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

Belur Taluk, Hassan District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

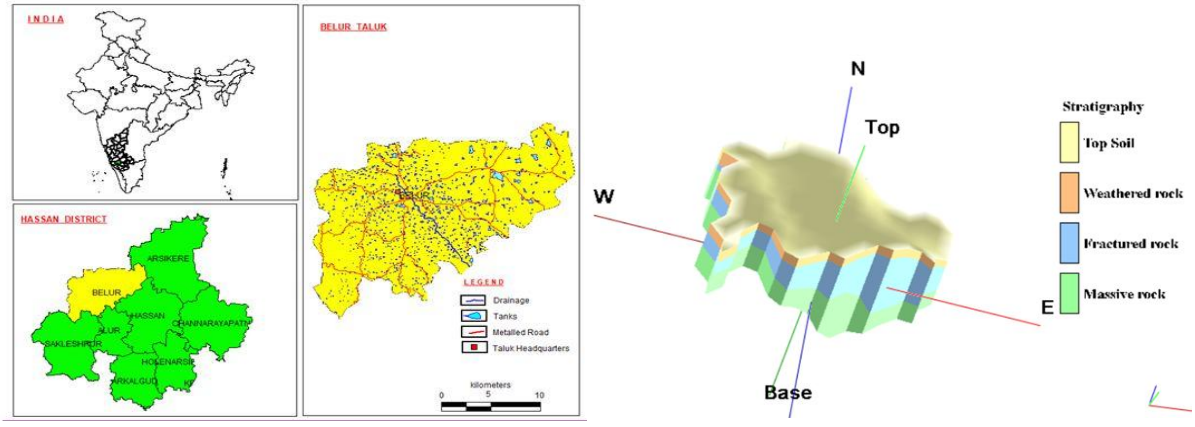
FOR OFFICIAL USE ONLY
No. *SWR/RP/NQM/2022-23/26*

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

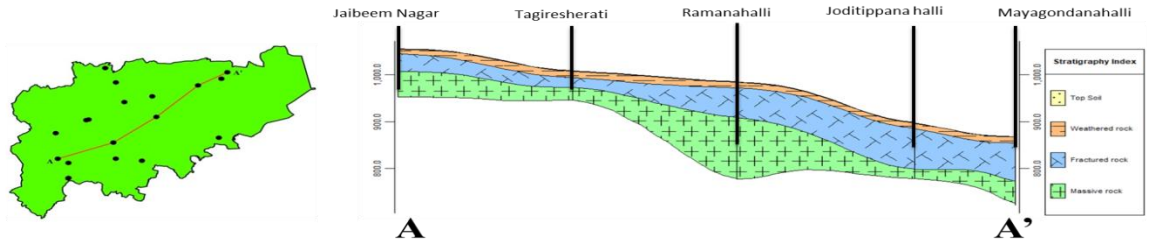
Government of India
Ministry of Jal Shakti
Department of Water Resources,
River Development &
Ganga Rejuvenation
Central Ground Water Board
South Western Region, Bengaluru

AQUIFER MAPS AND MANAGEMENT PLAN, BELUR TALUK, HASSAN DISTRICT, KARNATAKA STATE

(AAP – 2021-2022)



2D Aquifer Sections



By

Damera Anjaneyulu, Assistant Hydrogeologist, CGWB, SWR, Bengaluru

AUGUST2022

AQUIFER MAPS AND MANAGEMENT PLAN, BELUR TALUK, HASSAN DISTRICT, KARNATAKA STATE

(AAP – 2021-2022)

1 Contents

AQUIFER MANAGEMENT PLAN OF BELUR TALUK, HASSAN DISTRICT, KARNATAKA STATE

1. SALIENT INFORMATION

Name of the taluk: **BELUR**

District: **HASSAN** ; State: Karnataka

Area: 845 sq.km.

Population: 1,84,458 (As 2011 census)

Annual Normal Rainfall: 927 mm

1.1 Study Area

Aquifer mapping studies was carried out in Belur Taluk, Hassan district of Karnataka, covering an area of 845 Sq.Km under National Aquifer Mapping Project. Hassan Taluk of Hassan district is located between north Latitude 12° 50' 16" and 13° 17' 19" and eastern Longitude 75° 43'31" and 76° 07'33"and is covered in parts of Survey of India Toposheet Nos. 48 O/12, 16, 48 P/13 & 57 C/3, 4. Belur Taluk is bounded by Arsikere & Chikmagalore Taluks on north, Alur & Sakleshpura Taluks on south, Arsikere &Hassan Taluks on east and Sakleshpura & Mudigere Taluks on the western side. Location map of Belur Taluk of Hassan district is presented in **Figure-1.**Taluk administration of Belur Taluk is divided into 5 Hoblies. Belur town is also the Taluk head quarter and there are 356 inhabited and 27 uninhabited villages in the Taluk.

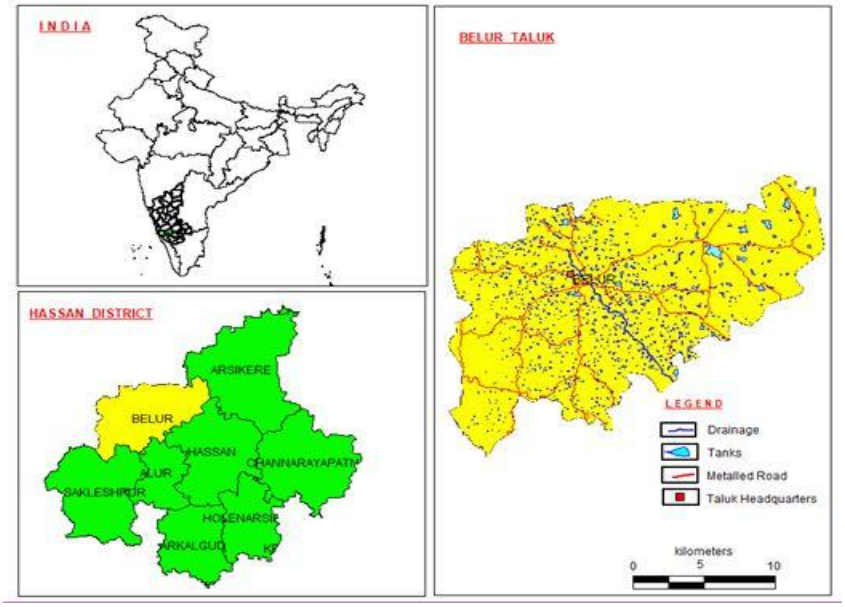


Fig-1: Location map

1.2 Population

According to 2011 census, the population in the Taluk is 1,84,458, in which 1,61,974 constitute the rural population and 22,484 urban population, which works out to 88 % (rural) and 12 % (urban) of the total population of Taluk. The study area has an overall population density of 218 persons per sq.km. The decadal variation in population from 2001 to 2011 is 0.38 % in BelurTaluk**(Table.1).**

