranges 0.087 – 0.5379 m
  Rising ranges 0.0306 – 1.3616 m
- Post-monsoon: Falling ranges 0.0048 – 0.3429 m
  Rising ranges 0.001 – 0.2782 m

Table-8: Depth to water level for pre-monsoon and post-monsoon

Sr. No	Village	Source	Pre-monsoon Depth to water May-2019 (mbgl)	Post-monsoon Depth to water Nov-2019 (mbgl)	Water level Fluctuation
	Aquifer-I				
1	Dongargaon	Dug Well	3.85	0.57	3.28
2	Ekamba	Dug Well	4.20	1.4	2.80
3	Borala	Dug Well	4.60	1.6	3.00
4	Borgi	Dug Well	4.84	2.92	1.92
5	Kandikheri	Dug Well	5.08	2.38	2.70
6	Nagur	Dug Well	7.60	3.95	3.65
7	Wadegaon	Dug Well	7.80	4.3	3.50
8	Santepur	Dug Well	8.18	0.33	7.85

9	Kamalnagar	Dug Well	9.43	2.25	7.18
Aquifer-II					
10	Aurad	Bore well	27.78	26.87	0.91
11	Belkuni (C)	Bore well	9.25	1.50	7.75
12	Tegampur	Bore well	7.60	0.95	6.65
13	Dongargaon	Bore well	8.60	3.25	5.35
14	Hokarna	Bore well	67.75	52.0	15.75
15	Ekamba	Bore well	18.10	13.10	5
16	Kamalnagar	Bore well	5.80	3.95	1.85
17	Sangam	Bore well	32.25	13.25	19
18	Ujani	Bore well	47.40	47.00	0.4
19	Wadagaon	Bore well	17.45	10.75	6.7

Table–9 Long Term Water Level Trends (Based on CGWB's National Hydrograph Stations).

Sl. No.	Location	Period of observation	Water level trend m/year				Aquifer
			Pre monsoon		Post monsoon		
			Fall	Rise	Fall	Rise	
1	Aurad	2010-2019	-	0.0505	0.1459	-	Basalt
2	Borala	2010-2019	0.3447	-	-	0.1608	Basalt
3	Borgi	2010-2019	0.2918	-	0.1816	-	Basalt
4	Dongargaon	2010-2019	-	0.7254	-	0.2782	Basalt
5	Ekamba	2010-2019	-	0.0306	-	0.0001	Basalt
6	Kamalnagar	2010-2019	0.4977	-	0.1101	-	Basalt
7	Kandikheri	2010-2019	0.1662	-	-	0.1559	Basalt
8	Kushnoor	2010-2019	-	1.3616	0.3429	-	Basalt
9	Nagur	2010-2019	0.5108	-	-	0.2028	Basalt
10	Rampur	2010-2019	0.5379	-	-	0.0348	Basalt
11	Santepur	2010-2019	0.1855	--	0.0048	-	Basalt

