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

Sulya Taluk, Dakshina Kannada District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

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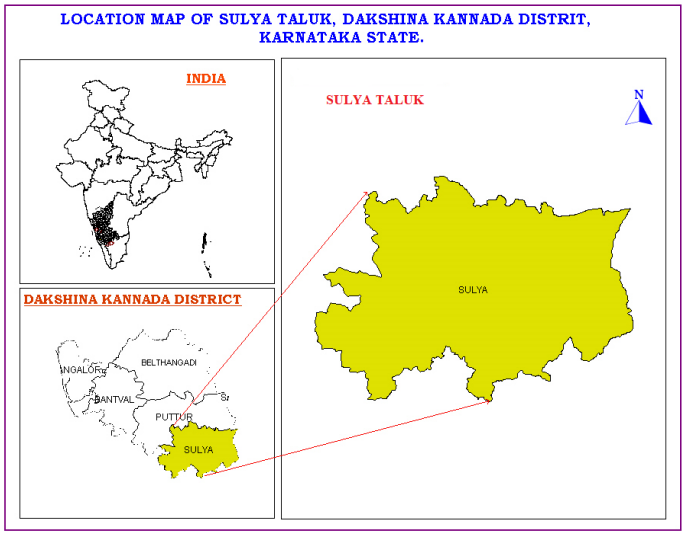
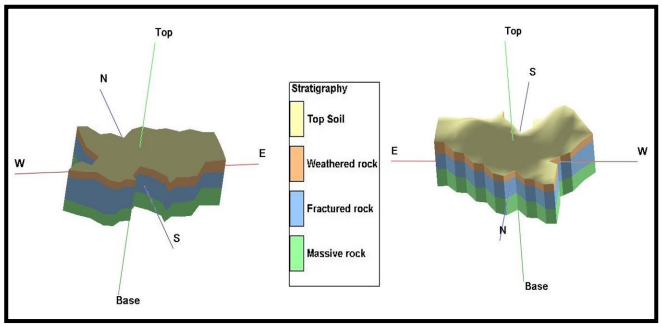
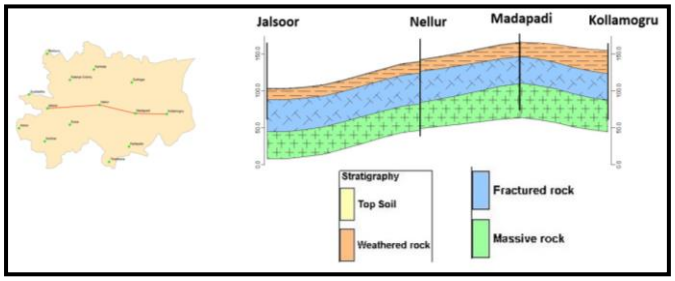
AQUIFER MAPS AND MANAGEMENT PLAN, SULYA TALUK, DAKSHINA KANNADA DISTRICT, KARNATAKA STATE

(AAP: – 2022-2023)







By

Naresh Chandra Sahoo, AHG, CGWB, SWR, Bengaluru

MAY 2023

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

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

1. SALIENT FEATURES

Name of the taluk: **SULYA**

District: **DAKSHINA KANNADA**;

State: **KARNATAKA**

Area: 859 sq.km.

Population: 1,45,227

Annual Actual Rainfall (2022): 4858.7 mm

1.1. Study Area

Aquifer Mapping Studies have been carried out in Sulya taluk, D. Kannada district of Karnataka, covering an area of 859 sq.kms under National Aquifer Mapping (NAQUIM) during the AAP 2022-23. The Sulya taluk is located between North Latitudes 12°27'50.04'' and 12°42'14.62" and East Longitudes between 75° 16' 54.62" to 75°40'14.09" and is falling in parts of Survey of India Toposheets 48P/6,48P/7 and 48P/10. The study area is bounded, on the North by Putur taluk, on the South by Kodagu taluk, on the East by Somverpet taluk, on the West by Kerala State boarder. Location map of Sulya taluk is presented in Fig-1. Sulya is the taluk Headquarter. There are 40 villages and 28 gram panchayats in this taluk.

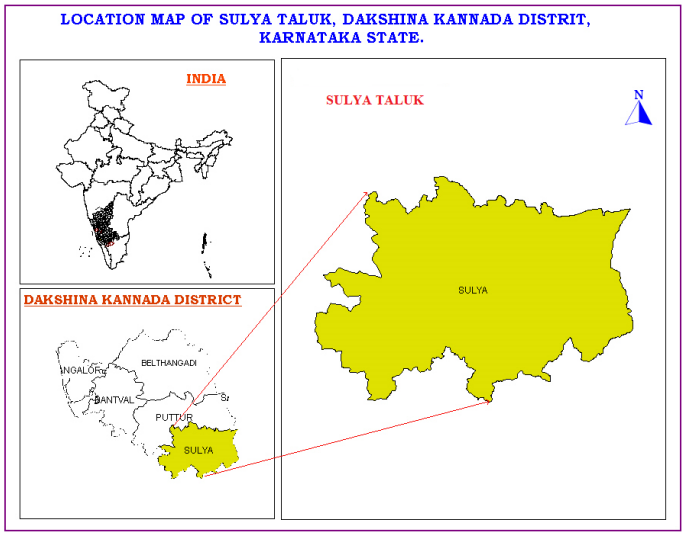

Fig. 1: Location Map

1.2 Population

According to 2011 census, the population in Sulya taluk is 1,45,636 . Out of which 72,126 are males while 73,101 are females. The average sex ratio of Sulya taluk is 1011. The Sulya taluk has an overall population density of 169 persons per sq.km. The decadal variation in population from 2001-2011 is 3.18 % in Sulya taluk. Details of Population of Sulya taluk is given in Table-1.

Table-1: Details of Population of Sulya taluk, Dakshin Kannada district

Male	Female	SC	ST	TOTAL	No. of Villages	No. of GPs	Literacy %	Density
72,126	**73,101**	**20,287**	**11,841**	**1,45,227**	**40**	**28**	**86.39**	**169.06**

Source: District at a glance 2017-18, Govt. of Karnataka

1.3 **Rainfall and Climate**

Sullya taluk experiences maritime climate characterized by excessive humidity(78%) during the greater part of the year. Generally, the weather is hot and humid throughout the year. The normal annual rainfall and rainy days in Sullya taluk for the period 1951 to 2000 is 3650 mm and 123 respectively . There are four seasons viz., **(1)** Four wet months of June, July, August and September, when the taluk encounters strong winds, high humidity, heavy showers and a slight fall in temperature. **(2)** Two warm and damp months of October and November when south west monsoon is retreating. **(3)** Three cool months of December, January and February when generally dry conditions prevail and **(4)** Three hot months of March, April and May, which is the period of rising temperature. The taluk depends mainly on monsoon for agricultural operations. The annual actual rainfall for the period from 2013 to 2022 is given in **Table-2a**. It shows that the lowest rainfall of 2150 mm is noticed during the year 2021 and highest rainfall is 4859 mm in the year 2022. The annual average rainfall during this period is 3409.758 mm. The rainfall trend analysis for the period 2013-2022 of Sulya taluk is presented in **Table-2b** and in **Fig. 2** which shows increasing trend**.**

Table 2a: Monthly Actual Rainfall (in mm)

