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

Belthangady Taluk, Dakshina Kannada District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

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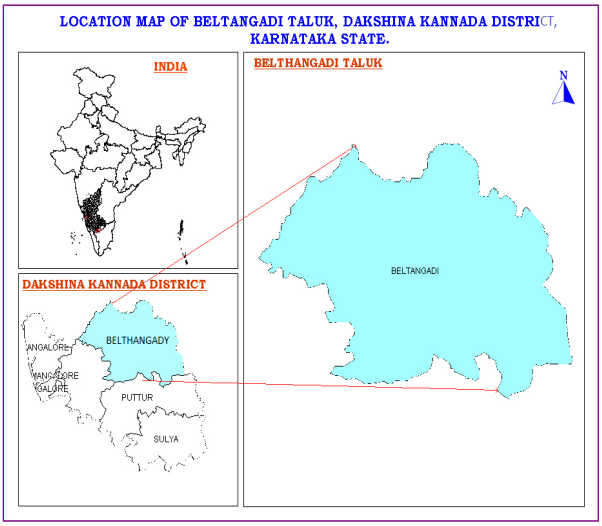
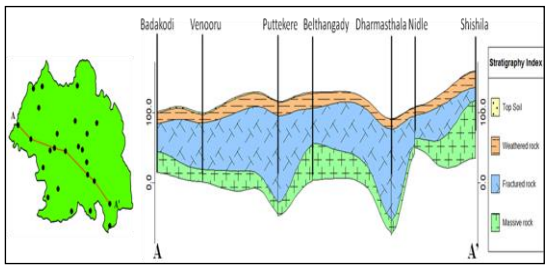
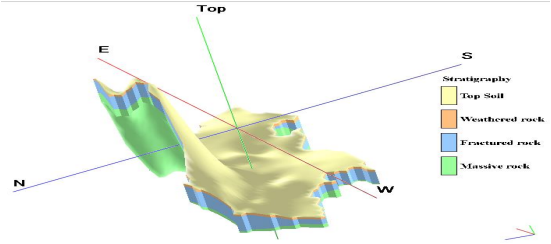
Bengaluru

AQUIFER MAPS AND MANAGEMENT PLAN, BELTHANGADY TALUK, DAKSHINA KANNADA DISTRICT, KARNATAKA STATE

(AAP: – 2022-2023)







By

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MAY 2023

AQUIFER MAPS AND MANAGEMENT PLAN, BELTHANGADY TALUK, DAKSHINA KANNADA DISTRICT, KARNATAKA STATE

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AQUIFER MANAGEMENT PLAN FOR BELTHANGADY TALUK, DAKSHINA KANNADA 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 the involvement of community for better groundwater governance.

Aquifer Mapping has been taken up in Belthangady taluk, Dakshina Kannada district with a view to formulate strategies for sustainable management plan for the aquifer system in accordance with the nature 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.

1.1 Objectives

The objectives of the aquifer mapping 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 hydrogeochemical 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 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 Belthangady taluk is as follows

- About 85% dependency on groundwater for irrigated agriculture
- Lack of surface water resources as alternate water sources
- Source Sustainability for drinking and irrigation, especially in lean periods
- Declining groundwater level trends in wells analyzed tapping phreatic aquifer during pre monsoon period.
- Contamination of Urban areas with municipal waste and sewage

1.4 Approach & Methodology

Integrated multi-disciplinary approach involving geological, geophysical, hydrological, hydrogeological and hydrogeochemical 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 geoelectrical layers with different resistivity have been interpreted in corroboration with the litho-stratigraphy of the observation wells and exploratory wells down to depths of 250 mbgl. Hydrological and Hydrometeorological 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 (GWD) observation wells, pinpointing exploratory sites for drilling through in-house, 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 FEATURES

Name of the Taluk	: Belthangady
District	: Dakshina Kannada
State	: Karnataka
Area	: 1375 sq.km
Population (Census 2011)	: 266589
Normal annual rainfall	: 4426 mm

2.1 Study area

Aquifer mapping studies have been carried out in Belthangady taluk, Dakshina Kannada district, Karnataka State under National Aquifer Mapping Project. Belthangady covering an area of 1387 sq.km and situated between latitudes 12°50'03”N - 13°11'09”N and longitudes 75°02'14”E - 75°33'06”E. The area is bounded on the north by Chikmagaluru district, on the south by Puttur and Kadaba taluks, on the east by the Hassan district and on the west by the Mudabidri and Bantwal taluks. The taluk has 03 hoblies, 48 Gram Panchayaths and 79 villages. Belthangady is the taluk headquarters.

The location map of the taluk is presented in **Fig.1**.

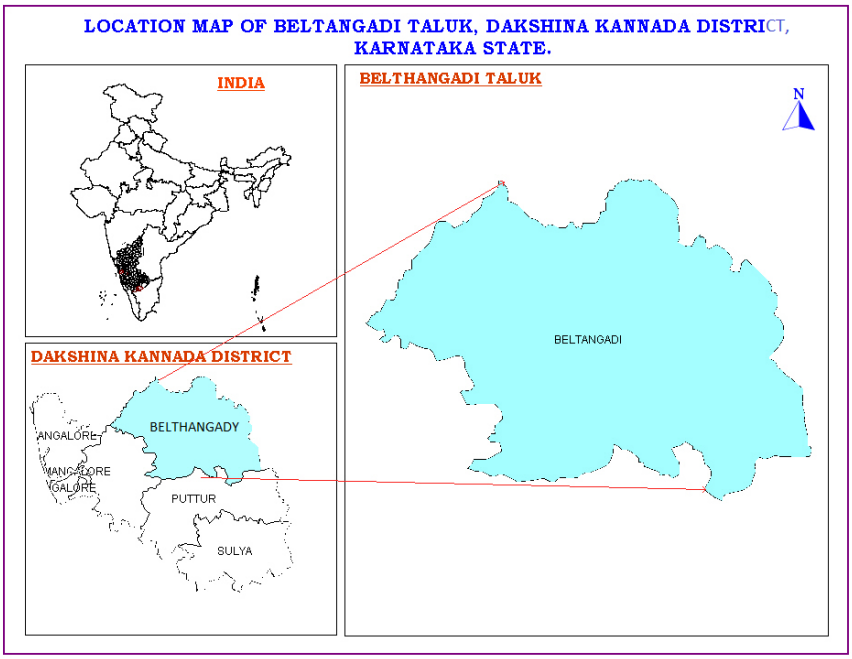

Fig.1: Location Map

2.2 Population

According to 2011 census, the human population in Belthangady taluk is 266589 out of which 6% constitutes the urban population and 94% constitutes the rural population. The taluk has an overall population density of 195 persons per sq.km. In the taluk, the decadal variation in population from 2001-2011 is 8.15%. The population details are given in **Table-1.**

Table-1: Population details

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
266589	131967	134622	12.76	251802	14787	8.15	-5.27	102.42

Source: District Statistical Report, 2018-19, Govt. of Karnataka

2.3 Rainfall and Climate

Belthangady taluk experiences semi-arid climate. The area falls under Coastal agro-climatic zone of Karnataka state and is categorized as drought prone in rabi season. The climate of the study area is quite agreeable and free from extremes. The year is usually divided into four seasons namely summer from March to May; rainy season or south-west monsoon season from June to September, post-monsoon season covering the months of October and November and dry or winter Season from December to February. Normal annual rainfall in the Taluk for the period 1961 to 2010 is 4426 mm. The rainfall data from 2017 to 2022 of the taluk is given in **Table.2.**

Table 2: Rainfall Data (2017 to 2022)

Year	Pre Monsoon														
	Jan			Feb			March			April			May		
	Normal (mm)	Actual (mm)	%DEP	Normal (mm)	Actual (mm)	%DEP	Normal (mm)	Actual (mm)	%DEP	Normal (mm)	Actual (mm)	%DEP	Normal (mm)	Actual (mm)	%DEP
2017	2.3	1.6	-31	0.5	0.1	-90	12.0	21.2	77	55.0	29.9	-46	168.9	195.3	16
2018	2.3	0.0	-100.0	0.5	0.3	-46.0	12	57	373	55	60	9	169	274	62
2019	2	0	-93	1	0	-98	12	1	-95	55	57	3	169	44	-74
2020	3	1	-82	2	0	-96	15	17	13	55	52	-5	152	162	7
2021	2.8	167.2	5871	2.3	11.1	383	15.0	9.0	-40	55.3	141.4	156	151.9	443.3	192
2022	2.8	0.3	-89	2.3	0.2	-91	15.0	41.5	177	55.3	100.9	82	152	283	87

Year	South West Monsoon											
	June			July			August			September		
	Normal (mm)	Actual (mm)	%DEP	Normal (mm)	Actual (mm)	%DEP	Normal (mm)	Actual (mm)	%DEP	Normal (mm)	Actual (mm)	%DEP
2017	947	924	-2	1429	778	-46	989	815	-18	362	398	10
2018	947	1271	34	1429	1299	-9	989	1347	36	362	90	-75
2019	947	482	-49	1429	987	-31	989	1402	42	362	707	96
2020	951	684	-28	1420	801	-44	1042	1154	11	391	779	99
2021	951.2	720.4	-24	1419.5	952.8	-33	1042	619	-41	391	435	11
2022	951.2	605.9	-36	1419.5	1810.0	28	1042.3	961.5	-8	391.0	428.4	10

Year	North East Monsoon									Annual Rainfall		
	October			November			December			(1st January to 31st December)		
	Normal (mm)	Actual (mm)	%DEP	Normal (mm)	Actual (mm)	%DEP	Normal (mm)	Actual (mm)	%DEP	Normal (mm)	Actual (mm)	%DEP
2017	274	373	36	85	32	-62	15	1	-95	4339	3569	-18
2018	274	320	17	85	25	-70	15	10	-32	4339	4753	10
2019	274	625	129	85	102	20	15	24	58	4339	4430	2
2020	285	498	75	94	103	10	17	8	-52	4426	4260	-4
2021	285	531	87	94	381	307	17	16	-7	4426	4427	0
2022	284.7	255.2	-10	93.8	116.5	24	17	39	134	4426.4	4642.6	5

2.4 Agriculture & Irrigation

Agriculture is the main occupation in Belthangady taluk. Major Kharif crop is Paddy. Important crops of Rabi season are vegetables and oilseeds **(Table-3)**. Coconuts grown in 19% and oil seeds in 0.02% of total crop area in the taluk. Pulses are grown in 0.01% and fruits in 2.9% of the total area. Short duration crop vegetable is grown only in 4 Ha (0.01%) of the crop area which requires ground water during post monsoon season especially during summer.