12	Wadegaon	2010-2019	0.0087	-	0.1856	-	Basalt

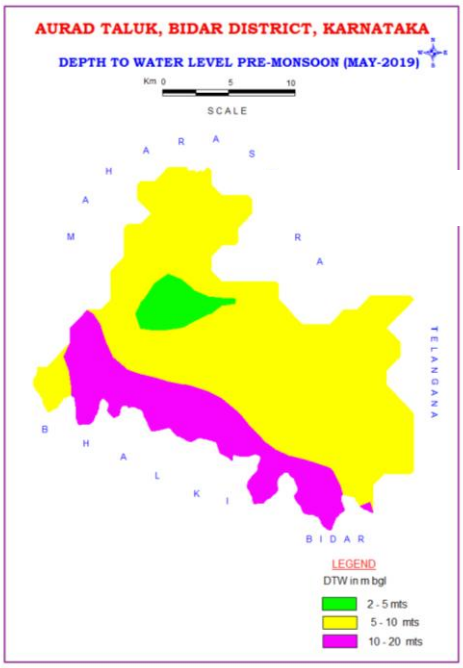


Fig-8: Pre-monsoon Depth to Water Level

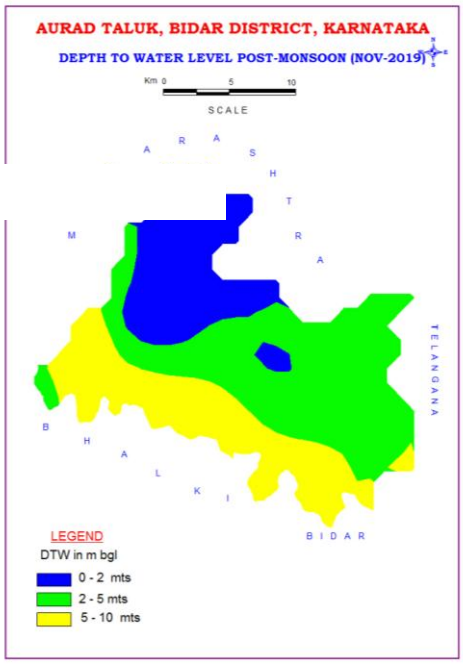


Fig-9: Post-monsoon Depth to Water Level

Fig-10: Water Level Fluctuation (Aq-I)

2 AQUIFER DISPOSITION

2.1 Aquifer Types

In Aurad taluk, two types of Basaltic aquifer systems exists;

i. Aquifer-I (Phreatic aquifer) comprising of Weathered Basalt
ii. Aquifer-II (Fractured aquifer) comprising of Fractured Basalt

Aurad taluk is mainly occupied by of Deccan Traps of basaltic composition. Deccan Traps consist of successive lava flows, mainly basaltic in composition (Massive basalt and Vesicular basalt). Basalt is the main water bearing formations (**Fig-11**). Ground water occurs within the weathered and fractured basalts under water table condition and semi-confined condition. The size and inter connectivity of vesicles, the joint patterns and inter-trapean beds control the occurrence and movement of water in Basalt.

In the area, bore wells were drilled from a minimum depth of 132.20 mbgl to a maximum depth of 266.50 mbgl. Depth of weathered zone ranges from 3.60 mbgl to 18 mbgl. (**Table.10**) Ground water exploration reveals that in aquifer-II, fractured formation was encountered between the depth of 22 to 215 mbgl. Yield ranges from less than 1 to 14 lps. The aquifer characteristics of phreatic and fractured aquifers are summarized in **Table-11**.