Table-1: Population details of BELURtaluk

Total	Male	Female	Share of the district population	Rural population	Urban population	Decadal change in population	Decadal change in rural population	Decadal change in urban population
184458	91306	93152	10.38	161974	22484	0.68	-0.96%	10.03%

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

1.3 Rainfall

Belur Taluk enjoys semi-arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Southern Dry agro-climatic zone of Karnataka state and is categorized as drought prone. The normal annual rainfall in Belur Taluk for the period 1951 to 2018 is 979 mm. Seasonal rainfall pattern indicates that, major amount of (496 mm) rainfall was recorded during South-West Monsoon seasons, which contributes about 54% of the annual normal rainfall, followed by North-East Monsoon season (194 mm) constituting 21% and remaining (235 mm) 26% in Pre-Monsoon season **(Table-2).**

Table-2:Average Rainfall Data of BelurTaluk, Hassan district, Karnataka (2001-2018)

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN.RAINFALL
BELUR	3.0	6.6	27.8	79.2	119.4	120.1	141.5	127.8	107.3	139.4	49.8	5.2	926.87

Table-3: The annual rainfall data of BELUR Taluk, Hassan district, Karnataka (2001-2018)

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
ANNRain	724	720	528	1014	1358	891	1148	1218	1292	1238	1088	704	559	1025	967	702	651	857

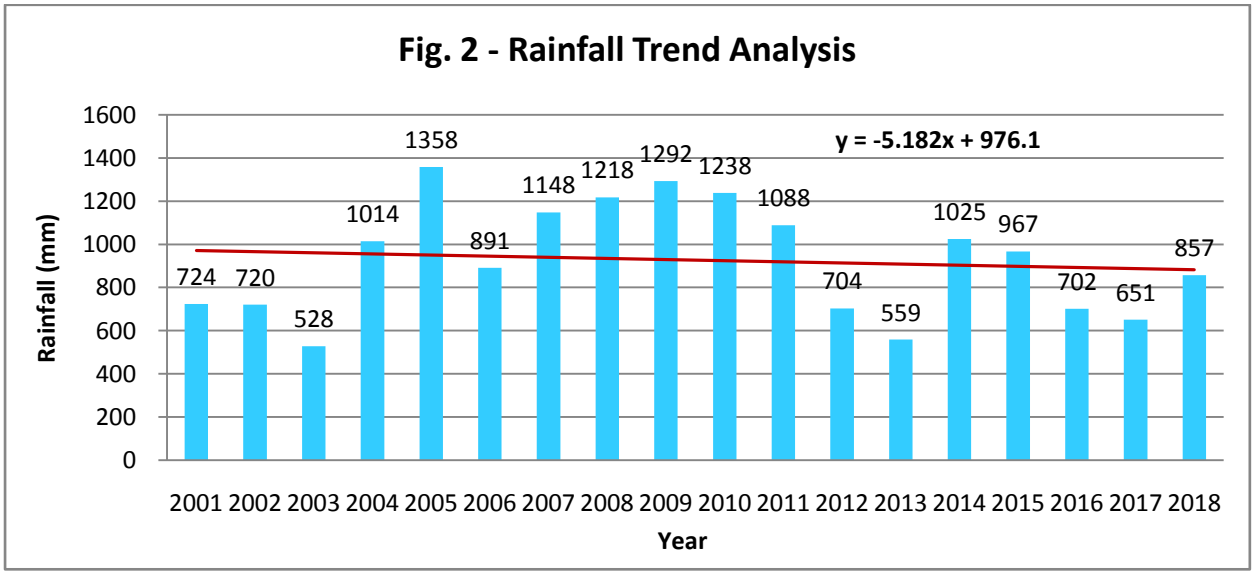


Fig. 2 - Rainfall Trend Analysis

The rainfall pattern in the Belur Talukreveals the irregularity of rainfall behaviour (**Fig-2**) and the rainfall varies from 528 mm to 1358 mm (**Table-3**). As mentioned above, the normal annual rainfall of Belur Talukis 927mm.Belur Talukreceived rainfall above normal during the years 2004-2011 and 2014-2015.

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Belur Taluk. Major Kharif crops are paddy, maize, ragi, tur and vegetables. Main crops of Rabi season are maize, ragi, horse gram, vegetables, groundnut, and sunflower. Water intensive crops paddy is grown in 9% of total crop area. Maize is grown in 53%, ragi in 16%, vegetables in 7% and pulses in 7% of total crop area of Talukin **Table.4.**

Table-4: Cropping pattern in BelurTaluk 2017-18 (Ha)

Year	Paddy	Maize	Ragi	Jowar	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
2017-18	2495	14288	4448	426	2018	828	1825	736	0	115

It is observed that net sown area accounts 51% and area sown more than once is 7% of total geographical area in Belur taluk **(Table-5).** Area not available for cultivation and Fallow land cover 23% &15% of total geographical area respectively. 50% of net area irrigated is only from bore wells and 32% from lift irrigation **(Table-6).**

Table-5: Details of land use in BelurTaluk 2017-18 (Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
BELUR	76774	6634	18422	12220	39464	5519

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

Table-6: Irrigation details in Belurtaluk (in ha)

Source of Irrigation	Net area irrigated (Ha.)	% of area
Canals	-	0
Tanks	1364	38.0
Wells	53	1.4
Bore wells	1086	30.3
Lift Irrigation	0	0
Other Sources	1087	30.3
Total	3590	