YEAR	JAN	FEB	MAR	APR	MAY	PRE-MON	JUN	JUL	AUG	SEP	SWM	OCT	NOV	DEC	POST-MON	ANN.
2013	0.0	36.0	58.0	99.0	0.0	193.0	515.0	597.0	1007.0	254.0	2373.0	177.0	80.0	0.0	257.0	2823.0
2014	0.0	0.0	0.0	59.6	283.0	342.6	349.0	902.0	878.0	511.0	2640.0	180.0	52.0	24.0	256.0	3238.6
2015	0.0	0.0	17.0	70.0	213.0	300.0	764.0	804.0	585.0	205.0	2358.0	259.0	89.0	8.0	356.0	3014.0
2016	2.0	0.0	0.0	26.0	142.0	170.0	889.0	738.0	560.0	269.0	2456.0	51.0	35.0	17.0	103.0	2729.0
2017	8.0	0.0	27.0	49.2	221.0	305.2	673.0	796.0	843.0	458.0	2770.0	57.0	10.0	0.0	67.0	3142.2
2018	0.0	0.0	91.0	95.0	518.0	704.0	1096.0	1477.0	1083.0	58.0	3714.0	115.0	63.0	3.0	181.0	4599.0
2019	0	0	0	84	27	111.0	302	810	1242	714	3068.2	514	97	20	631.0	3810.2
2020	0	0	15	64	230	310.1	580	775	941	616	2912.0	381	84	45	510.8	3732.9
2021	77.3	19.8	16.9	150.3	348.5	612.7	518.7	851.3	568	457	2394.6	487	382	9	878.1	3885.4
2022	0.0	2.8	44.4	143.6	557	747.7	442.1	1800.7	1130.2	314.6	3687.6	310.3	98.0	15	423.3	4858.6

(Source: Directorate of Economics and Statistics)

Table- 2b: Actual Annual rainfall (mm) in rain gauge station from 2013 to 2022

2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average
2823.0	3238.6	3014.0	2729.0	3142.2	4599.0	3810	3733	3885	4859	3583.3

(Source: Directorate of Economic and Statistics)

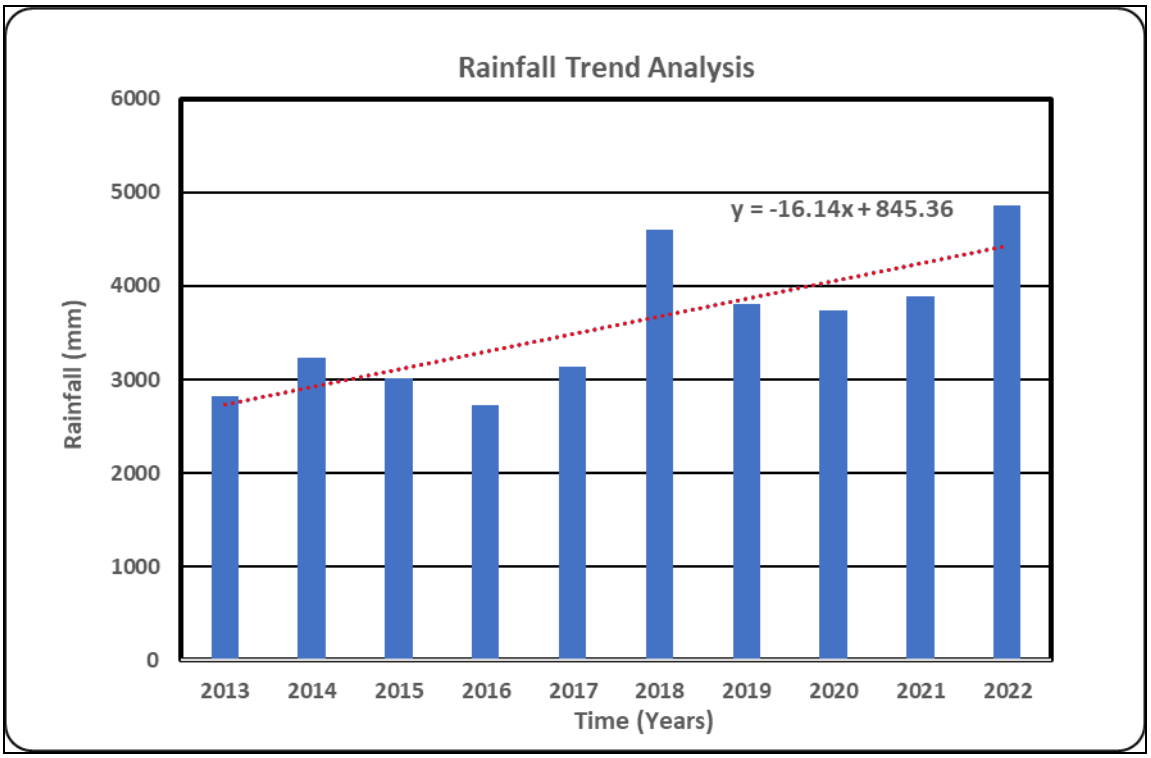

Fig. 2: Rainfall Trend Analysis

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Sulya taluk. Major crops are coconuts, arecanuts, condiments, spices, fruits, spices and paddy. Water intensive crops like paddy is grown only in 2.46% of the total cropped area. Coconuts and arecanuts are grown in 46.64 %, fruits grown in 17.41%, vegetables grown in 0.38%, pepper grown in 1.11%, cashew grown in 15.27% and rubber grown in 16.21 % of total cropped area in the taluk. Coconuts & arecanuits are grown more of about 46.64% of the total area. The short duration crops vegetables is grown in 126 Ha (0.38%) of the total cropped area which require ground water during post-monsoon season especially during summer.

Table-3: Cropping pattern 2017-18 (Ha)

Crop	Paddy	Pepper	cashew	Rubber	Pulses	Fruits	Vegetables	Oil seeds	Coconuts Arecanuts	Total crop
Area(ha)	808	366	5018	5328	156	5721	126	16	15328	32867
Area (%)	2.46	1.11	**15.27**	16.21	0.47	**17.41**	0.38	0.05	**46.64**	100.00

Source: District at a glance 2017-18, Govt. of Karnataka

About 50.39% of the geographical area is covered by forest. It is observed that net sown area accounts for 32.25% and area sown more than once is 0.60% of total geographical area in Sulya taluk. Area not available for cultivation and fallow land cover are 7.88% & 0.11% respectively of total geographical area.

About 43% of net area irrigated is from dugwells, 32.17% are from bore wells, 0.14% from lift irrigation and 24.67% is from other sources. Thus major source of irrigation is dugwell followed by borewell and other sources **(Fig.-3)**. 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.-4**.

Table-4: Details of land use 2017-18 (Ha)

Total Geographical Area	**Area under Forest**	**Area not available for cultivation**	**Other Uncultivated land**	**Fallow land**	**Net sown area**	**Area sown more than once**	**Gross sown area**
85900	43282	6767	5188	91	27703	518	28221
% of total area	**50.39**	7.88	6.04	0.11	**32.25**	0.60	32.85

Source: District at a glance 2017-18, Govt. of Karnataka

Table-5: Details of Irrigation (2017-18)

Source of Irrigation	Length in Km/No of structures	Gross area Irrigated (Ha)	Net area Irrigated (Ha)	% of Net area
Canals	----	-----	-----	----
Tanks	3	---	---	---
Dug Wells	7331	7312	7085	**42.99**
Bore/Tube wells	1428	5369	5302	32.17
Lift Irrigation	2	24	24	0.14
Other Sources		4160	4066	24.67
Total	8764	16,865	16477	100