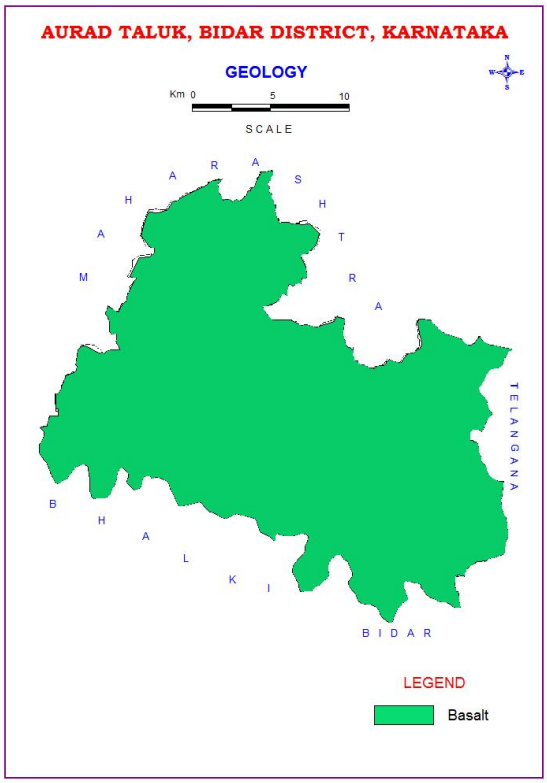


Fig-11: Geology Map

Table-10: Details of Ground Water Exploration

S.No	Location	Lat &Long	Depth (mbgl)	Casing (m)	Litholog y	SWL (mbgl)	Q (lps)	DD (m)	T (m^2/day)
1	Ujini-EW	18°23'15'' 77° 29'45''	204.00	3.60	Basalt/ Granite	11.72	5.41	20.96	10.05
2	Ujini-OW	18°23'15'' 77° 29'45''	235.85	16.0	Basalt/ Granite	26.84	3.47	24.85	7.83
3	Aurad--EW	18°15'15'' 77° 25'00''	266.50	6.00	Basalt/ Granite	>100	Neg	-	-
4	Muhol (B)-EW	18°13'30'' 77° 19'00''	175.10	6.0	Basalt	19.96	10.00	3.38	72.57
5	Muhol-OW	18°13'30'' 77° 19'00''	223.00	6.00	Basalt	22.19	6.73	2.48	71.59
6	Hokarna-EW	18°23'15'' 77° 29'45''	132.20	14.6	Basalt	16.08	14.00	9.44	23.85
7	Hokarna-OW	18°23'15'' 77° 29'45''	137.60	18.0	Basalt	18.81	9.90	11.94	18.81
8	BHANDAR KUMTA-EW	18^0 20' 45'' 77^0 19' 20''	198.45	-	Basalt	-	0.007	-	3.230
9	KAMALANA GAR EW	18^0 14' 15'' 77^0 10' 30''	134.95	-	Basalt	13.414	4.31	19.066	-
10	KAMALANA GA OW	18^0 14' 15'' 77^0 10' 30''	136.45	-	Basalt	12.000	2.75	19.789	-
11	SANGAM EW	18^0 10' 00'' 77^0 15' 00''	113.05	-	Basalt	19.090	4.00	17.610	
12	YENGUNDA EW	18^0 14' 30'' 77^0 27' 00''	159.85	-	Basalt	38.240	4.00	4.579	-

Table-11: Aquifer characteristics of Phreatic and Fractured aquifers

Aquifers	Phreatic Weathered/Shallow Zone (Aq.-I)	Fractured Fractured Zone (Aq.-II)
Prominent Lithology	Weathered Basalt	Fractured / Jointed Basalt and Granite
Thickness range (mbgl)	3-10	Fractures upto 215 mbgl
Depth range of occurrence of fractures (mbgl)	-	22-215
Range of yield potential (lps)	<1-3	<1 – 14
Specific Yield	2%	0.2%
T (m^2/day)	-	3.230-72.57
Quality Suitability for Domestic &Irrigation	Generally, Potable/Suitable	Generally, Potable/Suitable

2.2 3 D Aquifer disposition and Cross-Sections

Aquifer disposition – 3D and 2D aquifer dispositions (Rockworks output) are represented in **Fig.12 to Fig.14**.