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

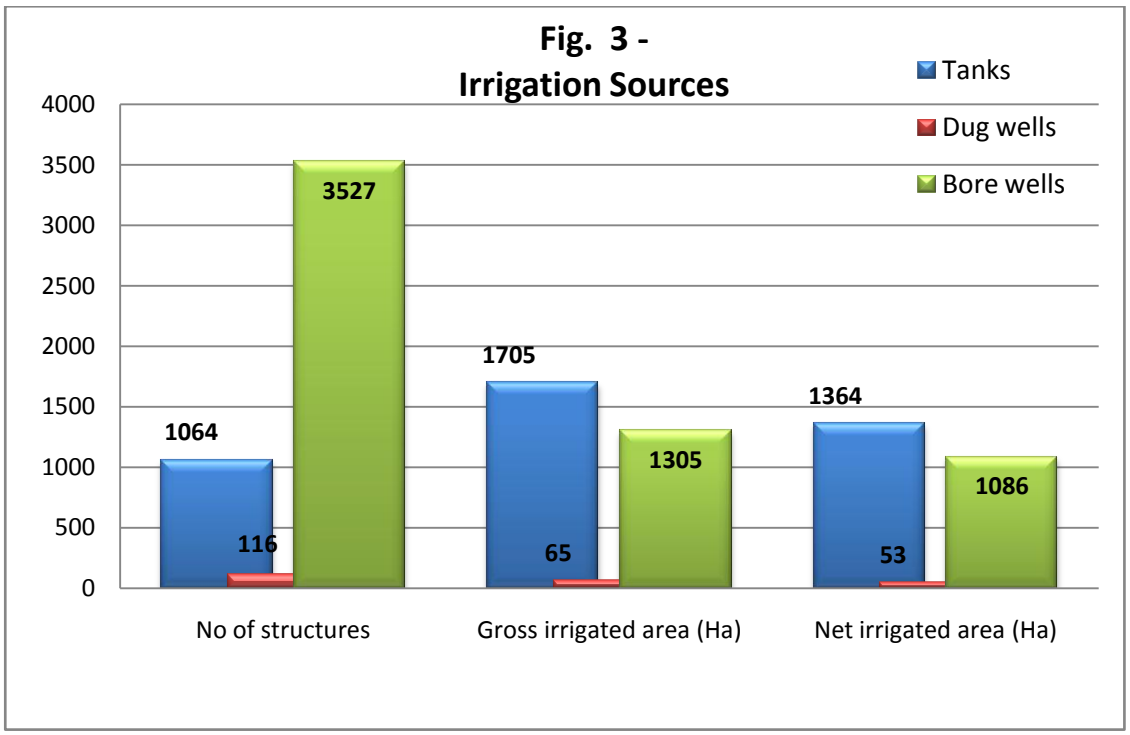


Fig.3. Irrigation source in Belur Taluk, Hassan district

1.5 Geomorphology, Physiography & Drainage

The general land elevation on the Northwestern side of the Taluk is about 1034 m amsl and 936 m amsl in the Southwestern side. The general slope is mostly towards South in western part of taluk and towards North in Eastern part of taluk **(Fig.-4).**

The Taluk is drained by 1st to 4th order streams and it fall in two sub-basins. Western half of taluk is draining into Hemavathi River that is flowing towards south wards, the tributary of Cauvery River and Eastern half of taluk is draining into Tunga-bhadra river which flow towards north wards, the tributary of Krishna River.The general drainage pattern is dendritic to sub-dendritic in nature**(Fig.-5).**

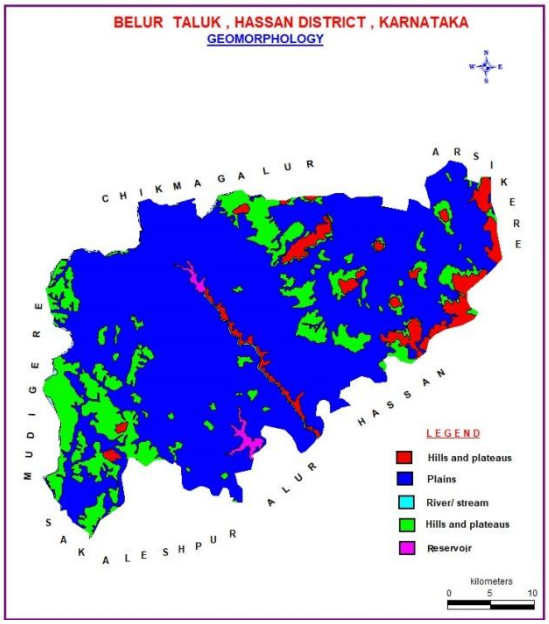


Fig.4. Geomorphology map

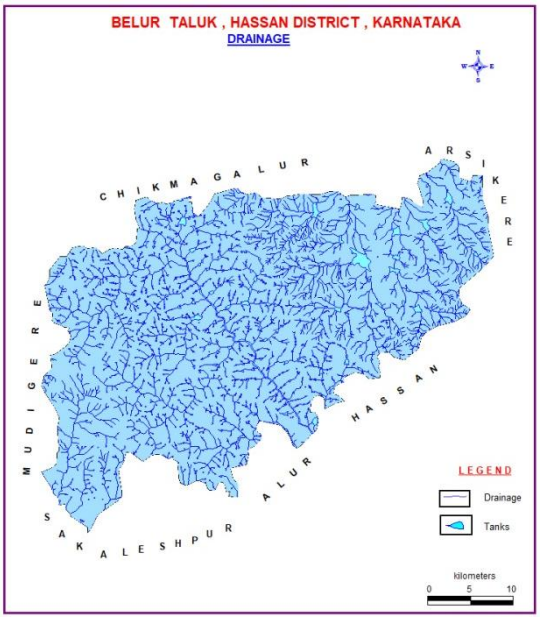


Fig.5. Drainage map

1.6 Soil

In general, the Taluk is covered by clay soil. Patches of loamy soil are also found at SW of taluk. The red soil in general derives from granite gneisses (**Fig.6).**

The land use map of the taluk is shown in **Fig.7.** Major part of the taluk is covered by agriculture activity.

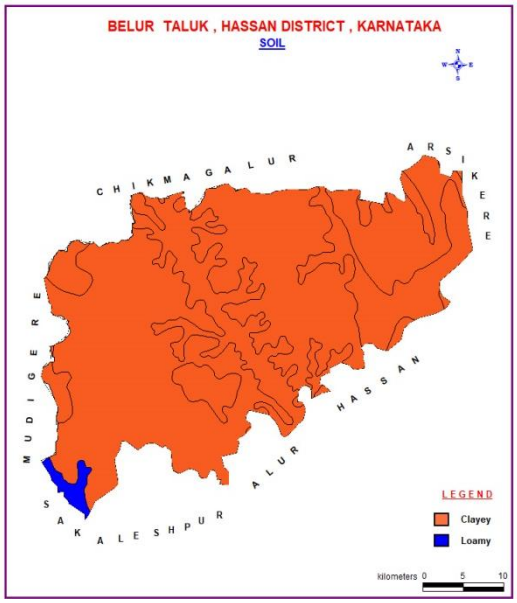


Fig-6: Soil Map

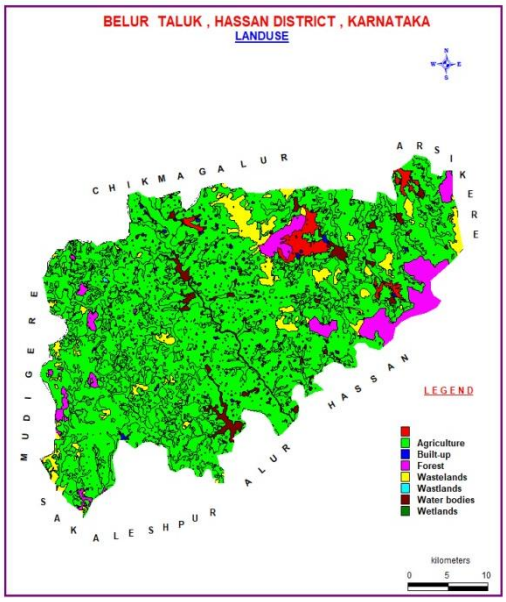


Fig-7: Land use Map

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**
BELUR	6319	Phreatic	Fractured (Down to 200m)	Dynamic + phreatic in-storage + fractured
		19978	1649	27946

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

- Net ground water availability for future irrigation development: 29.09MCM
- Domestic (Industrial sector) demand for next 25 years: 2.96 MCM

1.9 Water level behavior

(a) Depth to water level: The depth to water level data is shown in **Table.8**

Aquifer-I

- Pre-monsoon: 1.20-12.60 mbgl (**Fig.-8**).
- Post-monsoon: 0.60 – 7.30(**Fig.-9**).