Table-3: Cropping pattern 2018-2019 (Ha)

Crop	Paddy	Maize	Bajra	Jowar	Pulses	Fruits	Vege tables	Oil seeds	Sugar cane	Arecanuts	Coconuts	Total crop
Area(ha)	2223	0	0	1	4	967	4	7	0	24054	6378	33638
Area %	6.6	0	0	0.002	0.01	2.9	0.01	0.02	0	71.5	19	100

Source: District Statistical Report, 2019-20, Govt. of Karnataka

About 36.2% of the geographical area is covered by forest. It is observed that net sown area accounts for 31.9% and area sown more than once is 0.3% of total geographical area in Belthangady taluk. Area not available for cultivation, the other uncultivable land and fallow land cover are 22.9%, 7.6% and 1.4% respectively of total geographical area. About 42.5% of net area irrigated is from wells, 43.6% are from bore/tube wells and 86% of irrigation is from ground water. Thus major source of irrigation is groundwater **(Fig.2)**. The details of land use and the details of Irrigation are given in **Table 4 and 5** respectively. The land use pattern is given in **Fig.3**.

Table-4: Details of land use 2019-2020 (Ha)

Total Geographical Area	Area under Forest	Area not available for cultivation	Other uncultivable land	Fallow land	Net sown area	Area sown more than once	Gross sown area
137510	49837	31403	10519	1894	43857	387	44244
% of the area	36.2	22.9	7.6	1.4	31.9	0.3	32.2

Source: District Statistical Report, 2019-20, Govt. of Karnataka

Table-5: Details of Irrigation

Source of Irrigation	Length in Km/No of structures	Gross area Irrigated (Ha)	Net area Irrigated (Ha.)	% of area
Canals	0	0	0	0
Tanks	4	0	0	0
Wells	6717	14067	13972	42.5
Tube/Bore wells	1481	14468	14336	43.6
Lift Irrigation	1	8	8	0.02
Other Sources		4717	4557	13.88
Total		33260	32873	100

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

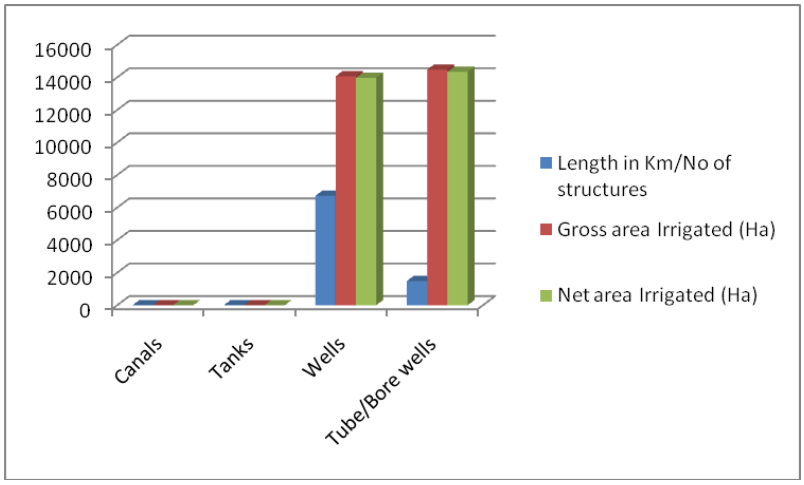

Fig.2:Sources of Irrigation

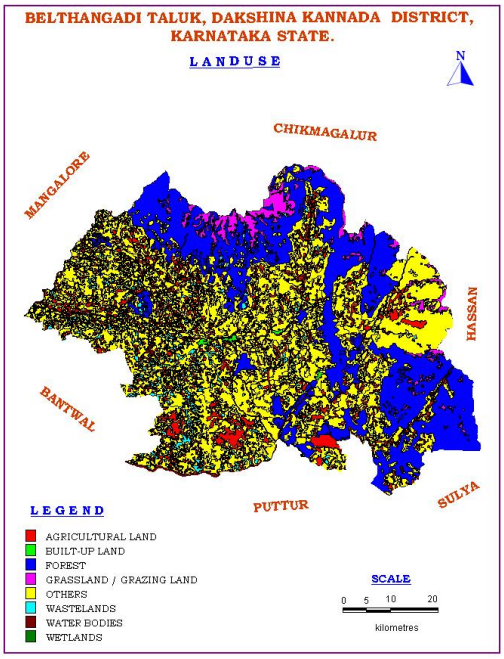

Fig. 3: Land use/land cover map

2.5 Geomorphology, Physiography & Drainage

The Taluk is categorised as Upland Pediplain **(Fig.4).** Physiographically, it can be divided into three physiographic units viz., hills and plateau, piedmont zones and pediplains. The northern and eastern part of the Taluk is hilly with thick forest cover which forms part of the Western Ghats. The hillsof the area range in elevation from 1200 to 1500 m above mean sea level. The ground surface is flat, gently sloping forming broad valleys and flat-topped hills. The Taluk is mainly drained by Kumaradhara River flowing in North-West direction. This river joins Nethravathi River at Uppinagadi village. Drainage pattern is dendritic to semi dendritic **(Fig.5)**.

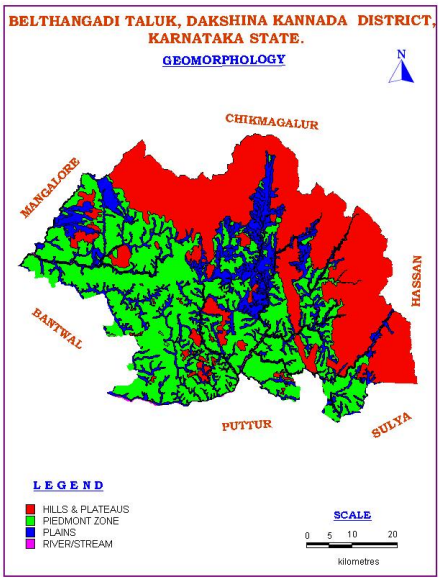

Fig. 4: Geomorphology map

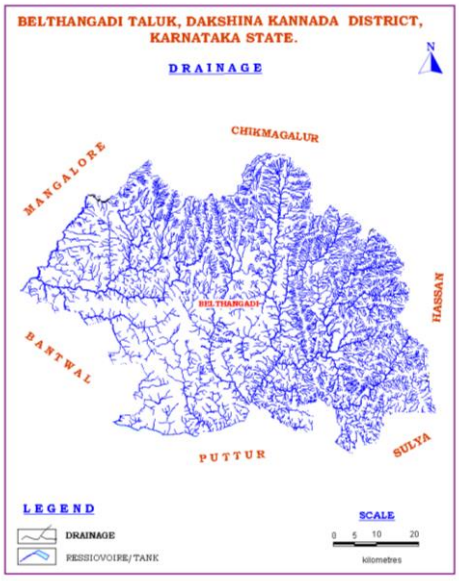

Fig. 5: Drainage map

2.6 Soil

Soils play a major role in hydrologic control of the infiltrating water. Soils are generally classified by taking their color, texture, fertilities and chemical combinations includes salts, minerals and the solution effect over them. The taluk comprises of mainly of two soil types namely Clayey soil and Clayey skeletal soil. Most of the area consists of clayey soils. Clayey skeletal soil is noticed in Eastern parts of the taluk **(Fig.6).**

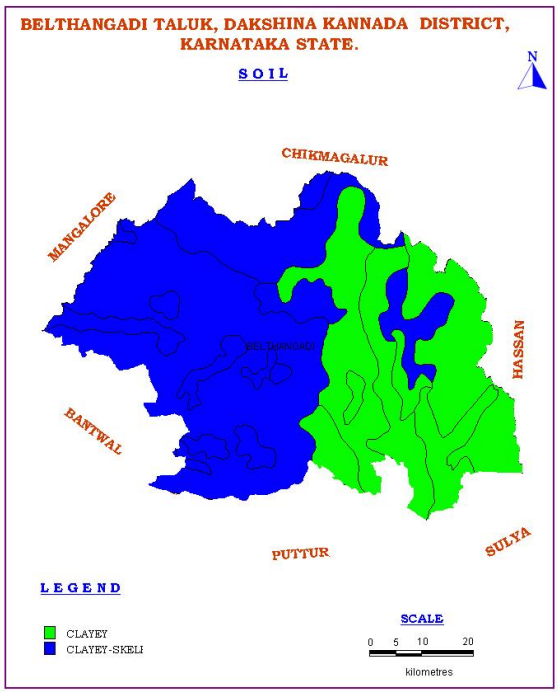

Fig. 6: Soil map

2.7 Ground water resource availability and extraction

As per the ground water resource estimation 2017 & 2020 (**Table 6**), the data on ground water resources shows that the net annual ground water availability is 8869 & 13871 ham respectively. The existing gross groundwater for irrigation is 5062 and 5718 ham. The stage of groundwater development is 65% & 46.7% and falling under 'Safe' category.

Table.6 Dynamic Ground Water Resource (2017 & 2020, in Ham)

Year	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross GW 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 Develop-ment	Existing Stage of Ground Water Development	Category
2017	8869	5062	701	5763	755	3052	65	SAFE
2020	13871.17	5717.85	760.78	6478.63	806.4	7346.91	46.71	SAFE

2.8 Existing and future water demands (as per GWRA-2017, 2020 and 2022)

As per the GWRA 2017 and 2020, the net ground water availability is 8869 & 13871 ham and the total ground water draft for all uses is 5763 & 6479 ham with stage of development at 65% & 46.7% and the taluk falls in Safe category. There is a scope for future irrigation development @ 7347 ham (2020). The domestic (Industrial sector) demand for next 25 years is estimated at 755 & 806 ham.

The details of dynamic ground water resources as on 2022 is shown in **Table-7**. It is observed that the stage of ground water extraction is slightly gone down in the taluk from 65% (2017) to 46.71% (2020) to 43.44 (2022) with an increase in the net ground water availability during 2022 with a figure of 16269.11 ham.

Table.7 Details of Dynamic Ground Water resource (as on 2022)

Annual Extractable GW Resource (Ham)	GW Extraction for Irrigation 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-Exploited/ Critical/ Semi-critical/ Safe/Saline)
16269.11	6486.2	2.57	579	7067.82	602.88	9177.45	43.44	Safe

2.9 Water level behavior

The water level data have been monitored from the representative dug wells and borewells under NHS monitoring programme for both pre and post monsoon seasons during 2022 in Aquifer I and Aquifer II. The depth to water level data is shown in **Table.8 (CGWB)** and **Table. 9 (SGWD)** for both Aquifer-I (Phreatic) and Aquifer-II (Fractured) respectively.

(a) Depth to water level :-

Aquifer I:

The water level data pertaining to the period of May 2022 (pre monsoon) and November 2022 (Postmonsoon) was used for the preparation of depth to water level map of the taluk.