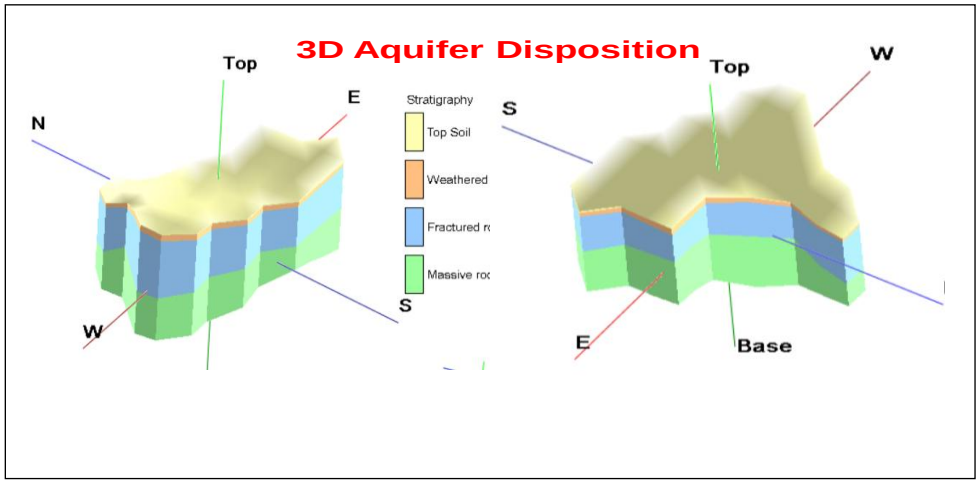


Fig-12: 3D Aquifer Disposition

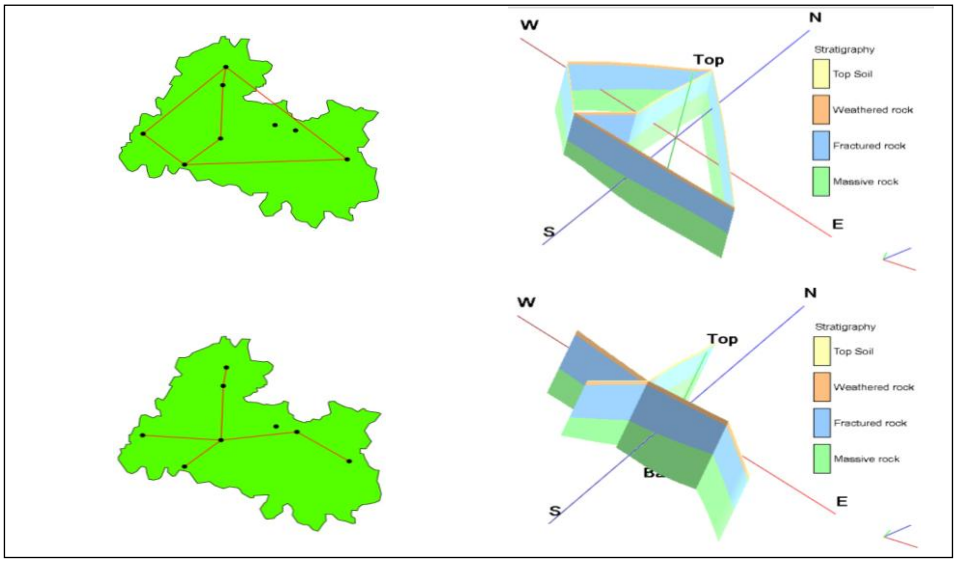


Fig-13: 3D Aquifer Fence Diagram

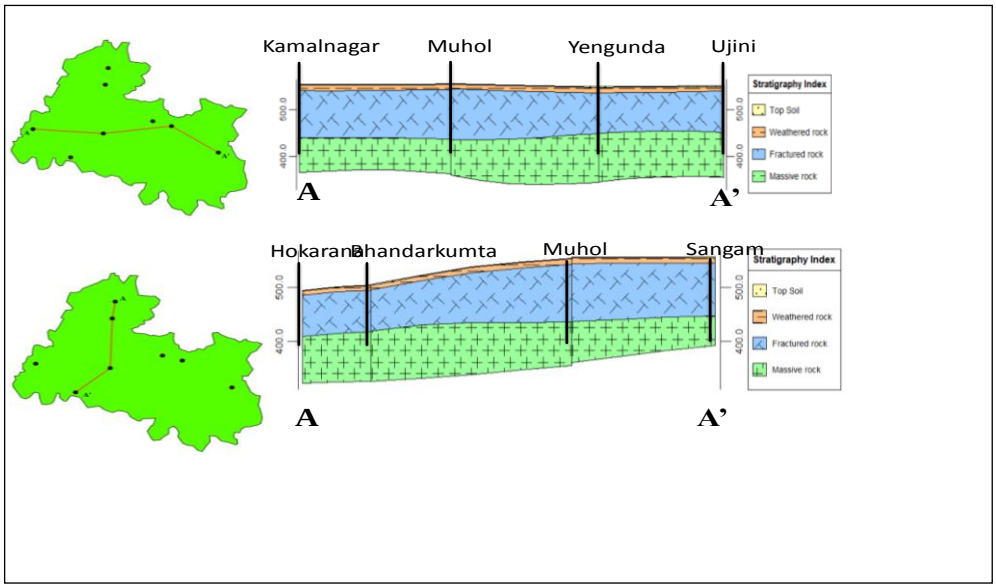


Fig-14: 2 D Aquifer Cross sections in different directions

3 Ground water resource, extraction, contamination and other issues

3.1 Aquifer wise resource availability and extraction

The details are shown below.

Table.12a Dynamic Ground Water Resource in Ham (2017)

Taluk	ANNUAL EXTRACTABLE GROUND WATER RESOURCES	EXISTING GROSS GROUND WATER DRAFT FOR IRRIGATION	EXISTING GROSS GROUND WATER DRAFT FOR DOMESTIC AND INDUSTRIAL WATER SUPPLY	EXISTING GROSS GROUND WATER EXTRACTION 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
AURAD	7700	2188	149	2336	163	5349	30	SAFE

The details of dynamic (Phreatic) ground water resources for Aurad taluk as on March 2020 is shown in **Table.12b.** It is observed that the stage of ground water extraction is slightly gone up in the taluk from 30 % to 37 % from 2017 to 2020 (**Table.12c**).This may be attributable to the increased dependence on ground water for irrigation in the absence of major canal irrigation system in the taluk. Further, it is to mention that ground water resource estimation was arrived separately for Kamalanagar taluk which is formed after the bifurcation of the Aurad taluk.