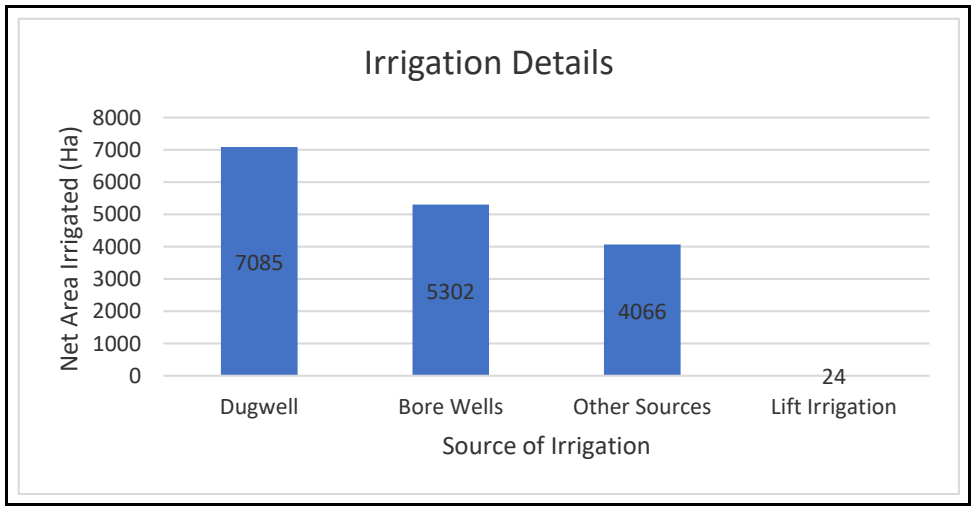

Fig.3: Irrigation Details

1.5 Geomorphology, Physiography & Drainage

The taluk exhibits highly undulating topography with series of forest clad high hill ranges projecting the Western Ghats. The forests are dense and inaccessible and vast areas are covered by teak and soft wood plantations. Many of the reserve forests have been cleared to raise rubber plantations.The hill ranges are dissected by numerous streams and streamlets carving deep valleys. The important rivers are the Payaswini river flows to the south west and the Kumardhara river drains along the northern boundary of the taluk. In addition, a number of rivulets drain the area. The taluk though flown by rivers and rivulets are not helpful for irrigation, as they flow mostly through wooden terrain.The few lower valley regions are the sites for agricultural activity in the taluk. The drainage system is well developed and the general drainage pattern is dendritic to sub-dendritic in nature in the taluk **(Fig. 5 and 6)**.

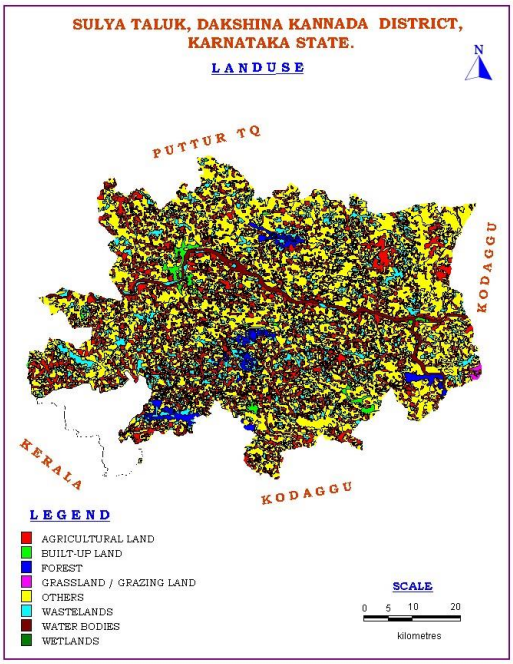

Fig. 4: Land use/land cover map

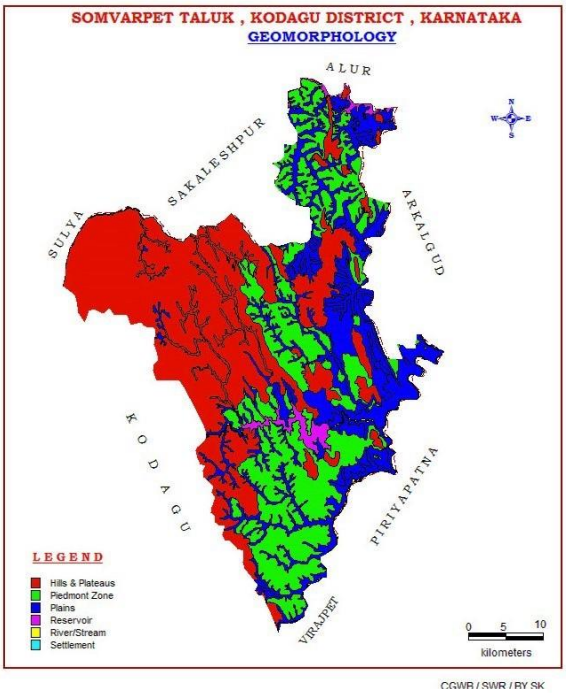

Fig.5: Geomorphology

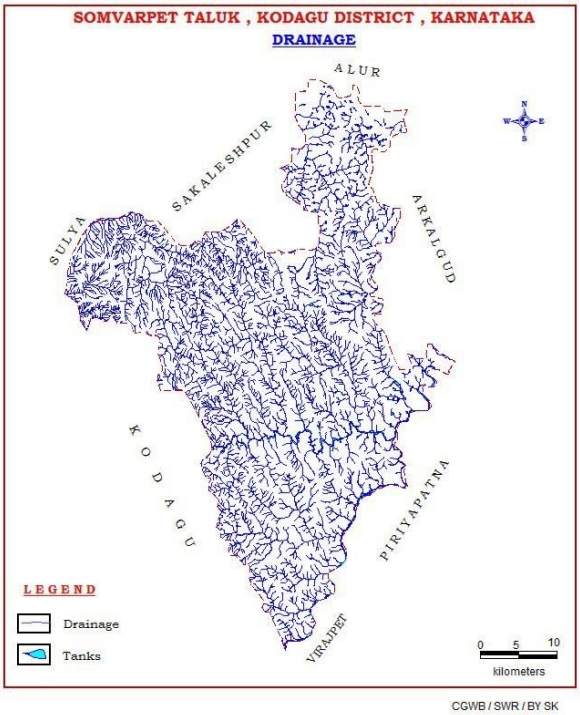

Fig.6: Drainage Map

1.6 Geology and Soils

The granitic gneisses form the major rock formation of the area. These granitic gneisses stand out as hillocks to the north-east of Sullya on Sullya-Subramanya road. In rest of the area they are exposed as small hillocks and isolated outcrops along the valley slopes, elevated grounds and river beds. The highly jointed granitic gneisses are conduits for groundwater storage and transmission. The top of the elevated mounds is covered by lateritic patches which are hard and compact. The soil is of slightly clayey, loamy and skeletal in nature. The geology and soil maps have been given in **Fig. 7 and 8.**

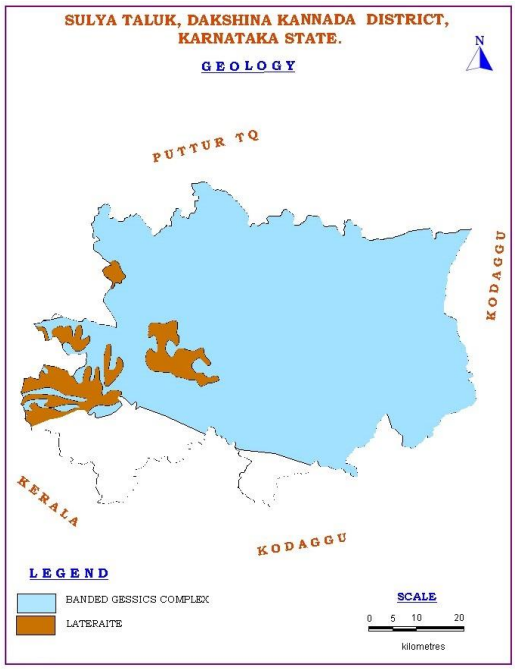

Fig. 7: Geology map

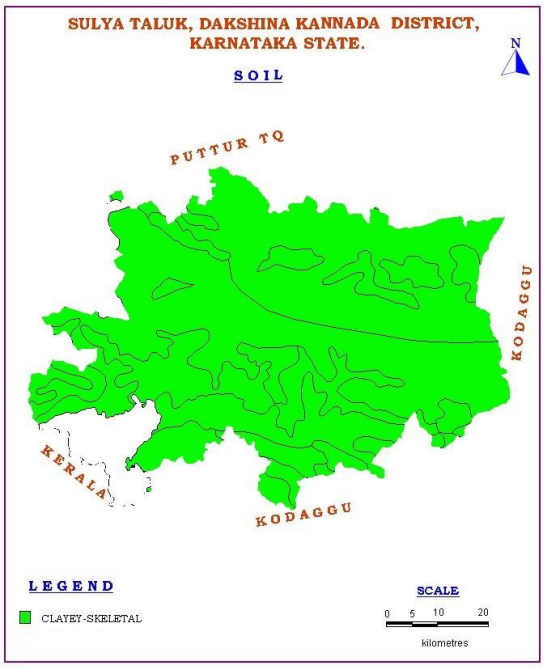

Fig. 8: Soil map

1.7 Ground water resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth is given in Table-6 below

Table 6: Total Ground Water Resources (GEC 2017) (Ham)