The depth to water level during May 2022 is varied from 3.25 to 10.85 mbgl **(Fig.7)**. Major part of the taluk shows water level in the range of 5 to 10 mbgl. Small patch recorded water level in the range of 10 to 20 mbgl and found in southern portion of the taluk. Water level ranging 2 to 5 mbgl is observed in the north eastern part of the taluk.

The depth to water level during November 2022 is varied from 2.6 to 9.08 mbgl **(Fig.8).** Half of the portion of the taluk shows water level in the range of 2 to 5 mbgl and other half of the taluk shows water level in the range of 5 to 10 mbgl. Almost distributed equally in the taluk.

Aquifer II:

The depth to water level during May 2022 is varied from 6.09 to 43.52 mbgl **(Fig.14)**. Major part of the taluk shows water level >40 mbgl in the eastern part of the taluk. Water level of 5-10, 10-20 and 20-30 mbgl is almost equally distributed in the taluk.

The depth to water level during November 2022 is varied from 4.37 to 39.32 mbgl **(Fig.15).** Majority of the taluk shows water level in the range of 20-40 mbgl in the eastern part of the taluk and small portion shows wl in the range of 10-20 mbgl in the middle part of the taluk.

(b) Seasonal water level fluctuation:-

Aquifer I:

The seasonal water level fluctuation is the difference of pre and post monsoon water level data of wells. The rise in water level ranges from 0.3 to 3.05 mbgl **(Fig.9).** The fall in water level ranges from -0.25 to -0.14.

Aquifer II:

The rise in water level ranges from 0.4 to 4.5 mbgl **(Fig.16).** There is no fall in water level and majority of the taluk shows rises >4 mbgl in the northern part of the taluk.

(c) Decadal water level and fluctuation:

During premonsoon, the decadal average water level ranges from 5 to 12.3 mbgl **(Fig.10)** and majority of the taluk shows water level in the range of 5 to 10 mbgl and 15% of the taluks shows in the range of 10 to 20 mbgl. The fluctuation map **(Fig.12)** shows the rise in water level ranges from 0.1 to 1.9 mbgl & the fall in only one well that shows -1.1 mbgl.

During postmonsoon it varies from 2.19 to 8.98 mbgl **(Fig.11)** and majority of the taluk shows water level in the range of 2 to 5 mbgl and 35% of the taluks shows in the range of 5 to 10 mbgl. The fluctuation map **(Fig.13)** shows the rise in water level ranges from 0.4 to 0.82 mbgl & the fall ranges from -3.5 to -0.1 mbgl.

Table 8: Depth to Water Level Data Pre-monsoon & Post-Monsoon,CGWB,SWR, Bangalore

Sr. No	Village	Type of Well	Depth of the Well (mbgl)	Pre-monsoon Depth to water Level (May 2022) (mbgl)	Post-monsoon Depth to water Level (November 2022) (mbgl)	Seasonal Depth to Water level Fluctuation (meter)
Aquifer-I (Phreatic Aquifer)						
1	Adantadka	Dug Well	13.0	7.40	7.54	-0.14
2	Alandangadi	Dug Well	13.0	7.4	4.85	2.55
3	Badanaje Macharu	Dug Well	14.0	10.85	7.8	3.05
4	Ballalu	Dug Well	13.0	7.12	6.38	0.74
5	Belthangadi1	Dug Well	50.0	6.76	5.2	1.56
6	Kokkada	Dug Well	11.0	7.01	5.52	1.49
7	Kukeadi	Dug Well	12.2	6.95	5.9	1.05
8	Nidigal	Dug Well	16.0	4.93	4.6	0.33
9	Nidle	Dug Well	10.9	10.71	9.08	1.63
10	Padangadi	Dug Well	15.0	9.57	8.1	1.47
11	Surya	Dug Well	11.7	3.82	2.6	1.22
12	Ujire	Dug Well	13.0	3.25	2.9	0.35
13	Venur	Dug Well	11.0	9.46	7.58	1.88
Aquifer-II (Fractured Aquifer)						
14	Belthangadi	Borewell	50.0	6.86	4.37	2.49

Table 9: Depth to Water Level Data Pre-Monsoon & Post-Monsoon, SGWD, Bangalore

Sl. No	Village	Type of Well	Depth of the Well (mbgl)	Pre-monsoon Depth to water Level (May 2022) (mbgl)	Post-monsoon Depth to water (November 2022) (mbgl)	Seasonal Water level Fluctuation (meter)
Aquifer-I						
1	B.Karandur	Dug Well	8.56	5.2	4.45	0.75
2	Mundaje	Dug Well	9.5	5.99	5.04	0.95
3	Naravi	Dug Well	8.7	5.2	5.15	0.05
4	Punjalkatte	Dug Well	8.59	5.24	5.19	0.05
5	Ujire	Dug Well	11	7.73	7.08	0.65
6	Uruvalu	Dug Well	9.6	6.15	6.4	-0.25
7	Venoor	Dug Well	12.6	7.55	7.8	-0.25
Aquifer-II						
8	Naravi	Borewell	72	11.22	6.72	4.5
9	Ujire	Borewell	66	43.52	39.32	4.2
10	Uruvalu	Borewell	90	6.09	5.69	0.4
11	Belthangady	Borewell	90	15.65	15	0.65

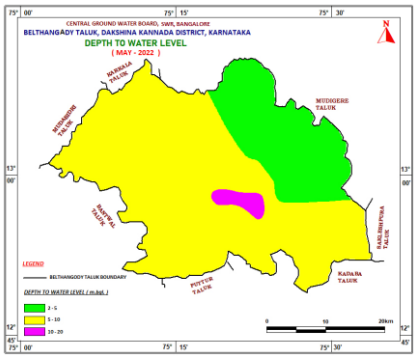

Fig.7: Pre-monsoon Depth to Water Level (Phreatic Aquifer)

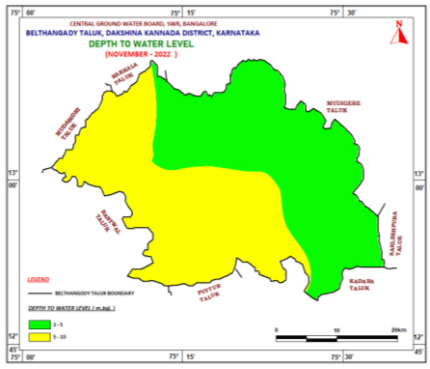

Fig.8: Post-monsoon Depth to Water Level (Phreatic Aquifer)

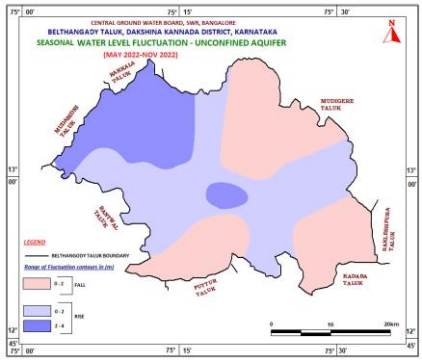

Fig.9: Seasonal Water Level Fluctuation (Phreatic Aquifer)

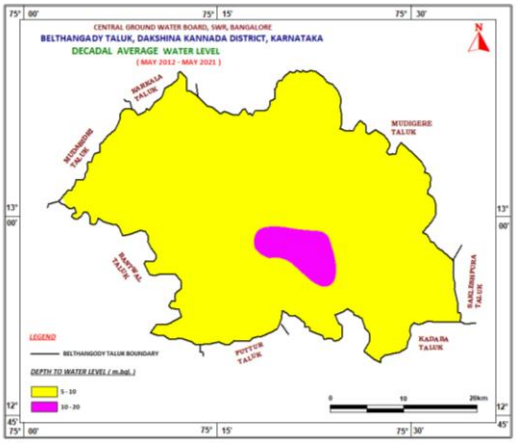

Fig.10: Decadal avg water level (Pre) (Phreatic Aquifer)

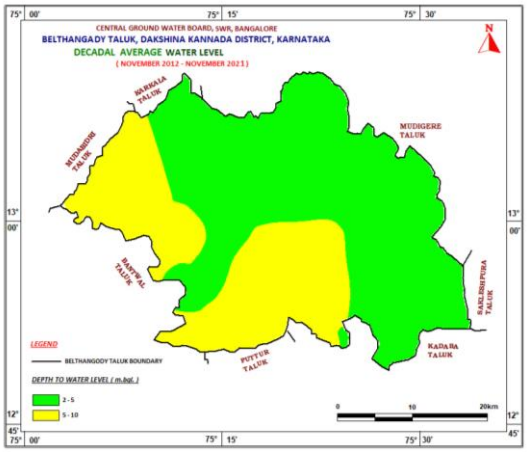

Fig.11: Decadal avg water level (Post) (Phreatic Aquifer)

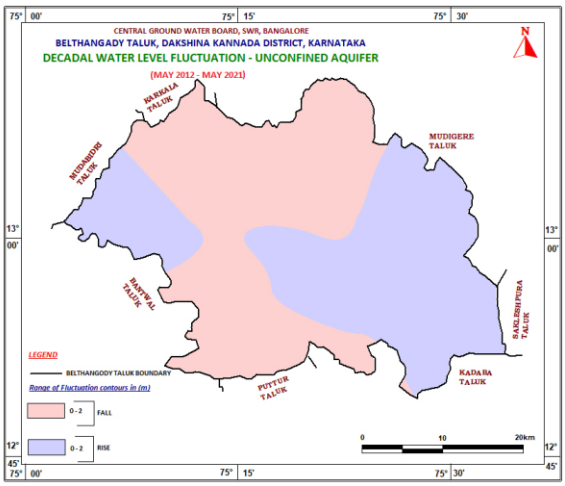

Fig.12: Decadal avg water level fluc (Pre) (Phreatic Aquifer)

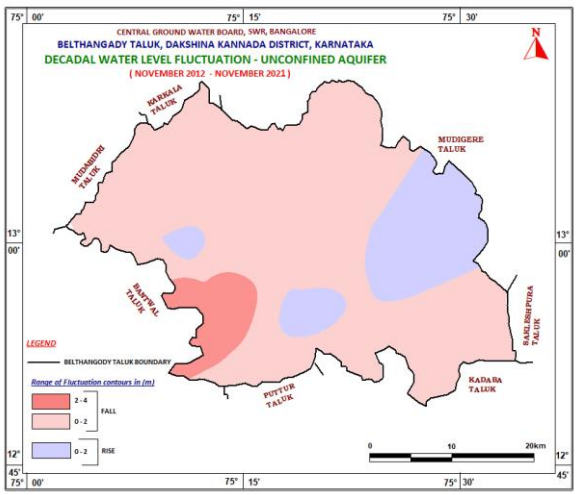

Fig.13: Decadal avg water level fluc (Post) (Phreatic Aquifer)