Table.12b Detail of Dynamic Ground Water Resource (As on March 2020)

Annual Extractable GW Resource (Ham)	GW Extraction for Irrigationl Use (Ham)	GW Extraction for Industrial Use (Ham)	GW Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net GW Availability for future use (Ham)	Stage of GW Extraction (%)	Categorization (Over-ExploitedE/Critical/Semicritical/Safe/ Saline)
3369.00	1107.68	0.0	153.42	1261.10	165.46	2095.86	37.43	Safe

Table .12c: Comparison of ground water availability and draft scenario in Aurad 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 (%)
	2013			2017			2020		
AURAD	5118	2159	42	7700	2336	30	3369	1261	37

3.2 Chemical quality of ground water and contamination

Interpretation from Chemical Analysis results in Aurad taluk is mentioned as under:

ELECTRICAL CONDUCTIVITY: In general, EC values range from 621 to 1346 µ/mhos/cm in the aquifer-I at 25^{o}C (**Fig-15**) and range from 500 to 2660 µ/mhos/cm in the aquifer-II. **(Table.13)**

CHLORIDE: Chloride concentration in ground water ranges between 56 and 256 mg/l in the aquifer-I (**Fig-16**))and ranges between 50 and 270 mg/l in the aquifer-II.

NITRATE: Nitrate concentration in ground water ranges from 11 and 101 mg/l in the Aquifer –I (**Fig-17**) and ranges from 12 and 56 mg/l in the Aquifer –II .

FLUORIDE: Fluoride concentration in ground water ranges between 0.28 and 1.41 mg/l in the aquifer-I (**Fig-18**) and ranges between 0.60 and 4.0 mg/l in the aquifer-II .

Table-13: Quality of ground water in Aurad taluk of Bidar district

Sr_No	LOCATION	PH	EC	Cl	NO3	F
Aquifer-I						
1	Aurad	8.03	1346	256	26	0.277
2	Borala	8.08	670	71	11	0.535
3	Borgi	8.01	621	56	19	0.509
4	Dongargaon	9.23	655	78	14	0.723
5	Ekamba	7.76	851	93	27	0.579
6	Nagur(N)	7.85	715	96	40	1.407
7	Rampur	7.78	691	63	24	0.969
8	Santepur	7.82	745	87	39	0.572
9	Wadegaon	7.72	1180	193	101	0.881
Aquifer-II						
10	Ujini	7.8	2660	270	26	3.8
11	Ujini	7.8	2660	270	12	4.0
12	Aurad	7.9	1100	121.0	17.0	0.6
13	Muhol (B)	8.0	510	57	37	1.0
14	Muhol	8.0	510	50	35	0.9
15	Hokarna	8.	760	114	49	1.0
16	Hokarna	8.2	800	135	56	0.9
17	Kamalanagar	-	850	174	-	-
18	Kamalanaga	-	825	167	-	-
19	Sangam	-	500	78	-	-
20	Yengunda	-	1240	243	-	-