Taluk	Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (Down to 200m)	Dynamic + phreatic in-storage + fractured
Sullya	6435.53	85781	7210	99426.53

1.8 Existing and Future Water Demands (as per GWRA 2022)

- Net ground water availability for future irrigation development: **2486.49 Ham**
- Domestic (Industrial sector) demand for projected year 2025: **341.48 Ham**

1.9 Water level behavior

The depth to water level has been monitored from 14 dugwells of CGWB, 4 dug wells of SGWD, Karnataka for phreatic aquifer (Aquifer-I). Simillarly for fractured aquifer (Aquifer-II), 2 borewells of CGWB and 5 borewells SGWD, Bangalore has been used for water level monitoring to depict the ground water regime of the taluk. The depth to water level and seasonal water level fluctuation data is shown in Table.8 (CGWB)) and Table. 9 (SGWD) for both Aquifer-I(Phreatic) and Aquifer-II(Fractured) respectively.

1.9.1. Aquifer - I:

The pre-monsoon (May 2022) depth to water level of Phreatic Aquifer indicates that depth to water level ranged from 0.9 m bgl (Sampaje) to 14.85 (Bellare). The pre-monsoon depth to water level map (Fig.-9) depicts that the water level in the range of 5 to 10 m bgl is the general water level in the taluk. Depth to water level in the range of 0-2 m bgl, 2-5 m bmp and 10-20 m bgl is observed as isolated patches in some parts of the taluk.

From the perusal of post-monsoon (Nov 2022) depth to water level data, it is observed that depth to water level ranged from 1.25 m bgl (Kallugundi) to 11.1 m bgl (Bellare). The Depth to water level map (Fig.10) shows that the water level in the range of 5 to 11 m bgl is the general water level in the taluk. Depth to water level in the range of 0 to 2 m bgl and 2-5 mbgl is observed as isolated patches in some parts of the taluk.

1.9.2. Aquifer-II:

The pre-monsoon (May 2022) piezometric water level of deeper aquifer (Bore well) data indicates that the depth to water level ranged from 6.9 m bgl (Subramanya) to 20.64 m bgl (Guthigar) in the taluk. The pre-monsoon piezometric water level map (Fig.-11) depicts that the water level in the range of 10 to 15 m bgl is the general piezometric level in the state. Depth to piezometric water level in the range of <10 m bgl and 15 to 21 m bgl is observed as isolated patches in some parts of the taluk.

The post-monsoon (Nov 2022) piezometric water level of deeper aquifer (Bore well) data indicates that the depth to water level ranged from 4.65 m bgl (Bellare) to 20.74 m bgl (Guthigar). The post-monsoon piezometric water level map (Fig.-12) depicts that the water level in the range of 10 to 21 m bgl is the general piezometric level in the state. Depth to piezometric water level in the range of <5 m bgl and 5-10 m bgl is observed mainly in some parts of the taluk.

1.9.3. Seasonal Water Level Fluctuation

Consequent upon seasonal rainfall, the water levels record a rise, indicating the buildup of storage in ground water reservoir. During the non-monsoon period, this gets depleted due to exploitation and natural discharge. Therefore, the water levels, in general show, a receding trend from December to May. The seasonal water level fluctuation for the year 2022 is available for 18 dug wells (Aquifer-I) and 7 piezometers (Aquifer-II). Out of 18 dug wells, 11 dugwells show rise in water level in the range of 0.07 m to 5.95 meter, while 7 dugwells show fall in water level in the range of 0.08 to 2.17 m. Out of 7 piezometers, 4 piezometers show rise in water level in the range of 0.45 m to 3.8 m. Fall in water level is shown in 3 piezometers in the range of 0.1 m to 0.6 m. The seasonal water level fluctuation map for Aquifer-I and Aquifer-II is shown in Fig.13 and Fig.14 respectively.

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	Ajjavra	Dug Well	9.7	6.3	6.2	0.1
2	Allety Mevinadka	Dug Well	9.5	6.65	6.48	0.17
3	Aranthodu	Dug Well	20	12.26	10.55	1.71
4	Balpa	Dug Well	12.57	6.85	9.02	-2.17
5	Bellare	Dug Well	16.5	14.85	11.1	3.75
6	Chowdichar-A	Dug Well	10.5	8.14	7.91	0.23
7	Goonadka	Dug Well	6.5	4.43	1.39	3.04
8	Jalsur	Dug Well	12.1	6.34	6.9	-0.56
9	Kallugundi	Dug Well	8.05	1.98	1.25	0.73
10	Sampaje	Dug Well	7.7	4.72	4.8	-0.08
11	Sonnagiri	Dug Well	7.3	7.15	4.53	2.62
12	Subramanya1	Dug Well	9	4.9	4.83	0.07
13	Sullia	Dug Well	11.5	3.41	3.7	-0.29
14	Yenekal	Dug Well	9.1	5.95	6.1	-0.15
Aquifer-II (Fractured Aquifer)						
1	Subramanya	Borewell	50	6.9	5.95	0.95
2	Sulya	Borewell	50	12.62	11.83	0.79

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

Sr. No	Village	Type of Well	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	Bellare	Dugwell	8.83	6.38	2.45
2	Guthigar	Dugwell	10.22	4.27	5.95
3	Jalsoor	Dugwell	5.4	7	-1.6
4	Sampaje	Dugwell	0.9	1.35	-0.45
Aquifer-II (Fractured Aquifer)					
1	Aranthodu	Borewell	15.48	15.03	0.45
2	Bellare	Borewell	8.45	4.65	3.8
3	Guthigar	Borewell	20.64	20.74	-0.1
4	Jalsoor	Borewell	8.03	8.63	-0.6
5	Sullia	Borewell	10.7	11.2	-0.5

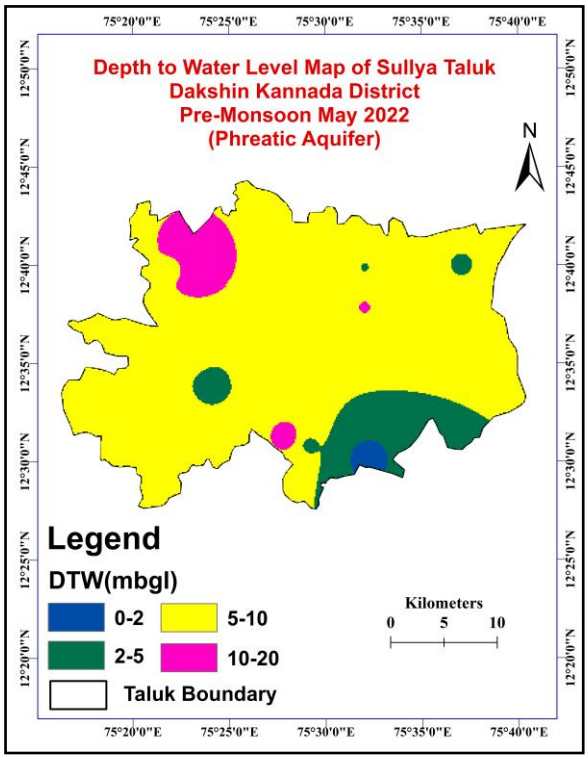

Fig.9: Pre-monsoon Depth to Water Level (Phreatic Aquifer)