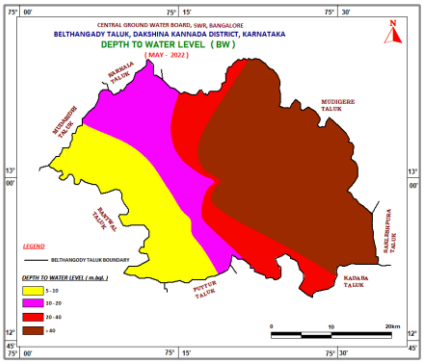

Fig.14: Pre-monsoon Depth to Water Level (Fractured Aquifer)

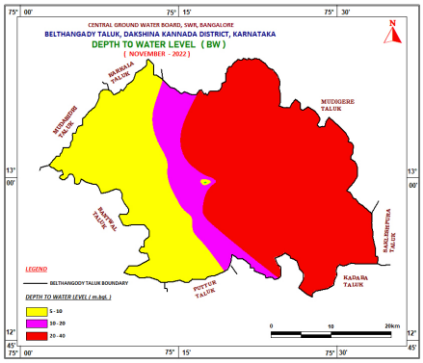

Fig.15: Post-monsoon Depth to Water Level (Fractured Aquifer)

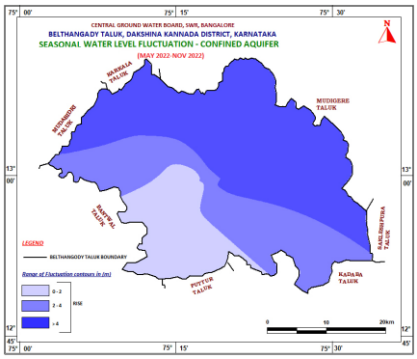

Fig.16: Seasonal wl fluctuation (Fractured Aquifer)

3. AQUIFER DISPOSITION

The occurrence and movement of water in the subsurface is broadly governed by geological frameworks i.e., nature of rock formations including their porosity (primary and secondary) and permeability. The principal aquifer in the area is Banded Gneissic Complex and the occurrence and movement of ground water in these rocks is controlled by various factors and it primarily depends on the degree of interconnection of secondary pores/voids developed by fracturing and weathering in the hard rock.

3.1. Aquifer Types

In Belthangady Taluk, there are mainly two types of aquifer systems

- **Aquifer-I (Phreatic aquifer)** comprising Weathered Banded Gneissic Complex
- **Aquifer-II (Fractured aquifer)** comprising Fractured Banded Gneissic Complex

In the taluk, Banded gneissic complex occupies major part of the taluk area and Schist & Laterite formation noticed as an isolated pocket (**Fig-17)**. Ground water occurs within the weathered and fractured gneisses and schist under water table condition and semi-confined condition. In the Taluk, bore wells were drilled from a minimum depth of 20 mbgl to a maximum of 260 mbgl. Depth of weathered zone (Aquifer-I) ranges from 2 mbgl to 20 mbgl. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depths of 25 to 256 mbgl. Fractured gneissic complex is the major water bearing formation **(Fig-18).** The yield of this aquifer unit II ranges from 0.4 to 7.7 lps. In general ground water in fractured aquifer is potable.

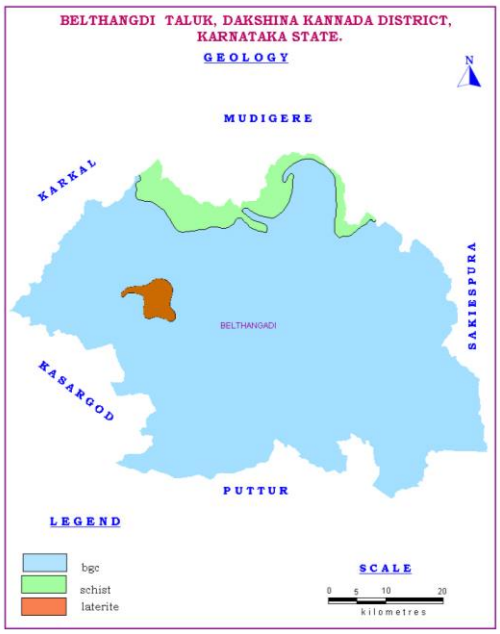

Fig.17: Geology Map

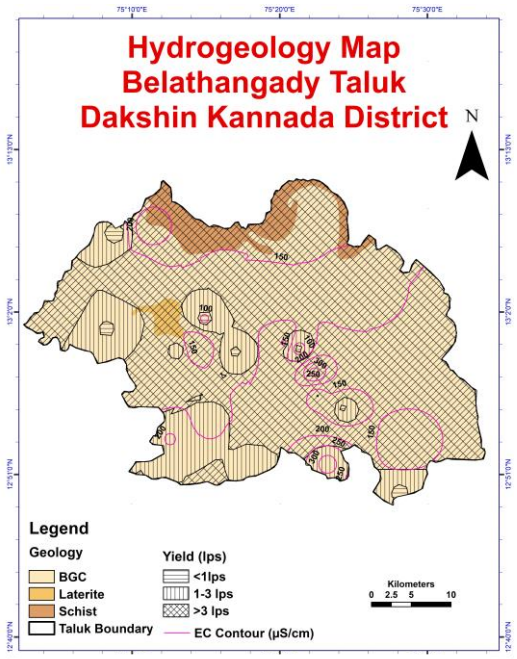

Fig.18: Hydrogeology map

3.1.1 Depth wise Aquifer System

The data generated from ground water monitoring wells, micro level hydrogeological inventories, exploratory and observation wells, various thematic layers was utilized to decipher the aquifer disposition of the area. In the Taluk, if we consider the vertical distribution of aquifer, two types of aquifer system are observed i.e., Aquifer – I which is a shallow phreatic aquifer and Aquifer – II which constitutes the deeper fractured aquifer.

a) Aquifer-I (Shallow Phreatic aquifer)

Aquifer – I comprises of Laterite, schist and weathered Banded Gneissic Complex. The spatial distribution of depth of occurrence and aquifer thickness of Aquifer-I is depicted in **Fig. 19a**. It indicates that the depth of occurrence of aquifer – I ranges from 8 to 76 m bgl.

However, it mainly occurs in the depth range of 8 to 40 m bgl covering 90% of the area in all the part of the Taluk. The depth of occurrence of 40 to 60 m bgl is observed in about 7% of area mainly in eastern and western parts of the Taluk. The deeper depth of occurrence of 60 to 76 m bgl is observed in about 3% of the area mostly in north-eastern part. The perusal of the map for aquifer thickness indicates that it ranges from 0.5 to 20 m, however aquifer thickness of 0.5 to 5 m is observed in about 60% of the area covering eastern and western parts of the taluk. The aquifer thickness of 5 to 10 m is observed in 30% of the areas covering western and southern parts. The thickness of 10-15 & 15-20 m is observed in North western part of the taluk covering an area of 10% and distributed equally i.e., 5% each.

b) Aquifer-II (Deeper Fractured aquifer)

It comprises of fractured Banded Gneissic Complex and Schistose rock. The spatial distribution of depth of occurrence and aquifer thickness of Aquifer-II is depicted in **Fig. 19b**. It indicates that the depth of occurrence of aquifer – II ranges from 28 to 230 m bgl. However, it mainly occurs in the depth range of 60 to 100 m bgl covering 50% of the area mainly in southern parts of the taluk. The depth of occurrence of 28 to 60 m bgl is observed in about 10% of area in southern parts. The depth of occurrence of 100 to 150 m bgl is observed in 30% in north-western & central parts of the taluk. The deeper depth of occurrence of 150-200 & 200-230 m bgl is observed in about 8% & 2% of area respectively in north-western & south-eastern parts of the taluk. The perusal of the map for fractured aquifer thickness indicates that it ranges from 1.5 to 23 m, however aquifer thickness of 1.5 to 10 m is observed in about 70% of the area covering throughout the taluk. The aquifer thickness of 10 to 15 m is observed in 20% of the area covering north-western & south-eastern parts. 15 to 20 m thickness is observed in 8% of the area in north-western & south-eastern parts of the taluk. The higher fractured aquifer thickness of 20 to 23 m is observed only in 2% area in isolated patches in south-eastern part of the taluk.

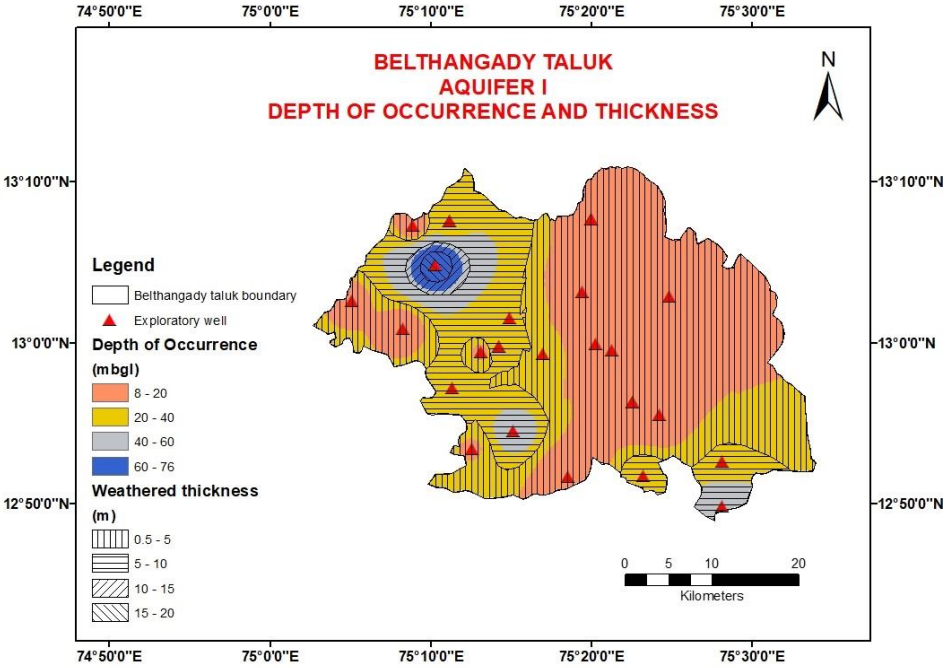

Fig.19a: Depth of Occurrence & Thickness map (Aq-I)