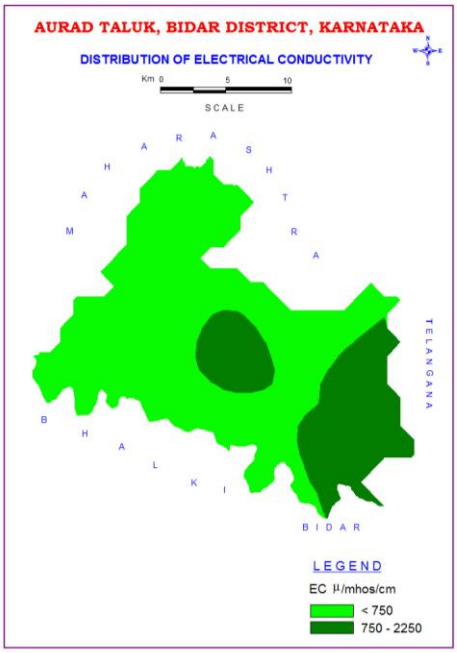


Fig-15 Distribution of EC

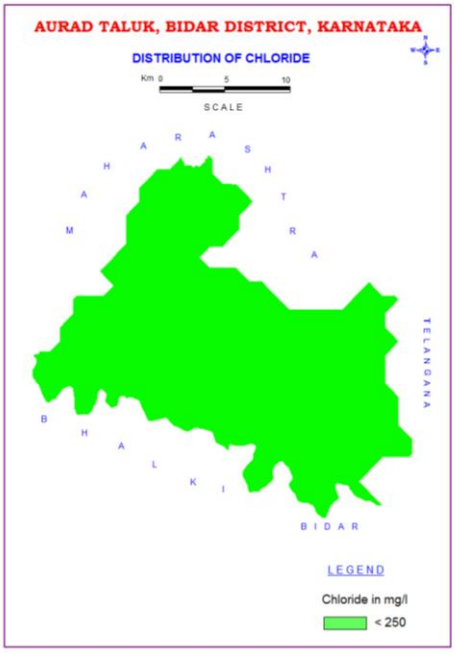


Fig-16 Distribution of Chloride

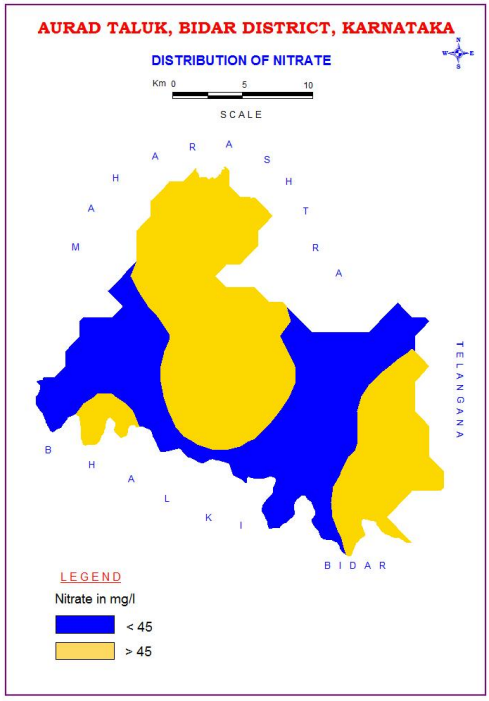


Fig-17 Distribution of Nitrate

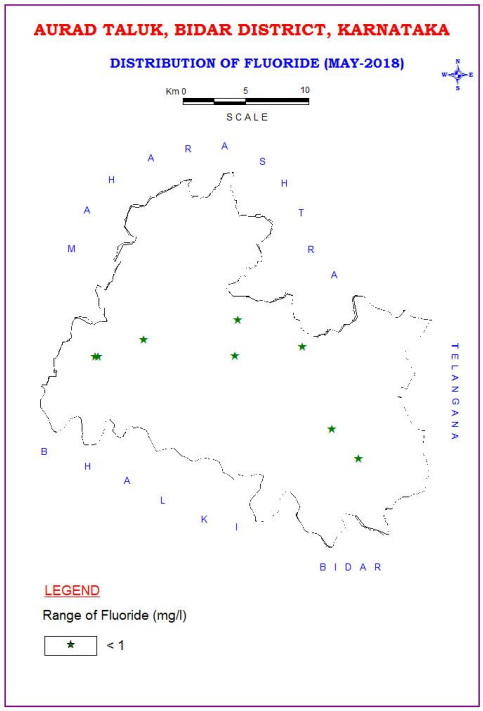


Fig-18 Distribution of Fluoride

4 GROUND WATER RESOURCE ENHANCEMENT

4.1 Aquifer wise space available for recharge and proposed interventions

It is recommended to augment ground water recharge through construction of artificial recharge structures, viz; check dams and percolation tanks (**Table-14**) as per the Master Plan prepared by CGWB (2020) which are already being implemented under various programmes. Under PMKSY Watershed component, 10000 farm ponds, 1000 check dams, 100 Nala Bunds, 450 percolation tanks and 1500 other recharge structures were proposed (Source: District irrigation plan report, Bidar district, 2016-17). 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. The area feasible for Artificial Recharge is arrived based on the criteria of more than 3 mbgl post monsoon water level, command area, hilly area and slope less than 3%. The slope map and the area feasible for artificial recharge are given in **Fig. 19** .The details of expected improvement in ground water availability due to recharge is shown in **Table.15**.

Table-14: Quantity of non-committed surface runoff & likely recharge through AR structures

Artificial Recharge Structures Proposed	Aurad taluk
Non committed monsoon runoff available (MCM)	26.04
Total no. of existing Artificial Recharge Structures	629
Number of Check Dams	-
Number of Percolation Tanks	-
Number of Sub surface dyke	1
Excepted recharge (MCM)	19.52

Table-15 Improvement in GW availability due to Recharge, Aurad taluk

Taluk	Net annual ground water availability	Existing gross ground water draft for all uses	Existing stage of ground water development	Expected recharge from proposed artificial recharge structures	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	%	%
AURAD	3369	1261	37	1952	13	24

After implementation of Artificial Recharge structures for GW recharge, the annual ground water availability will increase from 3369 to 5321 ham and the expected improvement in stage of development is 13% from 37% to 24 %.