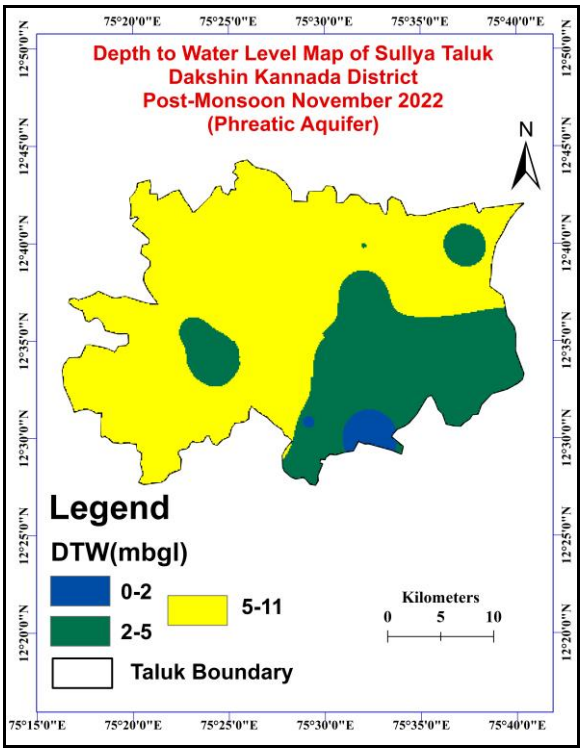

Fig.10: Post-monsoon Depth to Water Level (Phreatic Aquifer)

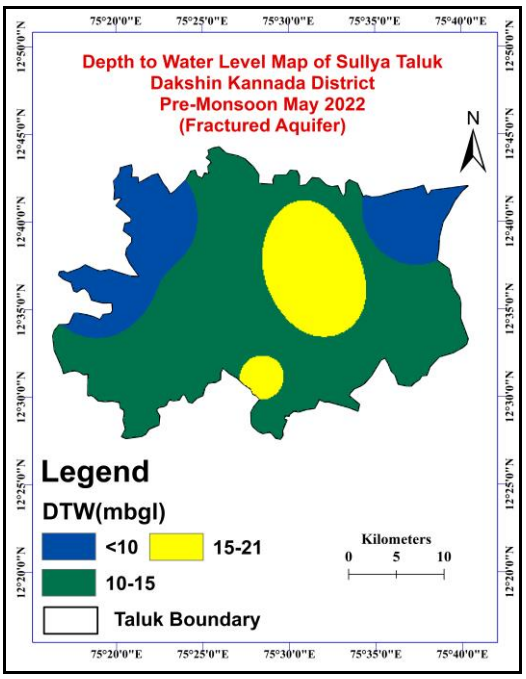

Fig.11: Pre-monsoon Depth to Water Level (Fractured Aquifer)

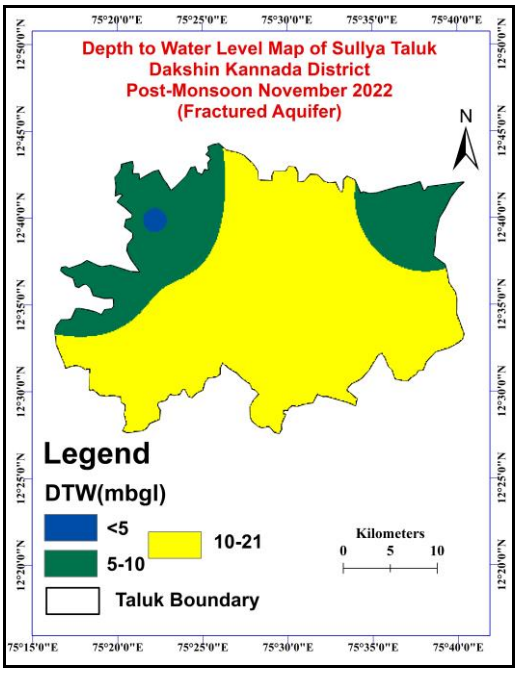

Fig.12: Post-monsoon Depth to Water Level (Fractured Aquifer)

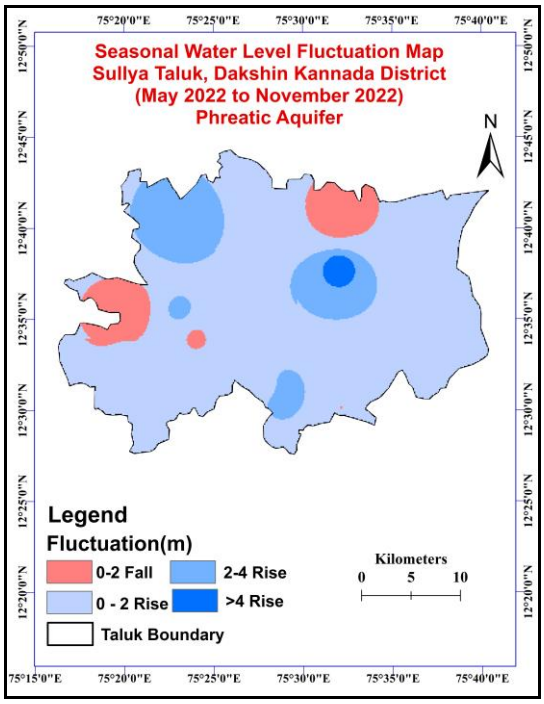

Fig.13: Seasonal Water Level Fluctuation Map (Phreatic Aquifer)

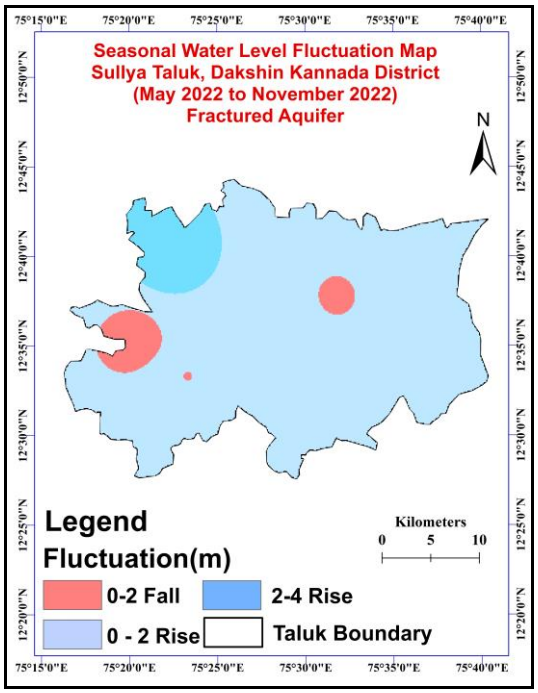

Fig.14: Seasonal Water Level Fluctuation Map (Fractured Aquifer)

2. AQUIFER DISPOSITION

2.1. Depth wise Aquifer Systems:

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.

Ground water occurs within the weathered and fractured banded gneissic complex under water table condition and semi-confined condition. Borewell inventory reveals that depth of weathered zone ranges from 6.8 mbgl to 40 mbgl (Fig.15). Fractured gneissic complex is the major water bearing formation (Fig-16). In the taluk bore wells were drilled to a maximum depth of 200 mbgl. Fractured formation was encountered between the depths of 14 mbgl to 100 mbgl. Yield ranges from Negligible to 7.7 lps.