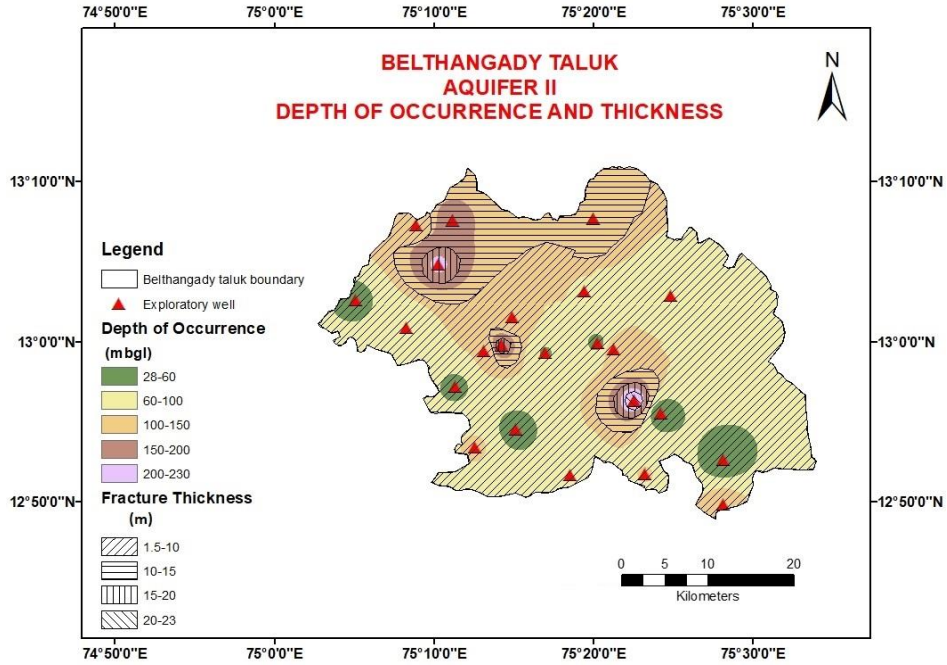

Fig.19b: Depth of Occurrence & Thickness map (Aq-II)

Table.10a: Details of Groundwater Exploration in Belthangady Taluk

Sl. No	Location	Long	Lat	Depth (mbgl)	Casing	SWL (mbgl)	Q (lps)
1	DHARMASTHALA EW	75.3758	12.9386	165.17	16.030	9.75	19.9
2	DHARMASTHALA OW	75.3758	12.9386	256.61	15.810	5.21	7.3
3	KOKKADA EW	75.3722	12.9653	26.83		12.9	4.32
4	KOKKADA OW	75.3722	12.9653	23.5		13.4	3.92
6	KUTLUR OW	75.1861	13.1264	150	20	14.6	5.5
7	KUTLUR EW	75.1861	13.1264	200	20	13.42	5
8	MUNDAJE EW	75.0333	13.3833	20.68		21.61	4.23
9	MUNDAJE OW	75.0333	13.3833	20.68		19.97	1.28
10	PUTTEKERE OW	75.2375	12.9958	158	19.94	12.7	9.5
11	PUTTEKERE EW	75.2375	12.9958	200	19.94	12.36	5.5
12	UJIRE OW	75.3333	13.1278	200	15.84	10.6	4.35
13	UJIRE EW	75.3333	13.1278	160	16.03	8.95	14.8

Table 10b: Well Inventory Data, Belthangady Taluk

Sl.No	Location	Long	Lat	Depth (m bgl)	Casing (m)	SWL (mbgl)	Yield (lps)
1	NARAVI	75.1485	13.1218	152	13	6.7	0.4
2	KOKRADI	75.1715	13.0807	210	76	8.2	4.4
3	VENOORU	75.1383	13.0146	92	12	7.9	0.78
4	BADAKODI	75.0847	13.0439	82	16	7.5	4.4
5	MADANTYARU	75.1893	12.9537	137	24	8.6	4.4
6	PUTHILA	75.2098	12.8904	122	18	7.9	2.15
7	MOGRU	75.3088	12.8612	146	8	8.1	2.15
8	KANIYOORU	75.2524	12.9086	61	36	6.5	2.15
9	KOKKADA	75.3876	12.8622	152	25	5.5	1.4
10	REKHYA	75.4687	12.8300	177	36	4.9	0.78
11	SHISHILA	75.4690	12.8773	122	24	3.9	4.4
12	NIDLE	75.4043	12.9252	37	12	9.8	0.78
13	UJIRE	75.3378	12.9987	76	10	3.5	3.16
14	BELTHANGADY	75.2830	12.9884	122	24	6.2	0.78
15	PADANGADY	75.2188	12.9901	122	18	9.1	2.15
16	MUNDURU	75.2483	13.0255	165	24	9.8	0.4
17	GANJAALU	75.3545	12.9920	204	14	8.6	0.78
18	NAVOORU	75.3238	13.0531	122	11	6.9	7.7
19	CHARMADY	75.4143	13.0483	116	14	7.8	3.16

3.2. 3 D aquifer disposition and Cross-Sections

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 Belthangady 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 are presented in **Fig.20, Fig.21** and 3D aquifer disposition fence diagram **in Fig.22.**

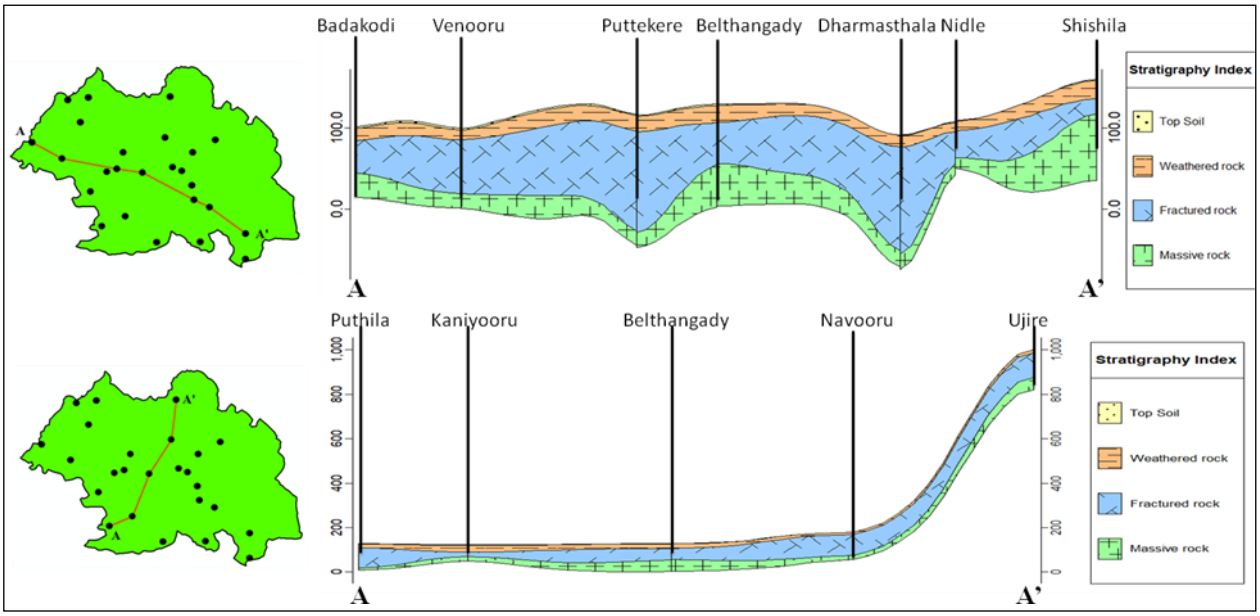

Fig.20: 2D Aquifer Cross Section

Hydrogeological cross section A-A' (Fig.-20) represents west – east direction and data of 8 exploratory wells has been utilised. It can be clearly seen from the west to central part i.e., from Badakodi to Puttekere, the thickness of Aquifer-II (deeper aquifer) is increasing and gradually decreases towards eastern part at Belthangady and again the thickness increases at Dharmasthala towards eastern side and again starts decreasing towards extreme part of eastern part at Shishila. The maximum depth of Aquifer-II is attained at Puttekere and Dharmasthala. On the contrary, the thickness of Aquifer-I (shallow aquifer) is constant from western to eastern part. In the next cross section, it represents the south-north direction and data of 5 exploratory wells has been utilised. From southern part the thickness of Aquifer-II is more and it gradually decreases at Kaniyooru and again starts increasing towards northern part till ujire whereas the the thickness of Aquifer-I is less and decreasing towards northern part.