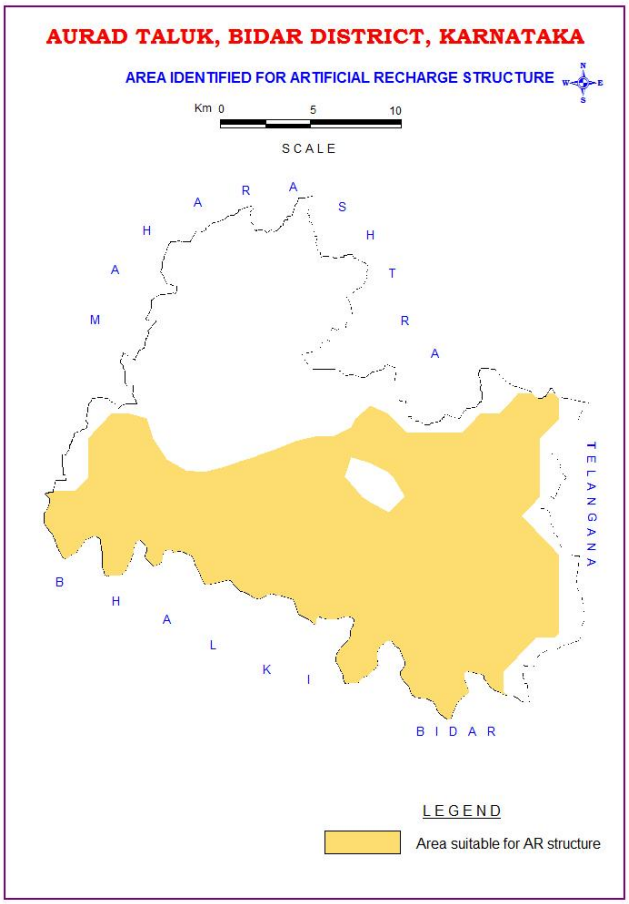


Fig.19: Artificial Recharge Feasibility Map

4.2 DEMAND SIDE INTERVENTIONS

4.2.1 Advanced irrigation practices

It is observed that dug wells and bore wells contribute 95% of the source for irrigation in Aurad taluk. Thus, by adopting the below mentioned techniques will contribute in ground water resource enhancement in the long run. (**Table.16**)

- Efficient irrigation practices like Drip irrigation & sprinkler needs to be adopted by the farmers in the existing 5172 ha of gross irrigated area by borewells and dugwells.
- Irrigation draft is 11078 ham.
- Efficient irrigation techniques will contribute in saving ground water by 4652 ham and thus will improve stage of development by 13% from 24% to 11% **(Table-16).**

Table-16: Improvement in GW availability due to saving by adopting water use efficiency.

Taluk	Cumulative annual ground water availability after implementing ar structures & irrigation development schemes	Existing gross ground water draft for all uses	Stage of ground water development after implementing AR structures & proposed irrigation development schemes through interbasin transfer	Saving due to adopting WUE measures	Cumulative annual ground water availability	Expected improvement in stage of ground water development after adopting WUE measures and implementation of the project	Expected improvement in overall stage of ground water development
	HAM	HAM	%	HAM	HAM	%	%
Aurad	17460	1261	24	4652	22221	13	11

4.2.2 Regulation and Control

Aurad taluk has been categorized as **"Safe".** However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority needs to be strictly implemented to avoid the taluk from slipping from safe category to semi-critical category in the future.

4.2.3 Other interventions proposed

- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Excess nitrate concentration is found in ground water samples require remedial measures viz.
    - Dilution of nitrate rich ground water through artificial recharge & water conservation.
    - Roof top rain water harvesting.
    - Improving quality by proper drainage and limited usage of Nitrogenous fertilizers
- Excess fluoride concentration is found in ground water samples require remedial measures viz.
    - Alternate source
    - Removal technology

4.2.4 Additional ground water abstraction structure

As mentioned above, the stage of ground water extraction for the taluk as per 2020 estimate is 37.43% and the taluk is Safe. Hence, there is scope for the development of the ground water resource through additional wells. As per the existing unit draft figures, there is scope to construct about 200o dug wells and about 2600 bore wells in the taluk so as to retain the taluk under "Safe Category" in the future. After the implementation, it is likely to create an additional irrigation potential of about 4600 ha. The sites for construction of these structures needs to be selected after considering the hydro-geologic feasibility and related aspects in the field.