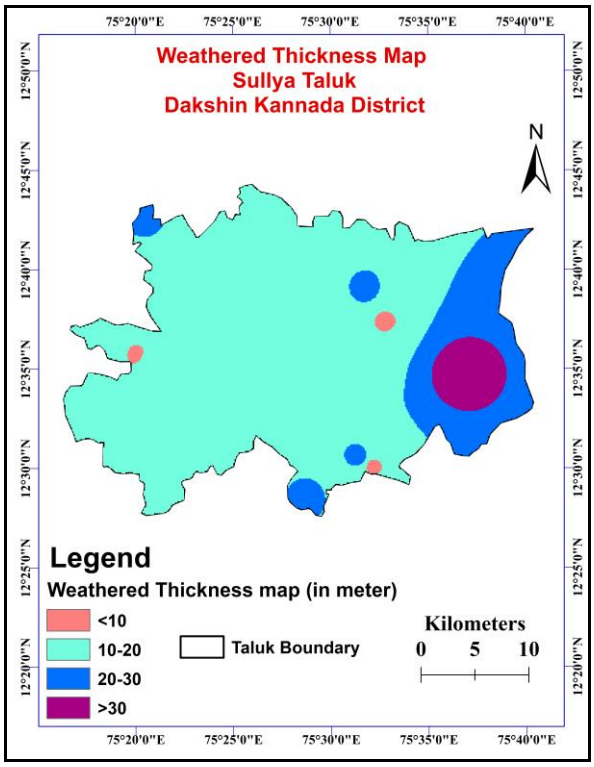

Fig.15: Weathered Thickness Map

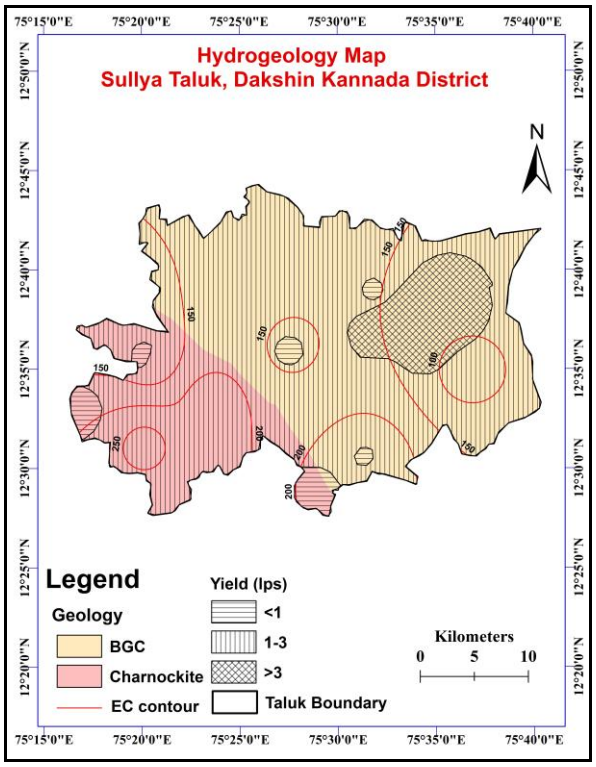

Fig.16: Hydrogeology Map

2.1.1 Aquifer-I (Shallow Phreatic aquifer)

Aquifer – I comprises of Laterites (weathering product of charnockite), weathered granitic schists and gneisses. The spatial distribution of depth of occurrence and aquifer thickness of Aquifer-I is depicted in Fig. 17. It indicates that the depth of occurrence of weathered zone of aquifer – I ranges from 14 to 40 m bgl. The shallow depth of occurrence of 14-20 mbgl occurs in about 60% of the taluk area while the deeper depth of occurrence of 30-40 mbgl occurs in about 15 % of the taluk.

The perusal of the map for aquifer thickness indicates that it ranges from 4 to 12 m, however aquifer thickness of 4 to 8 m is observed in about 60 % of the area of the taluk. The aquifer thickness of 8 to 12 m is observed in 40% of the taluk area.

2.1.2. Aquifer-II (Deeper Fractured aquifer)

It comprises of fractured granite gneiss and schistose rock. The spatial distribution of depth of occurrence and aquifer thickness of Aquifer-II is depicted in Fig. 18. It indicates that the depth of occurrence of fractures in aquifer – II ranges from 50 to 100 m bgl. However, it mainly occurs in the depth range of 50 to 70 m bgl covering about 80 % of the area throughout the taluk.

The perusal of the map for fractured aquifer thickness indicates that it ranges from 0 to 8 m, however aquifer fracture thickness of 4 to 8 m is observed in about 60% of the area throughout the taluk.

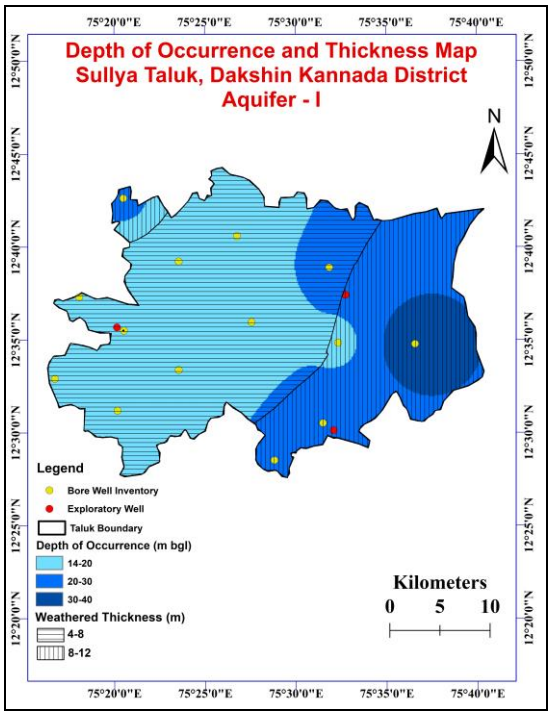

Fig.17: Depth of Occurrence and Thickness Map Sullya Taluk, D.Kannada District Aquifer-I

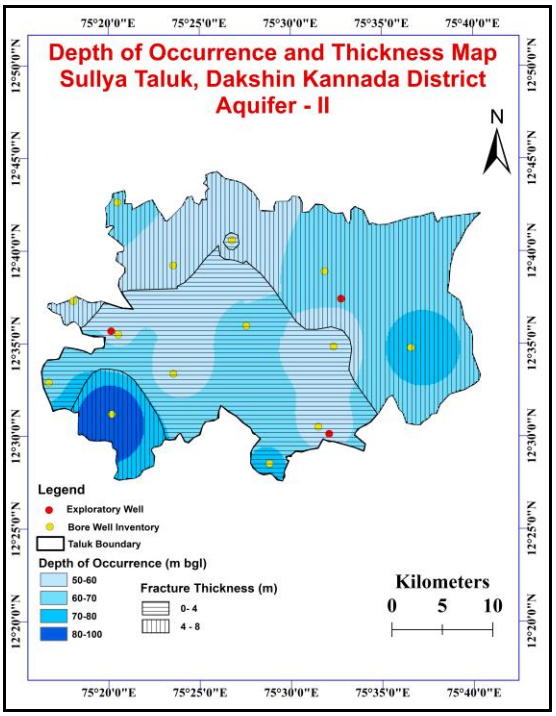

Fig.18: Depth of Occurrence and Thickness Map Sullya Taluk, D.Kannada District Aquifer-II

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

Sl. No	Location	Lat &Long	Depth (m bgl)	Lithology	SWL (mbgl)	Q (lps)	DD (m)	T (m^2/day)
1	Guttigaru EW	N12.62361111 E75.54583333	121	Granitic Gneiss	3.375	7.7	9.615	55
2	Guttigaru OW	N12.62361111 E75.54583333	122	Granitic Gneiss	3.065	7	9.27	55
3	Jalsoor EW	N12.594652 E75.335807	200	Granitic Gneiss	20.14	0.7	9.55	20
4	Kalgundi Ew	N12.502035 E75.534806	200	Granitic Gneiss	8.747	1.6	19.75	3