Aquifer-II

- Pre-monsoon: 6.80-39.40 mbgl
- Post-monsoon: 2.60-13.00 mbgl

(b) Water level fluctuation

Aquifer-I

- Seasonal Fluctuation: Rise ranges 0.60 – 5.35 m.

Aquifer-II

- Seasonal Fluctuation: Rise ranges 3.00-26.4 m.

(c) Long-Term Water level trend: The data is shown in **Table.9**.

- Pre-monsoon: Falling ranges 0.0713-1.4976m
  Rising ranges 0 m
- Post-monsoon: Falling ranges 0.0324-1.4428m
  Rising ranges 0.2513-0.6148m

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	Arehalli	DW	1.20	0.60	4.15
2	Hagare	DW	4.60	2.51	0.60
3	Singapurpet	DW	12.14	7.12	2.09
4	Shettigere	DW	12.65	7.30	5.02
Aquifer-II					
5	Arehalli	BW	13.95	6.15	7.80
6	Hagare	BW	6.80	3.80	3.00
7	Halebeedu	BW	39.40	13.00	3.00
8	Nagenahalli	BW	20.20	9.90	26.40
9	Rayapura	BW	7.15	2.60	10.30
10	Shettigere	BW	13.05	8.50	4.55
11	Belur	BW	10.35	3.50	4.55
12	Arehalli	BW	9.60	5.90	6.85
13	Bikkodu	BW	8.05	3.90	3.70

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			
			Pre monsoon		Post monsoon	
			Fall	Rise	Fall	Rise
1	Arehalli	2011-2020		0.0609	1	
2	Belur Pz	2011-2020		0.2321		0.1391
3	Belur1	2011-2020		0.0713		0
4	Halebeedu	2011-2020		1.4976		1
5	Singapurpet	2011-2020		0.4762		0.0401

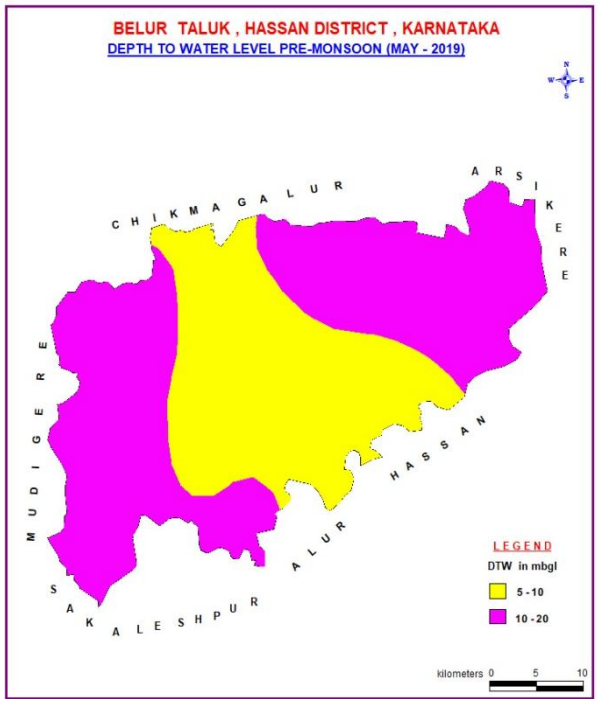


Fig-8: Pre-monsoon Depth to Water Level

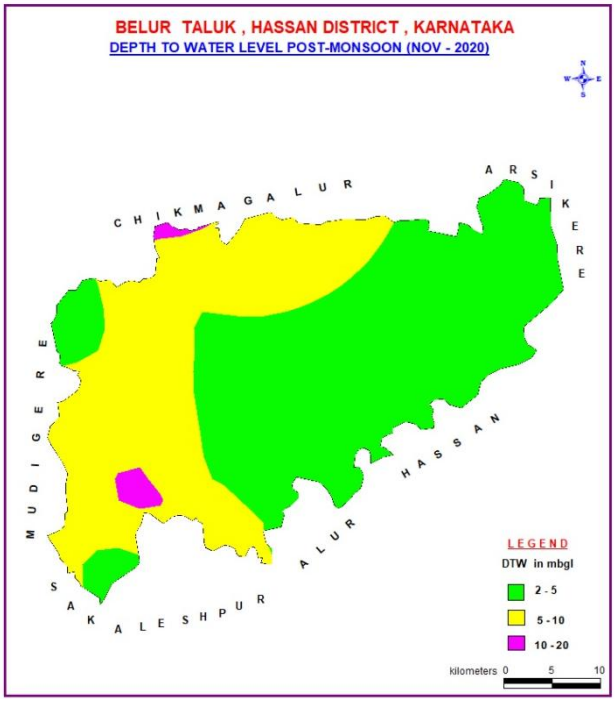


Fig-9: Post-monsoon Depth to Water Level

2 AQUIFER DISPOSITION

2.1 Number of aquifers

In BELUR taluk, there are mainly two types of aquifer systems

I. **Aquifer-I (Phreatic aquifer) Weathered Granite Gneiss**
II. **Aquifer-II (Fractured aquifer) Fractured Granite Gneiss**

In Belur Taluk, granitic-gneisses & schist are the main water bearing formations **(Figure-10)**. Ground water occurs within the weathered and fractured granitic-gneisses under water table condition and semi-confined condition. In the Taluk, bore wells were drilled from a minimum depth of 124 mbgl to a maximum of 263mbgl **(Table-10).** Depth of weathered zone (Aquifer-I) ranges from 9 mbgl to 41 mbgl **(Figure-11).** Ground water exploration

reveals that aquifer-II fractured formation was encountered between the depths of 6 to 262 mbgl. Yield ranges from 0.21 to 6 lps. Transmissivity ranges from 5 to 40 m^2/day.