5 SUMMARY AND CONCLUSIONS

The summary of management plans of Aurad taluk is given in **Table-17.**

Table-17: Summary of Management plan of Aurad taluk

Aurad taluk is Safe & present stage of Ground water Extraction as per GEC-2020(%)	37
Annual Extractable Ground Water Availability (MCM)	33.69
Existing Gross Ground Water Extraction for all uses	12.61
Area Feasible for Artificial Recharge (Sq.Km)	796
Total Ground water Resources (Dynamic & Static upto the depth of 200 mbgl) (MCM)	121.72
Expected additional recharge from monsoon surplus runoff (MCM) after the implementation of the project	19.52
Expected improvement in stage of ground water extraction after the implementation of the project (%)	37 to 24
Expected Saving due to adopting WUE measures (MCM)	46.52
Expected improvement in stage of ground water extraction after adopting WUE measures and implementation of the project (%)	24 to 11
Excess Nitrate concentration	• Dilution of nitrate rich ground water through artificial recharge & water conservation. • Roof top rain water harvesting • Improving quality by controlling usage of Nitrogenous fertilizers in agriculture field and maintaining the proper domestic drainage network system
Water Use efficiency measures	• Government to take initiative to encourage at least 70% farmers to adopt water use efficiency irrigations practices like dip & sprinkler irrigation

Ground Water resource: As per the resource estimation – 2020, Aurad falls under **Safe** category with the stage of ground water extraction is 37.43 **%.** Still, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk in view of the prevailing Semi-arid and Drought-prone conditions in the taluk and also due to the high dependence on ground water for irrigation.

Ground water resource enhancement: Increase in agricultural activity, 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.

Quantity of water available through non-committed surface run-off: The surplus non-committed monsoon run off is estimated to be 26.04 MCM. This can be used to recharge the aquifer mainly through check dams and percolation tanks as being practiced now under various programme by the Governmnet. An area of 796 sq.km is feasible for water conservation/artificial recharge in the taluk (CGWB 2020). As of now, check dams (287), percolation tanks (53) and Point Recharge Structures (295) were already been constructed under various programmes by Govt. of Karnataka(Artificial recharge Master plan 2020, CGWB). Considering the current existing dependability of ground water for all uses, it is mandatory to augment the ground water through artificial recharge.

Under PMKSY Watershed component 10000 farm ponds, 1000 check dams, 100 *Nala Bunds*, 450 percolation tanks and 1500 other recharge structures were proposed.

Periodical maintenance of artificial recharge structures is recommended for better recharge and long life of the structure.

It is recommended to periodical de-silting of existing surface water bodies to enhance recharge to the phreatic and fractured aquifers for sustainability.

Advanced irrigation practices: At present about 95 % of irrigation is by wells and bore wells (ground water). The irrigation practices like drip and sprinkler irrigation are comparatively less practiced in comparison with other mode of irrigation which needs to be expanded to save irrigation water by way of precision farming mechanism. This ultimately enhances the area under irrigation potential.

Change in cropping pattern: Farmers are facing inadequacy of groundwater for agriculture. Hence, change in cropping pattern and water economy irrigation practices are recommended. Farmers can opt for more rain-fed millets and water efficient Pulses for agricultural production. This needs active support from Government.

Drinking water Supply: In view of ground water contamination with higher concentration of Nitrate, identification of contamination free ground water source is essential. Alternatively, drinking water supply from surface water source needs to be covered at large.

Additional ground water abstraction structures: there is scope for the development of the ground water resource through additional wells. As per the existing unit draft figures, there is scope to construct

about 200o dug wells and about 2600 bore wells in the taluk so as to retain the taluk under “Safe Category” in the future.

Other Interventions proposed: The major issue in the taluk is water scarcity for domestic and irrigation purposes. To mitigate this critical issue of scarcity of potable drinking water, construction of rain water harvesting units at the household level are must. This will also help to improve the ground water quality by dilution.

Participatory management: Awareness programmes and practice of participatory approach needs to be strengthened with the involvement of all the stake holders for sustainable ground water management.

Regulation and control: Taluk is categorised as **"Safe".** However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority needs to be strictly implemented to avoid the taluk from safe category to semi critical category in the future.

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.