Table 10b: Well Inventory Data, Sullya Taluk

Sl.No	Location	Latitude	Longitude	Depth (mbgl)	Casing (m)	Lithology	Fracture zones (m)	Q (lps)
1	Sulya	12.556316	75.392501	92	15	Graniti Gneiss	15-16, 54-55	1
2	jalsoor	12.591699	75.342219	99	14	Graniti Gneiss	14-15, 58-59	1.25
3	Guddadka	12.621825	75.301219	92	19	Graniti Gneiss	19-20, 53-54	2.3
4	Kolchar	12.51991	75.336234	120	20	Graniti Gneiss	20-21, 99-100	1.75
5	Kadepala	12.508537	75.524925	92	24	Graniti Gneiss	24-25, 56-57	0.78
6	Nellur	12.599256	75.459417	95	15	Graniti Gneiss	15-16, 60-61	0.8
7	Kollamogru	12.579533	75.609616	120	40	Graniti Gneiss	40-41, 75-76	2.9
8	Thodikana	12.4753	75.4803	92	21	Graniti Gneiss	21-22, 71-72	0.53
9	Adoor	12.5485	75.2787	95	19	Graniti Gneiss	19-20, 68-69	0.7
10	Guthigar	12.6482	75.5309	95	22	Graniti Gneiss	22-23, 62-63	0.42
11	Karikala	12.6764	75.4462	99	16	Graniti Gneiss	16-17, 56-57	2.85
12	Mukkuru	12.7105	75.3417	101	21	Graniti Gneiss	21-22, 65-66	2.75
13	Kalanja Colony	12.653696	75.392579	96	17	Graniti Gneiss	17-18, 50-51	2.45
14	Madapadi	12.58062	75.538908	111	18	Graniti Gneiss	18-19, 52-53	2.62

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. 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.-19, Fig.-20 and Fig.21.**

The 3-D representation is presented in **Fig. -19**. The disposition of Aquifer-I and Aquifer-II followed by massive formation can be observed in the 3-D aquifer disposition. The depth of the top soil is in the range of 0 to 4.5 m bgl, followed by weathered aquifer observed upto 40 m, which is followed by fractured aquifer which is disposed up to 100 m bgl depth followed by massive formation devoid of any ground water.