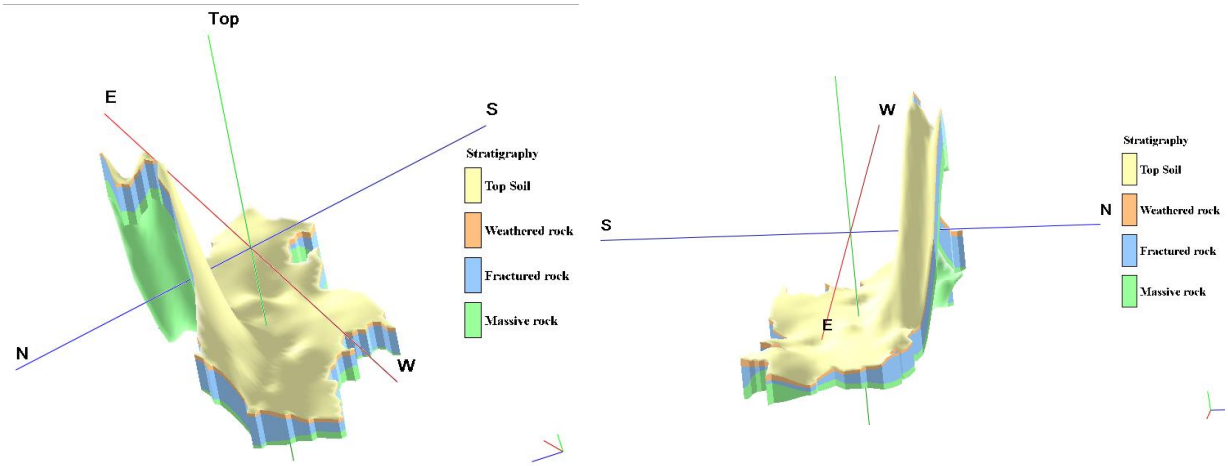

Fig.21: 3D Aquifer Disposition

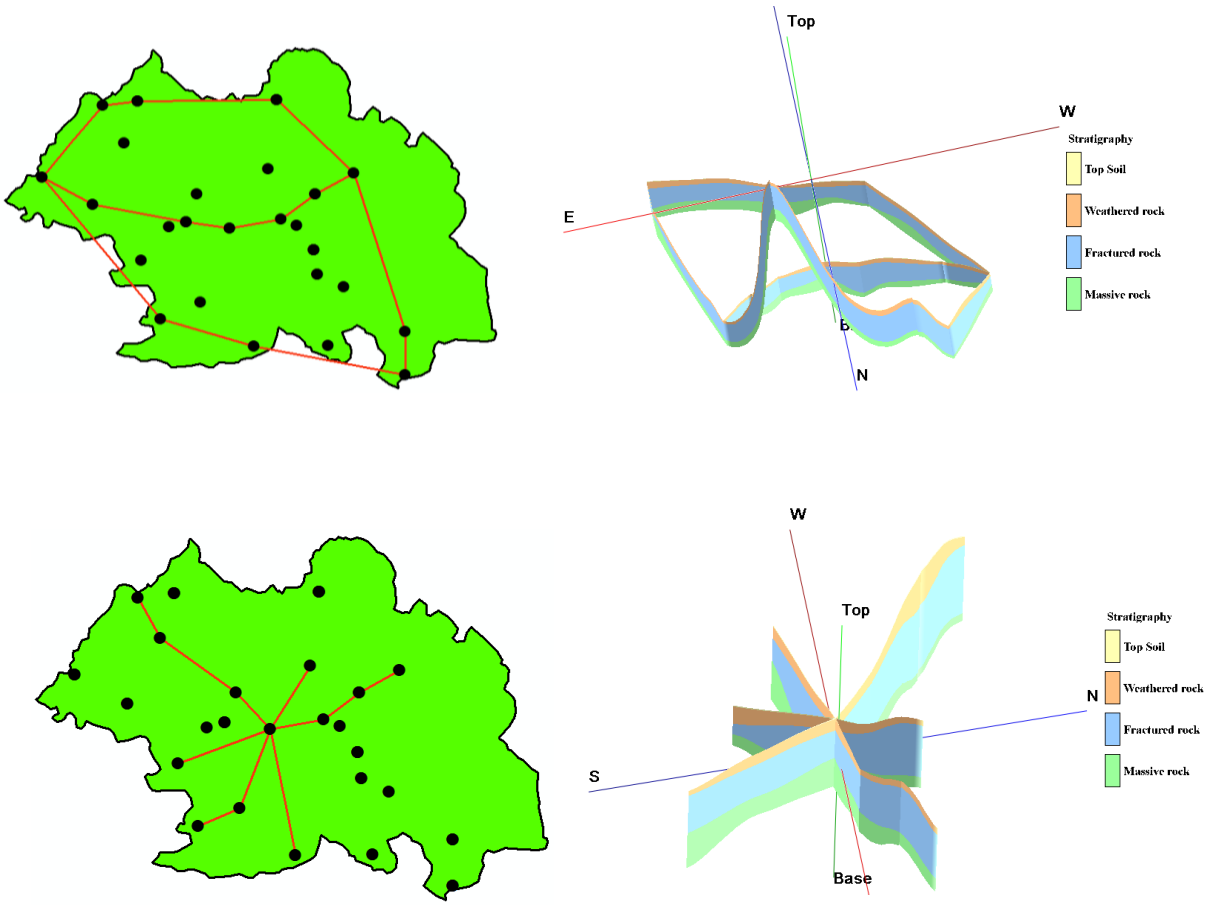

Fig.22: 3D Aquifer Fence diagram

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

The main ground water issues are over exploitation, Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, deeper water levels especially in Aquifer II, declining water level trend which are all inter-related or inter dependent.

4.1 Comparison of Ground Water Resource and Extraction

The Dynamic Ground Water Resource 2017, 2020 and as on 2022 have already been summarised above and are shown in **Table 11**. It is observed that the ground water availability in 2022 is more compare to 2017 and 2020 due to increase in rainfall and in water table. It is attributable to the improvement in the irrigation practice, influence of command area and also due to the water conservation / recharge activities carried out in the taluk by various state govt. and other agencies.

Table 11: Comparison of groundwater availability and draft scenario (in ham)

Taluk	2017			2020			2022		
Belthangady	GW availability	GW Extraction	Stage of GW development	GW availability	GW Extraction	Stage of GW development	GW availability	GW Extraction	Stage of GW development
	8869	5763	65	13871	6479	47	16269	7068	43

4.2 Chemical quality of ground water and contamination

The quality of shallow ground water has been evaluated from CGWB monitoring wells and water quality of fractured aquifer in Belthangady taluk has been evaluated by sampling and analysis of water samples collected from wells inventoried during field work as monitoring wells of CGWB. The water in phreatic aquifer zones is found in potable form. The well wise chemical analysis data of the samples are given in the **Table 12.**

Electrical conductivity (EC), Chloride (Cl), Nitrate (NO3), and Fluoride (F) parameters are observed to be in the range of desirable limit as per BIS, 2012.

The value of pH ranges from 6.1 to 7.1. EC value is in the range of 67 to 317 m/mhos/cm at 25^{o}C. Cl ranges from 7 mg/l to 32 mg/l. The value of NO_3 ranges from 0.68 to 19.32 mg/l. Fluoride ranges from negligible to 0.95 mg/l.

Table 12: Ground water quality (2022)

Sl.No	Location	PH	EC	TH	Ca	Mg	Na	K	HCO3	Cl	SO4	NO3	F
			µS/cm	<.....mg/L.....>									
1	Kokkada	6.1	317	90	20	9.7	24.67	2.14	122	20	10	19.32	0.39
2	Nidle	6.2	111	35	10	2.4	7.55	1.13	43	11	2	5.5	0.00
3	Ujjare	6.12	203	55	12	6.0	18	1.19	55	32	2	11.45	0.95
4	Badanaje Machoor	6.23	122	45	14	2.4	5.93	0.24	57	8	ND	3.13	0.88
5	Ballalu	6.21	134	45	12	3.6	11.66	2.21	67	14	ND	0.68	0.20
6	Nidgal	6.25	97	30	6	3.6	7.4	1.02	39	7	3	6.59	0.43
7	Surya	6.31	186	75	18	7.3	12.99	3.63	81	14	5	12.5	0.46
8	Belthangady	6.18	125	35	10	2.4	11	2.7	55	9	3	5.5	0.34
9	Adanthadka	6.38	111	30	10	1.2	10.67	2.11	46	9	2	7.79	0.73
10	Vennur	6.6	110	30	6	3.6	12.73	2.08	37	19	4	5.35	0.40
11	Kukedi	6.97	76	20	6	1.2	9	1.09	24	14	ND	3.59	0.47
12	Padangadi	7.1	116	50	14	3.6	7.37	1.21	69	7	ND	4.35	0.39
13	Alangadi	7	67	25	6	2.4	6.02	0.93	24	9	ND	3.92	0.44

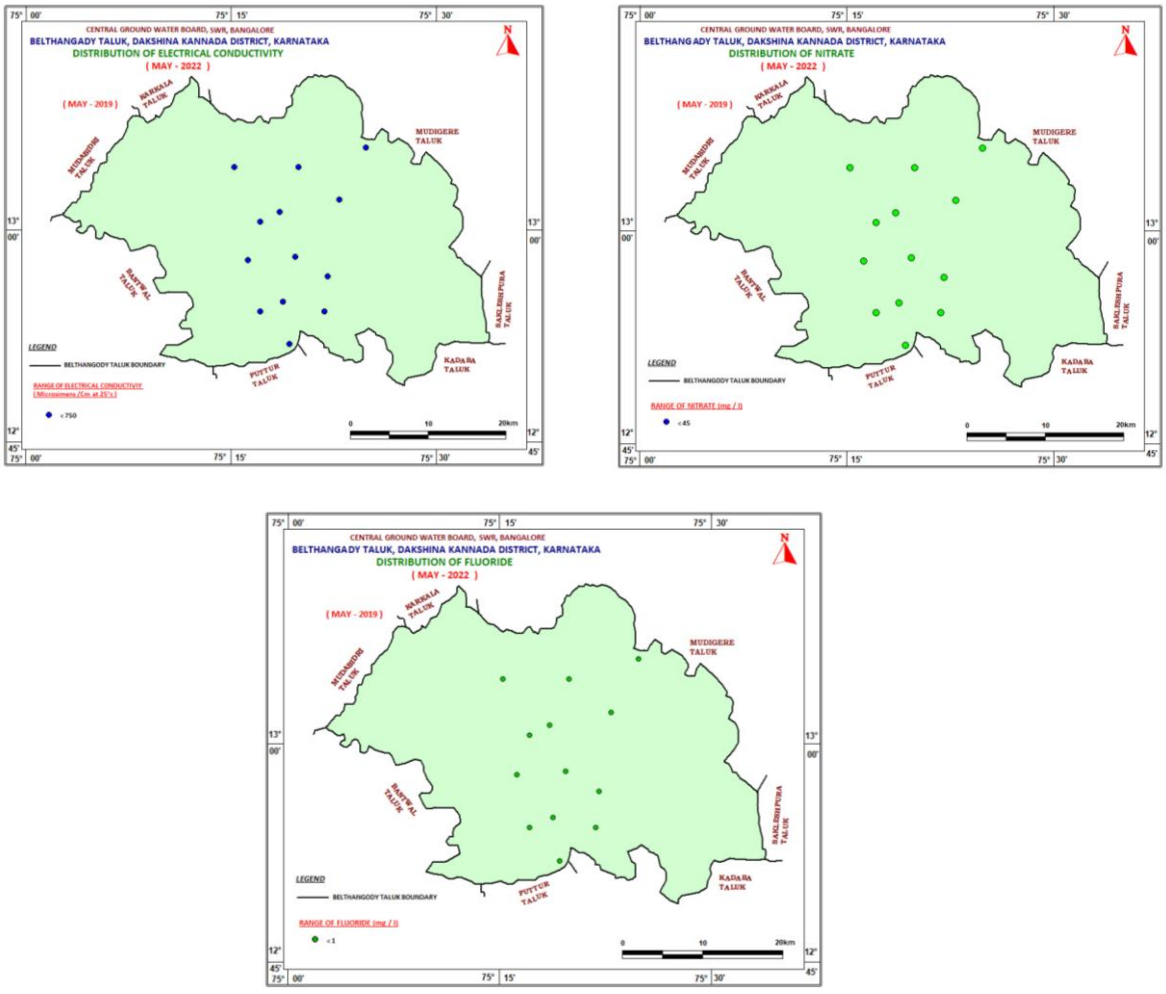

Fig.23: Ground water quality maps

5. GROUNDWATER 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 desaturated aquifer system, both phreatic & deeper **(Aquifer I & II)** in the taluk through construction of artificial recharge structures, viz; check dams, percolation tanks & Sub surface dykes (**Table.13**). 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.