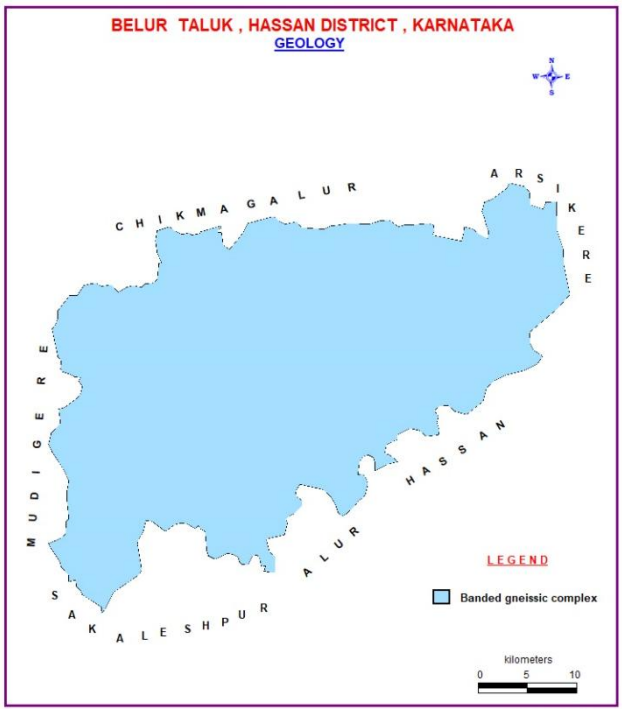


Fig.10. Geology map

Table-10: Details of Ground Water Exploration

Sl. No.	Location	Latitude & Longitude	Depth Drilled (mbgl)	Casing length (m)	Lithology	Fracture Zones (m)	SWL (mbgl)	Q (LPS)	DD (m)
1	Karagada EW	13.2306 75.8525	256	10.63	Granite gneiss	24.39, 26.39, 77.73, 79.73 , 83.35, 85.35, 255.19,256	0.73	6	43.49
2	Karagada OW	13.2306 75.8525	263	6.12	Granite gneiss	18.77,20.39,262.61, 263	4.15	nil	
3	Adaguru EW	13.1583 76.0600	200	24	Granite gneiss		5	1.19	31.88
4	Hebbalu EW	13.2000 75.9200	200	32	Gr,Gneiss	Nil		neg	
5	Ghattadahalli EW	13.2100 76.0400	200	20	Granite gneiss	22.92, 33.05	3.1	1.75	
6	Haledegere EW	13.1245 75.9054	165	31.5	Granite gneiss	45.20 - 46.80, 161.44 - 163.44			11.29
7	Haledegere OW	13.1245 75.9051	165	17.5	Granite gneiss	22.28 - 23.92, 71.76 - 73.76			7.19
8	MADIHALLI		180	41				0.21	13.63

	(BelurTq) EW								
9	BIKODU EW		65				2.88	4	11.405

Table-11: Basic characteristics of each aquifer

Aquifers	**Weathered Zone (Aq.-I)**	**Fractured Zone (Aq.-II)**
Prominent Lithology	Weathered Granite gneiss	Fractured Granite gneiss
Thickness range (mbgl)	41	Fractures upto 262 mbgl
Depth range of occurrence of fractures (mbgl)	-	6 - 262
Range of yield potential (lps)	80% between 50 - 263	
Specific Yield	Poor yield	<1 - 6
T (m^2/day)	2%	0.2%
Quality Suitability for Domestic &Irrigation	Suitable	Suitable

2.2 3-D aquifer disposition and Cross-Sections

2.2.1 Aquifer disposition – Rockworks output

Sub-surface aquifer disposition are prepared based upon the outcome of ground exploration programme. Mainly. Four zones are categorized namely Top soil, Weathered, Fractured and Massive zones. These zones are represented using rockworks to depict the subsurface sections and models and presented in **Fig.-11, Fig.-12 and Fig.13.**