Table-13: Details of Proposed AR structures

Geographical area	1375
Area feasible for AR	863
Non committed monsoon runoff available (MCM)	75.307
Number of Check Dams	87
Number of Percolation Tanks	68
Number of Subsurface dykes	2
Tentative total cost of the project (Rs. in lakhs)	2262.049
Excepted recharge (MCM)	17.49
Additional irrigation Potential (Lakh hectares)	0.068

The area feasible for artificial recharge structures in Belthangady taluk is shown in **Fig.24.** The tentative location of the recharge structures in Dharwad taluk is shown in **Fig.25.** The tentative list of the proposed Percolation tanks and Check dams are listed in **Annexure 1.**

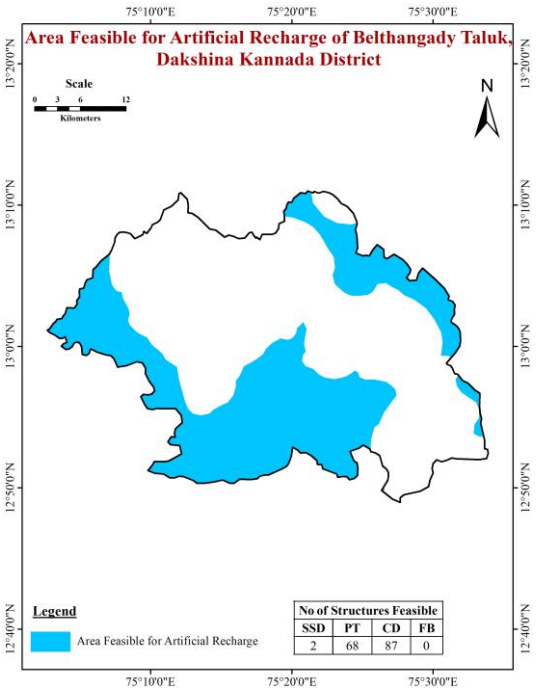

Fig.24: Tentative Locations of AR Structures

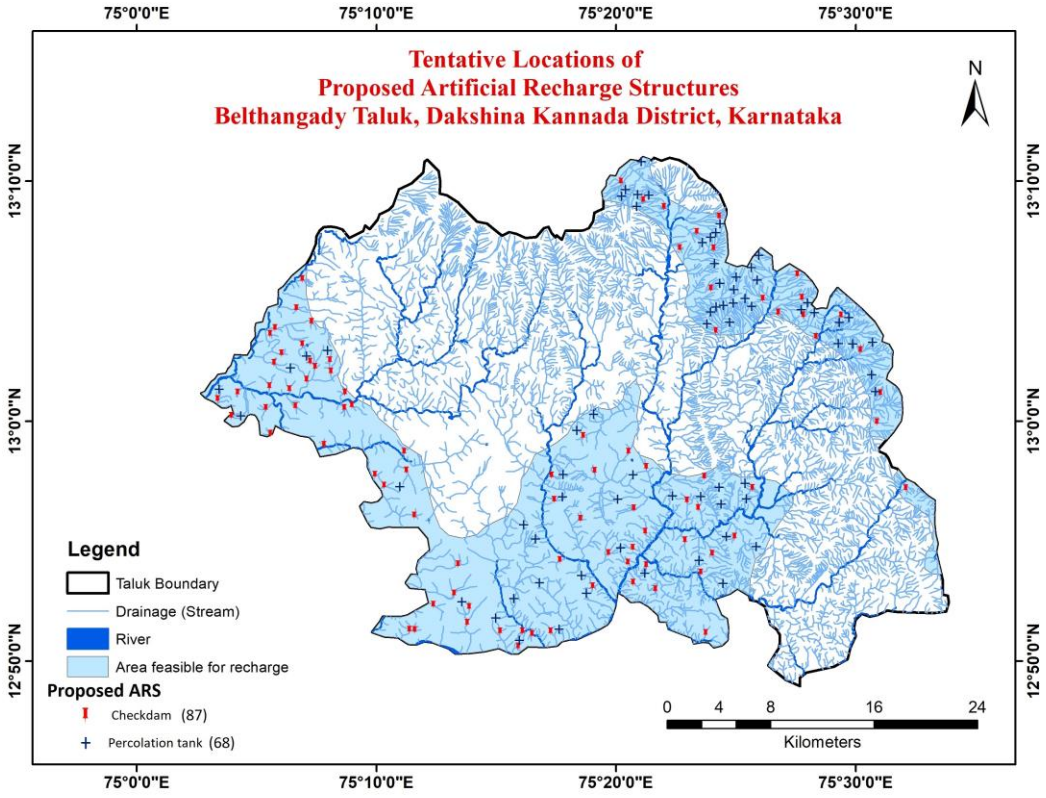

Fig.25: Tentative Locations of AR Structures

After implementation of Artificial Recharge structures for GW recharge, the annual ground water availability will increase from 16269 to 18018 ham and the expected improvement in stage of extraction is 3.8% from 43% to 39.2%. **(Table 14)**

Table 14: Improvement in GW availability (GWRA 2022) due to Recharge

Taluk	Net annual ground water availability	Existing Ground Water extraction for all uses	Existing Stage of Ground water extraction	Expected recharge from proposed artificial recharge structures	Cumulative annual ground water availability after implementation of AR structures	Expected improvement in stage of ground water extraction after the implementation of the project	Expected improvement in stage of ground water extraction
	HAM	HAM	%	HAM	HAM	%	%
Belthangady	16269	7068	43	1749	18018	3.8	39.2

5.2 Resource Savings by Demand Side Interventions

The important crops grown are Paddy, pulses, fruits, vegetables, arecanuts and coconuts etc. Groundwater 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 have to be adopted by the farmers in the existing 32873 ha of net irrigated area. It is proposed to adopt micro irrigation (drip) techniques in paddy (2223 ha), fruits and vegetables (971 ha) and in Arecanuts (24054 ha). It is assumed that 25% of paddy i.e., 555 ha, 50% of fruits & vegetables i.e., 490 ha and 25% of Arecanuts i.e., 6013 ha is irrigated by ground water. Implementation of efficient irrigation techniques will contribute in saving ground water by 1119 ham. The details of the resource enhancement through artificial recharge in the taluk and through Water Efficiency practices in Irrigation are shown in **Table.15.**

Table.15: Improvement in GW availability due to Recharge and WUE

Sl. No.	**Resource Details**	**As per 2022 Estimation**
1	Net Ground Water Availability in Ham	16269
2	Existing ground water draft for all uses in Ham	7068
3	Existing Stage of Ground Water Development in percentage %	43%
4	Expected Recharge from Artificial Recharge sources in Ham	1749
5	Cumulative Ground water availability in Ham	18018
6	Expected improvement in stage of ground water development %	39%
8	Saving due to adopting Water Use Efficiency in Ham	1119
9	Ground water availability after AR & WUE in Ham	19137
10	Expected improvement in stage of ground water development after implementation of AR & WUE %	**36.9%**

5.3 Ground Water Development Plan

In Belthangady taluk, the present stage of ground water extraction (2022) is 43 % with net ground water availability for future use is 9177 ham and total extraction is 7068 ham (2022). The ground water draft for irrigation purpose is 6486 ham, thus indicating that ground water irrigation needs to be encouraged in the area after considering the “Safe” level of extraction of 43%, which can be implemented in scientific manner. The implementation of the plan needs to be based on site

specific detailed hydrogeological, geophysical and scientific surveys for pinpointing the sites for construction of dug wells and bore wells.

As per the conservative estimate and after considering the average unit draft figure for the taluk, about 1104 dug wells (15-30 m depth; 3 to 5 m diameter) are recommended to be constructed in feasible areas. Further as per the estimate about 50 bore wells (40 to 100 m depth; 150 mm dia) are also recommended to be drilled in feasible areas so as to maintain the safe category of the taluk. The likely additional irrigation potential which can be created considering prevailing crop water requirement for the area is will be 4144 ha.

Table – 16 a: Feasibility of Additional GW abstraction structures based on GWRA 2022 availability

Annual Extractable GW Resource (Ham)	Net GW Availability for future use (Ham)	Stage of GW Extraction (%)	GWR required to take SOE to 60%	Total Extrac-tion / Draft	Balance GWR available to enhance SOE 60%	No. of DW feasible considering 82% of balance GWR with unit draft of 2 ham	No. of BWs feasible considering 18% of balance GWR with unit draft of 9.7 ham
16269	9177	43.4	9761.4	7068	2693.4	1104	50

Table – 16 b: Ground Water Resource Development Plan as per GWRA 2022 availability

Items	**Proposed Structures**		**Total**
Present GW Availability is 16269 MCM Present Gross Annual Extraction is 7068 MCM Present Stage of GW Development is 43.4%	**Dug wells – 1104** Depth: 15 to 30 m Dia: 3 to 5 m Av. Annual Gross draft – 2 ham	**Bore well - 50** Depth: 40 to 100 m Dia – 150 mm Av. Annual Gross draft – 9.7 ham	**1154**
Additional irrigation potential created considering crop water requirement of 0.65 m (Ha)	**3398**	**746**	**4144**

Note- Hydrogeological and scientific intervention is needed for pinpointing the sites for construction of dugwells and Borewells

5.4 Regulation and Control

As per the resource estimation – 2022, Belthangady taluk falls under "**Safe"** category with the stage of ground water extraction of 43.4**%**. 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.

5.5 Other interventions proposed

- Belthangady Taluk receives high amount of rainfall during monsoon. There is good availability of seepage water during post monsoon period.
- There is extensive scope for seepage and rain water harvesting through construction of percolation tank, and farm ponds.
- Moisture and water use efficiency is possible to boost up agricultural production and to solve drinking water problem (District Irrigation Plan, Pradhan Mantri Krishi Sinchai Yojana, Dakshin Kannada district).
- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.