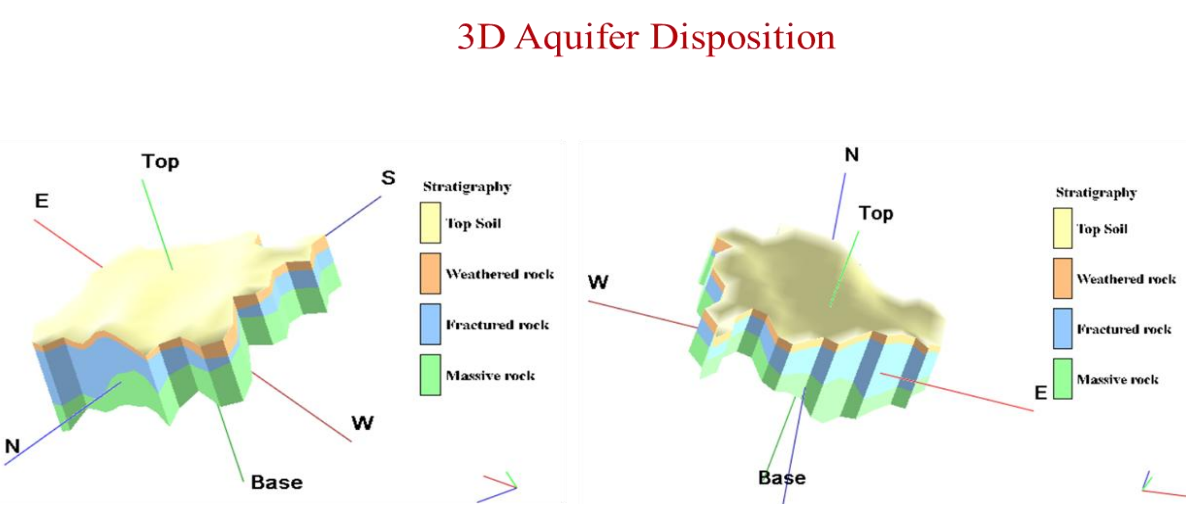


Fig-11: 3D Aquifer Disposition

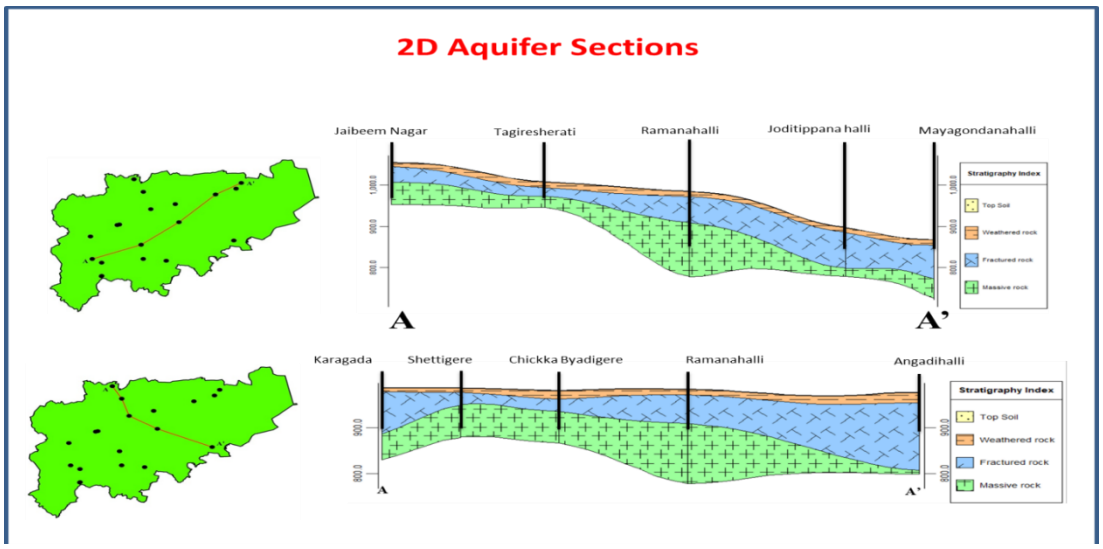


Fig-12: Cross sections in different directions

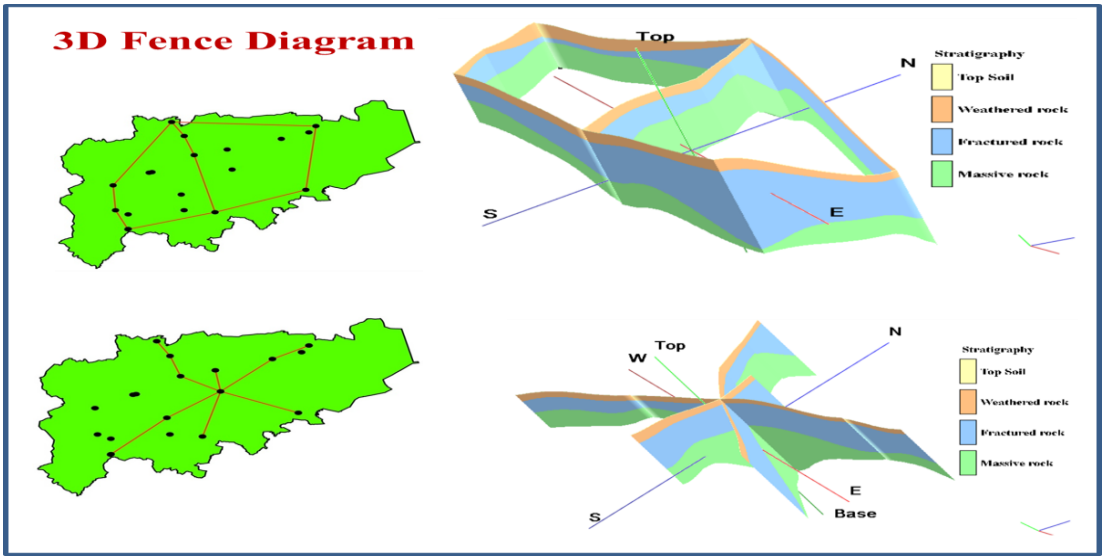


Fig-13: 3D Aquifer Fence Diagram

3 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

3.1 Aquifer wise resource availability and extraction

Table.12: Present Dynamic Ground Water Resource of Belur Taluk (2020)

Annual extractable ground water resources (ham)	Existing gross ground water draft for irrigation (ham)	Existing gross ground water draft for industrial water supply (ham)	Existing gross ground water draft for domestic water supply (ham)	Existing gross ground water extraction for all uses (ham)	Allocation for domestic and industrial use for next 25 years (ham)	Net ground water availability for future irrigation development (ham)	Existing stage of ground water extraction (%)	Category
6629.85	3902.20	0.00	304.05	4206.25	308.91	2636.23	63.44	safe

Table.13: Comparison of ground water availability and draft scenario in BELUR 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 (%)
	2017			**2020**		
BELUR	6319	4182	66.44	6630	4206	63.18

It is seen that the stage of ground water extraction is improved slightly in the taluk in comparison with 2017. However, with respect to 2017 estimations, there is an decrease of 3% in the stage of ground water development i.e.,66 to 63% though the taluk is categorized as "**Safe**".

3.2 Chemical quality of ground water and contamination

Interpretation from Chemical Analysis results in Belur Taluk is mentioned as underand the data is shown in **Table.14.**

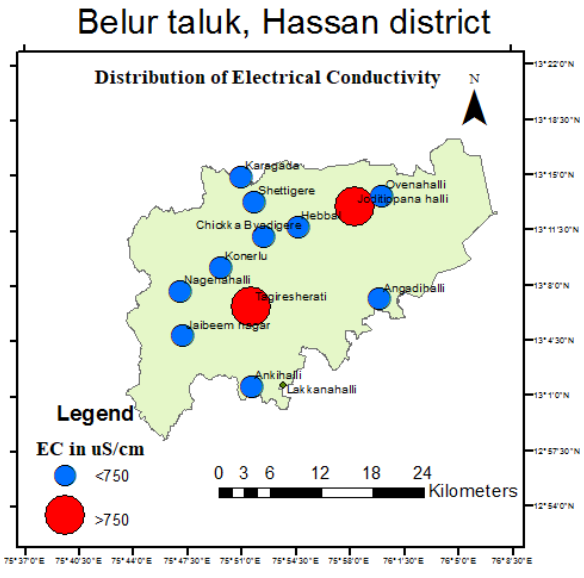
- **ELECTRICAL CONDUCTIVITY:** In general, EC values range from 224 to 830 µ/mhos/cm in the aquifer-I at 25^{o}C **(Fig.14).**
- **CHLORIDE:** Chloride concentration in ground water ranges between 17 and 108 mg/l in the aquifer-I**(Fig.15).**
- **NITRATE:** Nitrate concentration in ground water ranges from 0 and 128 mg/l in the Aquifer – I**(Fig.16).**
- **FLUORIDE:** Fluoride concentration in ground water ranges between 0.1 and 1.5 mg/l in the aquifer-I**(Fig.17).**

Table-14: Quality of ground water in BELUR TALUK of HASSAN DISTRICT

S. No.	Location	pH	EC (mg/L)	Cl (mg/L)	NO3 (mg/L)	F (mg/L)
Aquifer-I						
1.	Angadihalli	7.14	681	84	56	0.7
2.	Hebbal	6.83	638	56	74	0.1
3.	Joditippanahalli	7.15	1077	66	28	0.4
4.	ChickkaByadigere	7.35	648	56	66	0.4
5.	Shettigere	7.08	703	70	128	0.4
6.	Karagada	7.04	614	45	55	1.1
7.	Ovenahalli	6.17	354	49	46	0.2
8.	Konerlu	6.93	347	31	42	0.4
9.	Nagenahalli	7.08	278	17	2	0.7
10.	Jaibeemnagar	5.94	224	28	27	0.3
11.	Tagiresherati	7.14	788	108	42	1.5

12.	Lakkanahalli	6.819	540	64	3.35	0.1
13.	Ankihalli	6.278	500	92	0	0.6

In general, ground water quality in BELUR TALUK is good for drinking purpose except at 6 places where nitrate is found to be greater than the permissible limit as per “Indian Standard Drinking Water Specification 2012”. Ground water samples have also been tested and found suitable for agriculture & irrigation purposes in major part of the taluk, where EC is less than 750 µ/mhos/cm except at one place.



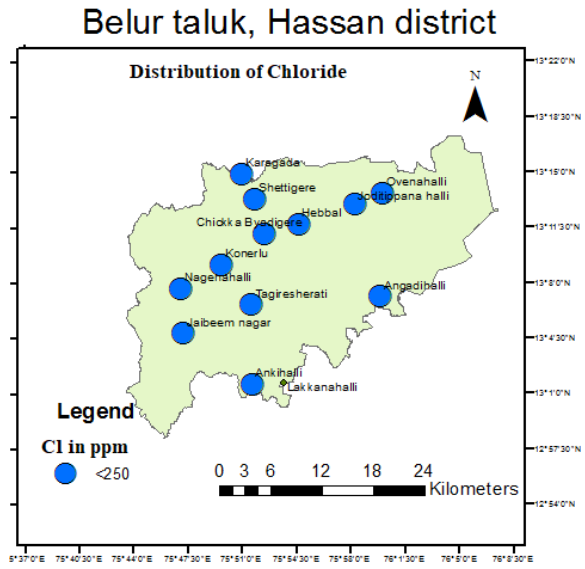
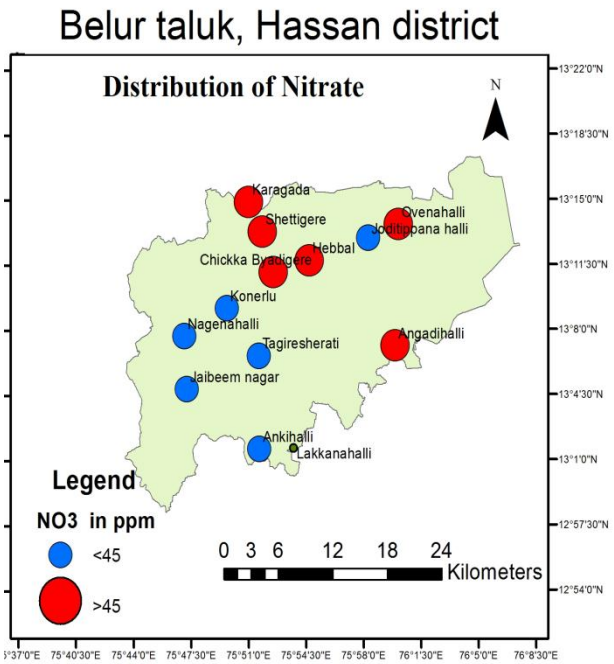


Fig-14 Distribution of Electrical Conductivity (Aq-I) **Fig-15 Distribution of Chloride (Aq-I)**



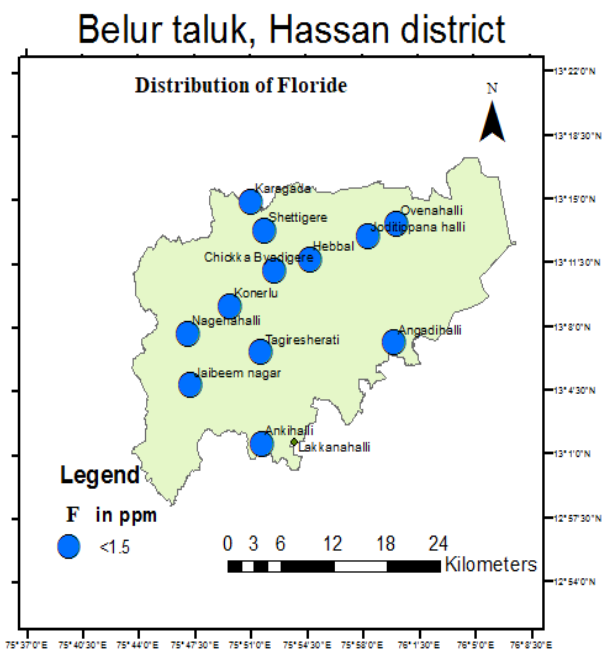


Fig-16 Distribution of Nitrate (Aq-I) **Fig-17 Distribution of Fluoride (Aq-I)**

4 GROUND WATERMANAGEMENT PLAN

4.1 Resource Enhancement by Supply Side Interventions

Recharge to dry **phreatic aquifer zone (Aq-I)** through construction of artificial recharge structures, viz; check dams, percolation tanks & Sub surface dyke (**Table-15**) is recommended. 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 are given in **Fig. 18.**

The entire area of Belur Talukis feasible for rechargei.e., 790 sq.km. and the surface surplus non-committed runoff availability is 79.383MCM, which is considered for planning of AR structures. For this, a total of 2 sub-surface dykes, 71 percolation tanksand 418 Check dams are proposed. The volume of water expected to be conserved/recharged @75% efficiency is 59.537MCM through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 56.55Cr. The additional area which can be brought under assured ground water irrigation will be about 7200 hectares. However, the figures given are tentative and pre-fieldstudies / DPR are recommended prior to implementation of these recharge structures.

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

Artificial Recharge Structures Proposed	**BELUR TALUK**
Area feasible for artificial recharge (sq.km)	**790**
Non committed monsoon runoff available (MCM)	79.383
Total no. of existing artificial recharge structures	491
Number of Check Dams	418
Number of Percolation Tanks	71
Number of Sub surface dyke	2
Tentative total cost of the project (Rs. in Cr)	56.55
Excepted recharge (MCM)	59.537
Additional irrigation potential (Hectares)	7200

Note: The numbers proposed are tentative and detailed feasibility studies are required in field to finalize the actual locations for the construction of AR structures.