6. 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 of areas which are all inter-related or inter dependent. The summary of ground water management plan of the taluk is given in **Table-17.**

Table 17: Summary of Management plan

Stage of GW Extraction and Category (2022)	43.4 %, Safe
Annual Extractable GW Resource (Ham)	16269
Total Extraction (Ham)	7068
Ground Water Draft for Irrigation (Ham)	6486
Ground Water Resource Enhancement by Supply side Interventions	
No of Proposed AR structures SSD PT CD	 2 68 87
Expected Additional Recharge to GW due to AR (Ham)	1749
Additional Irrigation Potential that can be created (Ha)	6800
Total Estimated Expenditure (Rs. in Cr.)	22.62
Change in Stage of GW Extraction (%)	43.4 to 39.2
Ground Water Resource Savings by Demand side Interventions	
Expected Saving due to adopting WUE measures (Ham)	1119
Change in Stage of GW development (%)[Both supply & demand side interventions]	43.4 to 36.9
Ground Water Resource Development Plan	
Balance GWR available to enhance SOE 60% (Ham)	2693.4

No. of wells proposed **DW** – Depth: 15 to 30 m, Dia: 3 to 5 m, Unit Cost –Rs. 3.00 lakh, Av. Annual Gross draft – 2 ham **BW** – Depth: 40 to 100 m, Dia: 150 mm, Unit Cost – Rs. 2.00 lakh, Av. Annual Gross draft – 9.7 ham	1104 50
Additional irrigation potential created considering crop water requirement of 0.65 m (Ha)	4144
Total Estimated Expenditure (Rs. in Cr.)	34.13
Increase in Stage of GW Extraction (%)	43.4 to 60

As per the resource estimation – 2022, Belthangady taluk falls under Safe category with the stage of ground water extraction is 43.4 %. 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 a scientific and multi-pronged ground water management strategy covering supply side interventions, demand side interventions, ground water development interventions and ground water quality protection aspects as mentioned in the management plan suggested above

- **Ground water resource enhancement by supply side interventions**: Quantity of surface water available through non-committed surface run-off is estimated to be 75.3 MCM. This can be used to recharge the aquifer mainly through percolation tanks (68), check dams (87) and sub surface dyke structures (2). The volume of water expected to be recharged is 1749 ham through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 22.62 Cr. The additional area which can be brought under assured ground water irrigation will be about 0.068 Lakh hectares.
- **Ground water resource enhancement by demand side interventions**: At present about 86 % of irrigation is by wells and bore wells (ground water). The micro irrigation practices like drip and sprinkler irrigation are comparatively less practiced in comparison with traditional surface flooding mode of irrigation. Efficient irrigation practices like Drip irrigation and sprinkler has to be adopted by the farmers in the existing 32873 ha of net irrigated area. It is proposed to adopt micro irrigation (drip) techniques in paddy (2223 ha), fruits and vegetables (971 ha) and in Arecanuts (24054 ha). It is assumed that 25% of paddy i.e., 555 ha, 50% of fruits & vegetables i.e., 490 ha and 25% of Arecanuts i.e., 6013 ha is irrigated by ground water. Implementation of efficient irrigation techniques will contribute in saving ground water by 1119 ham. However, in long run the practice of efficient irrigation techniques will add to the ground water resource in large extent.

- **Ground Water Resource Development Plan:** The present stage of ground water extraction (2022) is merely 43.4 % with net ground water availability of 16269 ham and total extraction of 7068 ham. The ground water draft for irrigation purpose is @ 6486 ham, thus indicating that ground water irrigation needs to be encouraged in the area. To overcome the low ground water development, it is imperative to have a robust ground water resource development plan for the area, which can be implemented in scientific manner. The implementation of the plan needs to based on site specific detailed hydrogeological, geophysical and scientific surveys for pinpointing the sites for construction of dugwells and Borewells.
- In view of above, the focus of proposed ground water development plan is to up the ante of ground water development from the present 43% to 60% in a systematic way by adopting scientific approach. About 1104 dugwells (15-30 m depth; 3 to 5 m diameter @ Rs. 3.00 lakh/dugwell) are recommended to be constructed in feasible areas. Further 50 borewells (40-100 m depth; 150 mm dia @ Rs. 2.00 lakh/borewell) are also recommended to be drilled in feasible areas. Additional irrigation potential which can be created considering crop water requirement of 0.65 m (Ha) will be 4144 ha. The total expenditure proposed to be incurred is Rs. 34.13 Cr.
- **Regulation and control:** Taluk is categorized as **"Safe".** 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.
- **Participatory management:** Awareness programmes and practice of participatory approach needs to be strengthened with the involvement of all the stake holders for sustainable management.

Annexure 1:

A) Tentative Locations of Proposed Percolation Tanks, Belthangady taluk

Sl.No	Long	Lat	Village
1	75.2661	12.8477	Ilanthila
2	75.2936	12.8555	Mogru
3	75.2496	12.8633	Uruvalu
4	75.2261	12.8744	Karaya
5	75.2621	12.8767	Uruvalu
6	75.3127	12.8805	Bandhara
7	75.4078	12.8872	Nidle
8	75.2801	12.8877	Kaniyuru
9	75.3093	12.8928	Bandhara
10	75.3533	12.8943	Patrame
11	75.3910	12.9032	Nidle
12	75.3364	12.9120	Belalu
13	75.4309	12.9128	Kalanja
14	75.2772	12.9181	Kaniyuru
15	75.4099	12.9196	Nidle
16	75.2691	12.9278	Nyayatharf
17	75.4063	12.9423	C.Bidre
18	75.3345	12.9457	Belalu
19	75.4240	12.9459	Pudhupettu
20	75.2960	12.9474	Koyyuru
21	75.3922	12.9474	Dharmasthala
22	75.3725	12.9479	Dharmasthala
23	75.4049	12.9539	Pudhupettu
24	75.1829	12.9544	Maladi
25	75.4231	12.9566	Pudhupettu
26	75.3452	12.9626	Dharmasthala
27	75.2965	12.9628	Koyyuru
28	75.3060	12.9934	Laila
29	75.0724	13.0035	Arambodi
30	75.3177	13.0047	Ujre
31	75.5138	13.0204	Neriya
32	75.0574	13.0221	Arambodi
33	75.5109	13.0320	Neriya
34	75.1068	13.0369	Hosangadi
35	75.1181	13.0451	Karimanilu
36	75.1327	13.0489	Moodukodi
37	75.4981	13.0536	Neriya
38	75.4879	13.0539	Neriya
39	75.5117	13.0546	Neriya
40	75.3965	13.0675	Charmadi
41	75.4886	13.0684	Neriya
42	75.4122	13.0687	Charmadi

43	75.4953	13.0719	Neriya
44	75.4712	13.0753	Neriya
45	75.3991	13.0756	Charmadi
46	75.4621	13.0773	Charmadi
47	75.4030	13.0790	Charmadi
48	75.4275	13.0795	Charmadi
49	75.4080	13.0802	Charmadi
50	75.4149	13.0818	Charmadi
51	75.4664	13.0820	Charmadi
52	75.4231	13.0850	Charmadi
53	75.4153	13.0912	Charmadi
54	75.4055	13.0956	Charmadi
55	75.4314	13.0978	Charmadi
56	75.4170	13.0999	Charmadi
57	75.4275	13.1065	Charmadi
58	75.4019	13.1093	Charmadi
59	75.4326	13.1151	Charmadi
60	75.3933	13.1240	Malavanthige
61	75.3991	13.1276	Malavanthige
62	75.4027	13.1309	Malavanthige
63	75.4058	13.1369	Malavanthige
64	75.3477	13.1491	Malavanthige
65	75.3371	13.1561	Malavanthige
66	75.3561	13.1568	Malavanthige
67	75.3484	13.1573	Malavanthige
68	75.3400	13.1607	Malavanthige

(Source: Master Plan, CGWB, 2020. 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, Belthangady taluk

Sl.No	Long	Lat	Village
1	75.2652	12.8432	Ilanthila
2	75.2748	12.8517	Ilanthila
3	75.3957	12.8525	Kokkada
4	75.2878	12.8535	Ilanthila
5	75.2681	12.8536	Ilanthila
6	75.2526	12.8537	Uruvalu
7	75.1932	12.8546	Thekkar
8	75.1896	12.8548	Thekkar
9	75.2297	12.8596	Karaya
10	75.2312	12.8706	Karaya
11	75.2062	12.8721	Bharya
12	75.2205	12.8799	Bharya
13	75.3607	12.8828	Kokkada
14	75.3171	12.8849	Bandhara
15	75.3451	12.8874	Kokkada
16	75.3923	12.8945	Nidle
17	75.3543	12.8995	Patrame
18	75.2233	12.9002	Thanneeru Pantha
19	75.3415	12.9014	Bandhara
20	75.2941	12.9032	Kaniyuru
21	75.4003	12.9075	Nidle
22	75.3279	12.9080	Bandhara
23	75.3449	12.9117	Belalu
24	75.3812	12.9170	Patrame
25	75.4157	12.9194	Nidle
26	75.3537	12.9228	Belalu
27	75.3085	12.9317	Belalu
28	75.1931	12.9341	Parenki
29	75.3455	12.9391	Belalu
30	75.3903	12.9393	Dharmasthala
31	75.3826	12.9446	Dharmasthala
32	75.2902	12.9451	Koyyuru
33	75.5347	12.9531	Shishila
34	75.4282	12.9531	Pudhupettu
35	75.1719	12.9548	Kukkala
36	75.3947	12.9611	Dharmasthala
37	75.2885	12.9620	Koyyuru
38	75.1656	12.9624	Maladi
39	75.3184	12.9650	Ujre
40	75.1876	12.9653	Maladi
41	75.3544	12.9678	Dharmasthala
42	75.1859	12.9784	Sonanduru
43	75.3420	12.9784	Ujre

44	75.1302	12.9831	Bajre
45	75.3104	12.9894	Ujre
46	75.0929	12.9910	Ajjibettu
47	75.5148	12.9990	Neriya
48	75.0657	13.0034	Sanghabettu
49	75.0896	13.0087	Arambodi
50	75.1443	13.0087	Venuru
51	75.1103	13.0100	Gunduri
52	75.1495	13.0106	Venuru
53	75.0561	13.0150	Arambodi
54	75.5172	13.0191	Neriya
55	75.1448	13.0194	Moodukodi
56	75.0700	13.0196	Arambodi
57	75.1063	13.0218	Hosangadi
58	75.0921	13.0239	Hosangadi
59	75.1180	13.0285	Karimanilu
60	75.1350	13.0342	Moodukodi
61	75.1241	13.0373	Karimanilu
62	75.0955	13.0401	Badakodi
63	75.1207	13.0410	Karimanilu
64	75.1343	13.0418	Moodukodi
65	75.1007	13.0468	Badakodi
66	75.5033	13.0489	Neriya
67	75.1150	13.0531	Kashipatna
68	75.4724	13.0581	Neriya
69	75.0928	13.0601	Badakodi
70	75.4027	13.0621	Charmadi
71	75.0962	13.0642	Kashipatna
72	75.1216	13.0686	Peradi
73	75.4897	13.0729	Neriya
74	75.4634	13.0732	Neriya
75	75.4461	13.0749	Charmadi
76	75.1109	13.0780	Kashipatna
77	75.4354	13.0845	Charmadi
78	75.4625	13.0853	Charmadi
79	75.3993	13.0918	Charmadi
80	75.1151	13.0983	Marodi
81	75.4595	13.1015	Charmadi
82	75.4011	13.1197	Malavanthige
83	75.3776	13.1198	Malavanthige
84	75.3895	13.1310	Malavanthige
85	75.4049	13.1417	Malavanthige
86	75.3665	13.1483	Malavanthige
87	75.3521	13.1533	Malavanthige

(Source: Master Plan, CGWB, 2020. It is likely that the number of structures proposed may vary depending upon the ground truth verification and feasibility criteria)