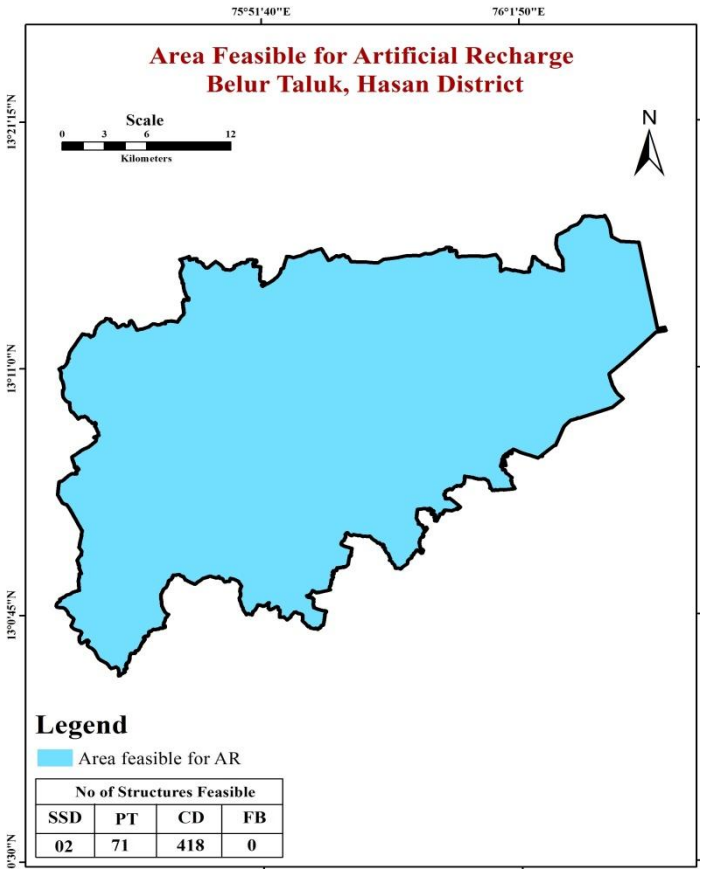


Fig. 18: Locations of Proposed Representative Artificial Recharge Structures

4.2 Resource Savings by Demand Side Interventions

4.2.1 Water Use Efficiency by Micro Irrigation Practices

It is observed that dug wells and bore wellscontribute32% of the source for irrigation in Belur Taluk. The water efficient methodology may be applied for growing paddy which is grown in 2495ha and is ground water dependent as compared to the other crops which are mainly grown during kharif. Initially, the micro irrigation techniques (drip) are proposed in 25% of paddy cultivated area of 2495 ha i.e., 624 ha. Considering the crop water requirement of 2.00 m and savings of 25% i.e., 0.50 m by drip irrigation, it will contribute in saving ground water by 1247 ham and thus will improve stage of development marginally. However, in long run the practice of Efficient irrigation techniques will add to the ground water resource in large extent. **(Table-16).**

Table 16: Improvement in GW availability (2020) due to savings by adopting water use efficiency

Annual Extractable GW Resource(Ham)	Total GW extraction for all uses	Stage of ground water extraction	Paddy Area proposed for WUE	Unit savings	Total Saving due to adopting WUE measures	Cumulative annual Extractable GW Resource	Expected improvement in stage of ground water extraction after the implementation of the project	Expected improvement in overall stage of ground water extraction
HAM	HAM	%	HA	M	HAM	HAM	%	%
6629.85	3902.20	63.44	624	0.50	311	6940	2.47	63.44 to 60.96

4.2.2 Change in cropping pattern

Water intensive crop like paddy are grown in 13% of total cropped area. At present, the stage of ground water extraction is also on lower side @ 63.44% (2020), thus change in cropping pattern has not been suggested.

4.3 Ground Water Development Plan

In Belur Taluk, the present stage of ground water extraction (2020) is merely 63.44 %, say 63% with net ground water availability for future use of 2636.23ham and total extraction of 4206.25ham. The ground water draft for irrigation purpose is estimated to be 3902.20 ham and there is further no scope for developing the resource for irrigation as a part of development with appropriate scientific backing.

4.4 Regulation and Control

BELUR Talukhas been categorizedas **"Safe".** However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority(KGWA) needs to be strictly implemented to avoid the taluk from safe category to semi critical or higher category in the future.

4.5 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 of deeper aquifer require remedial measures viz.
  - Alternate source
  - Removal technology

5 SUMMARY AND RECOMMENDATIONS

The main ground water issues are Low Ground Water Development, Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, Deeper Water Levels particularly in Aquifer-II in some parts, hilly and plateau areas which are all inter-related or inter dependent and Inferior Ground Water Quality due to fluoride contamination especially in deeper aquifer. The summary of ground water management plan of BELUR Talukis given in **Table-17.**

Table 17: Summary of Management plan of BELUR TALUK

Present stage of Ground water Extraction and Category as per GEC-2020(%)	63.44, Safe
Annual Extractable Ground Water Resources (ham)	6629.85
Existing Gross Ground Water Extraction for all uses	3902.20
Ground Water Resource Enhancement by Supply side Interventions	
Area Feasible for Artificial Recharge (ha)	79000

Expected additional recharge from monsoon surplus runoff (ham)		59537
Additional irrigation potential (Hectares)		7200
Ground Water Resource Savings by Demand side Interventions		
Paddy Area proposed for WUE (ha)		624
Expected Saving due to adopting WUE measures (ham)		311
Expected improvement in stage of ground water extraction after adopting WUE measures and implementation of the project (%)		63.44 to 60.96
Government to take initiatives to encourage at least 70% farmers to adopt water use efficiency irrigations practices like dip & sprinkler irrigation		-
Excess Nitrate concentration	In limited places especially in shallow aquifer 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	
Excess Fluoride concentration	In limited places especially in deeper aquifer Alternate source Removal technology	

As per the resource estimation – 2020, Belur Talukfalls under Safe category with the stage of ground water extraction is 63.44 %. However, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk in the coming days to avoid water crisis in the future. It is suggested to adopt ascientific and multi-pronged ground water management strategy covering supply side interventions, demand side interventions, ground water development interventions and ground water qualityprotection aspects as mentioned in the management plan suggested above

Ground water resource enhancement by supply side interventions: The surface surplus non-committed runoff availability is 79.383 MCM, which is considered for planning of AR structures. For this, a total of 2 sub-surface dykes, 71 percolation tank and 418 Check dams are proposed. The volume of water expected to be conserved/recharged @75% efficiency is 59.537 MCM through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 56.55 Cr. The additional area which can be brought under assured ground water irrigation will be about 7200 hectares. However, the figures given are tentative and pre-fieldstudies / DPR are recommended prior to implementation of these recharge structures.

Ground water resource enhancement by demand side interventions: It is observed that dug wells and bore wellscontribute33% of the source for irrigation in Belur Taluk. The water efficient methodology may be applied for growing paddy which is grown in 2495 ha and is ground water dependent as compared to the other crops which are mainly grown during kharif. Initially, the micro irrigation techniques (drip) are proposed in 25% of paddy cultivated area of 2495 ha i.e., 624 ha. Considering the crop water requirement of 2.00 m and savings of 25% i.e., 0.50 m by drip irrigation, it will contribute in saving ground water by 311 ham and thus will improve stage of development marginally.

Change in cropping pattern: Water intensive crop like paddy are grown in 9% of total cropped area. At present, the stage of ground water extraction is also on lower side @ 63.44% (2020), **thus change in cropping pattern has not been suggested**.

Ground Water Resource Development Plan: the present stage of ground water extraction (2020) is merely 63.44 %, say 63% with net ground water availability for future use of 6629.85ham and total extraction of 4206.25 ham. The ground water draft for irrigation purpose is estimated to be 3902.20

ham and there is no further scope for developing the resource for irrigation as a part of development with appropriate scientific backing.

Nitrate Contamination: Proper drainage of sewage and scientific disposal of sewage water by the concerned urban/rural agency needs to be adopted along withlimited usage of Nitrogenous fertilizersby farmers to avoid nitrate contamination. All the ground water sources for drinking water supply may be checked for ground water quality parameters as per BIS norms.

WUE in Domestic Sector: WUE practices are the prime management option in domestic sector as well in view of having high density clusters of urban households and establishments. In premium apartments and infrastructure projects, use of three-way line for fresh water, bathroom water and toilet water will enable reuse of grey water for gardening, car washing and flushes etc. The water saver fixtures/ aerators can be used for kitchen & bathroom pipes, bath showers and water free urinals.

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 deteriorating 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.