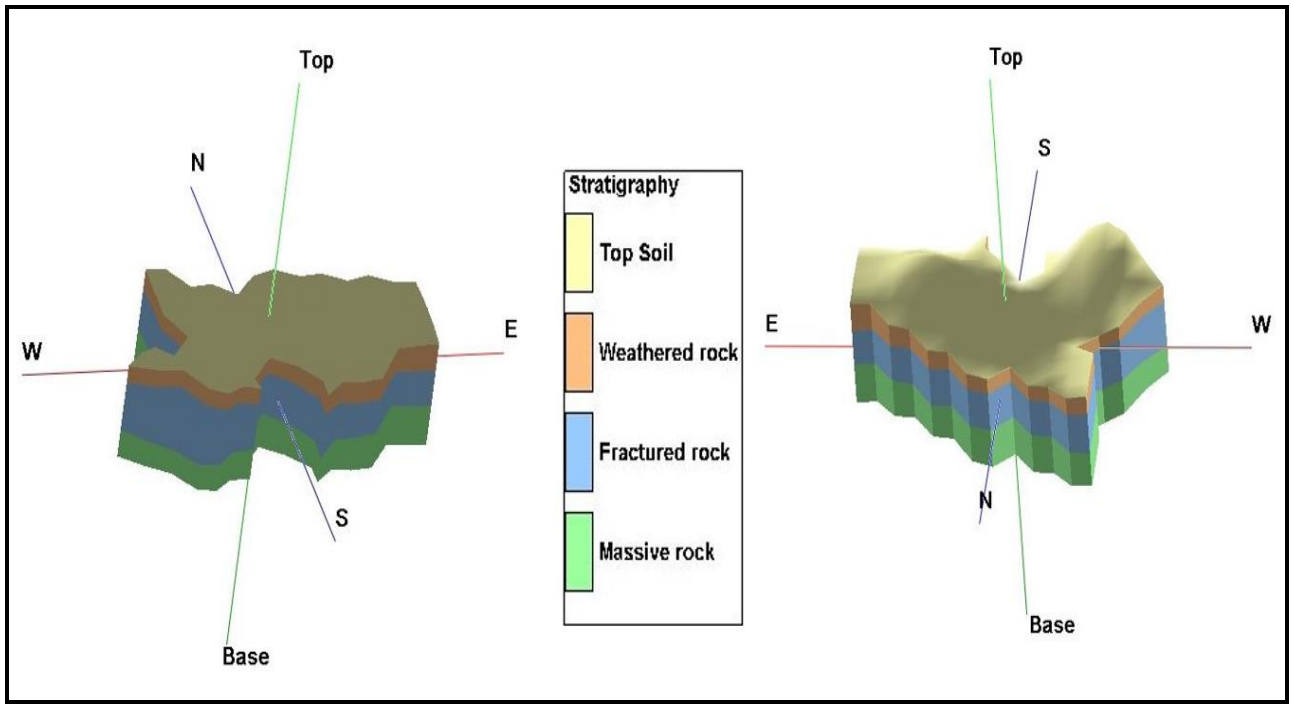

Fig.19: 3D Aquifer Disposition

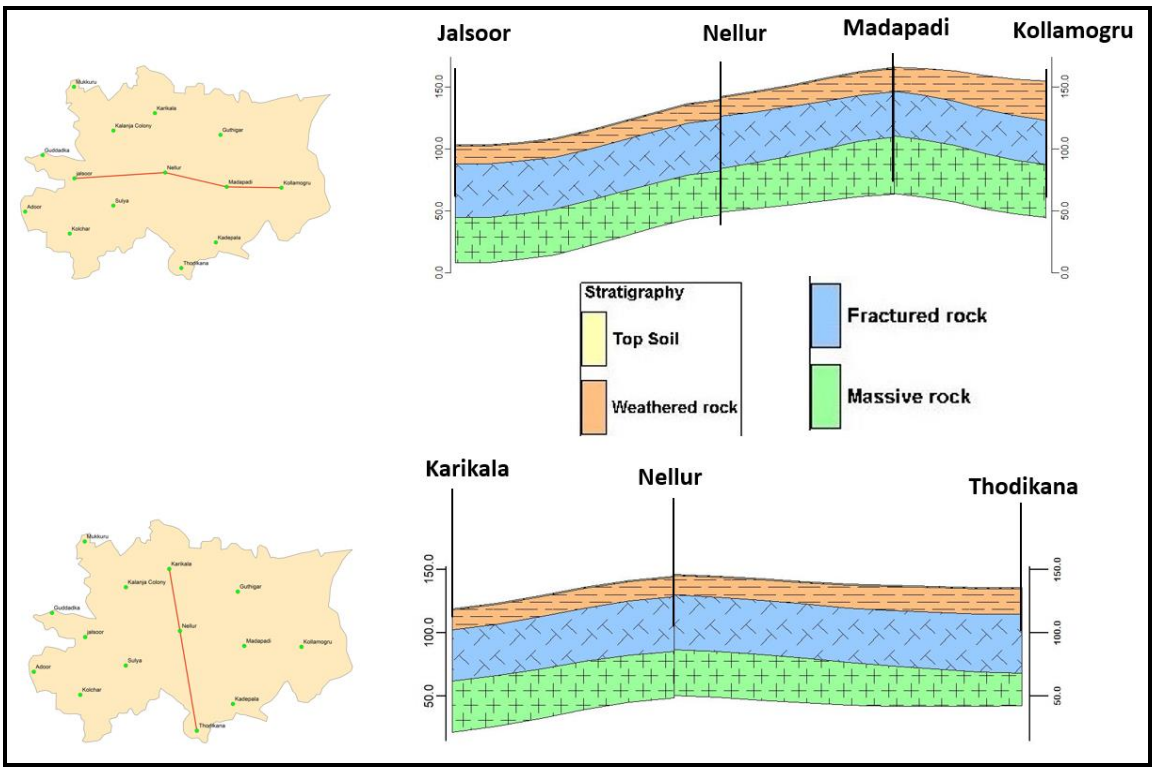

Fig.20:2D Aquifer Cross Section

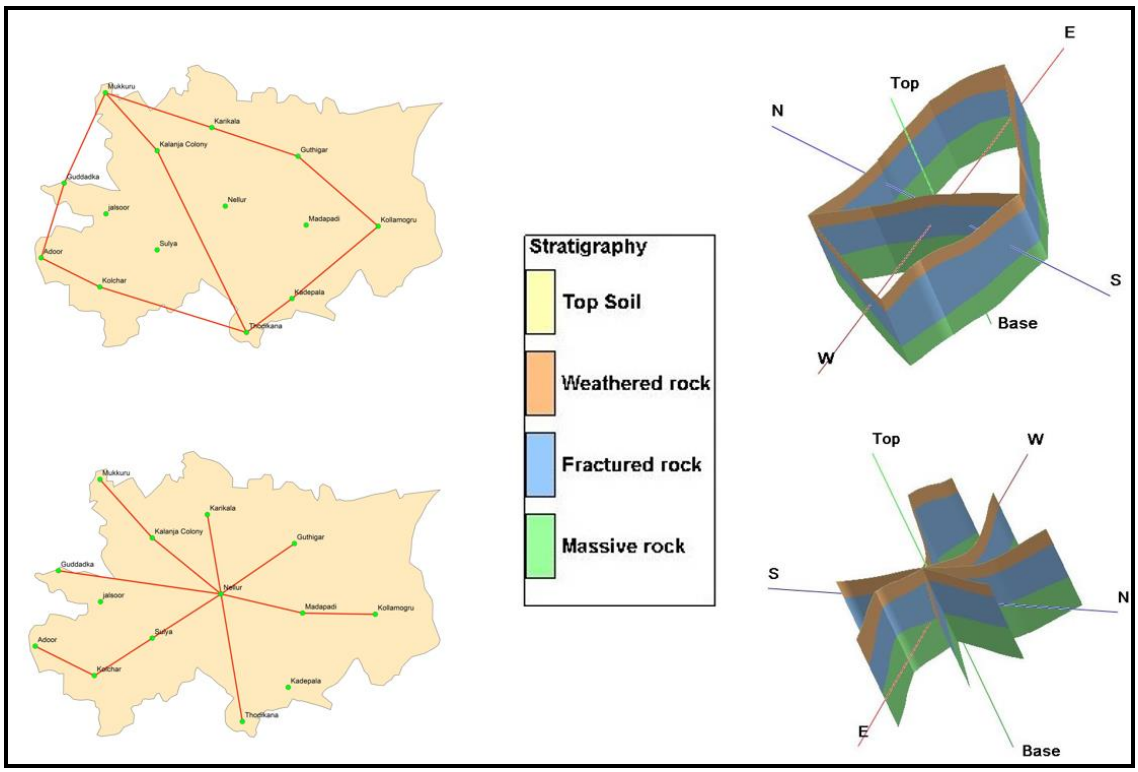

Fig.21:3D Aquifer Fence Diagram

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

3.1. Aquifer wise resource availability and extraction

Table 11: Present Dynamic Ground Water Resource of Sullya Taluk (2022)

Annual extractable ground water resources (ham)	Existing gross ground water draft for irrigation (ham)	Existing gross ground water draft for domestic and industrial 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
4966.71	**2138.4**	**328.3**	**2466.7**	**341.48**	**2486.49**	**49.66**	**SAFE**

Table 12: Comparison of ground water availability and draft scenario in Sullya 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 (%)
	2017			**2020**			**2022**		
Sullya	**6436**	**2893**	**45**	**6845.79**	**1804.00**	**26.35**	**4966.71**	**2466.7**	**49.66**

It is evident from the above table (**Table-10 and Table-11**) that Groundwater availability increased from 2017 to 2020 while in 2022 it is decreased from 6845.79 ham to 4966.71 ham. For assessment year 2020 and 2022 the taluk is disturbed as compared to assessment year 2017. Since the net extraction is below 60%, the taluk is categorized as "**safe**".

3.2. Chemical quality of ground water and contamination

Interpretation from Chemical Analysis results in Sullya taluk is mentioned as under and the data is shown in **Table.12**. The pH ranges from 5.72 to 6.86 in Aquifer-I and 6.58 to 7.67 in Aquifer-II at 25^0C. EC values ranges from 33 to 230 µ/mhos/cm in aquifer-I at 25^oC (Fig.-22) and from 87 to 265 µ/mhos/cm in the aquifer-II(Fig.25). Nitrate concentration in ground water ranges from 0.31 to 12.9 mg/l in the Aquifer–I (Fig.23) and ranges from 0.05 to 0.93 mg/l in the Aquifer–II(Fig.26). Fluoride concentration in ground water ranges between 0 to 0.9 mg/l in the aquifer-I (Fig-24) and ranges between 0.02 to 0.11 mg/l in the aquifer-II(Fig.27).

In general, ground water quality in Sullya taluk is good for drinking purpose as per "Indian Standard Drinking Water Specification 2012".

Table-13: Quality of ground water in Sullya taluk, Dakshin Kannada District

S. No.	Location	pH	EC (µS/cm)	NO_3 (mg/L)	F (mg/L)
Aquifer-I (Phreatic Aquifer)					
1	Sampaje	6.17	92	12.25	0.20
2	Kallugundi	6.05	34	5.35	0.90
3	Goonadaka	6.25	181	1.69	0.30
4	Aranthodu	6.21	230	8.57	0.89
5	Alletty Mevinadaka	6.17	110	1.41	0.94
6	Ajjavara	6.33	93	2.45	0.48
7	Sulya	6.1	144	9.6	0.24
8	Sonnagiri	6.50	33	1.62	0.00
9	Jalsoor	5.72	120	12.9	0.70
10	Subramanya1	6.86	44	0.31	0.38
11	Bellare	6.62	134	3.24	0.46
12	Balapa	6.7	121	2.89	0.05
13	Yenkal	6.83	76	1.37	0.64
Aquifer-II (Fractured Aquifer)					
1	Sulya	7.44	224	1	0.07
2	jalsoor	7.65	120	1	0.09
3	Guddadka	6.58	116	0	0.05
4	Kolchar	7.52	265	0	0.05
5	Kadepala	7.65	230	0	0.07
6	Nellur	7.67	142	0	0.11
7	Kollamogru	7.10	87	0	0.03

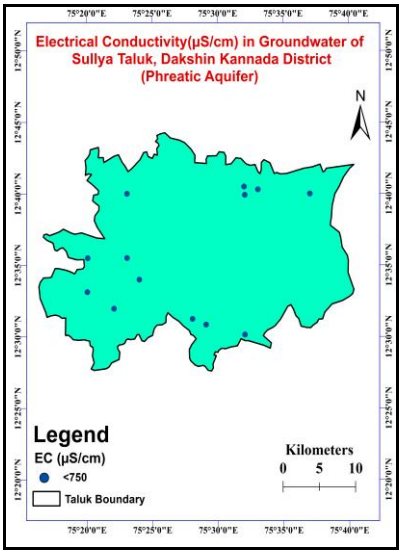

Fig-22. Distribution of EC (Phreatic Aquifer)

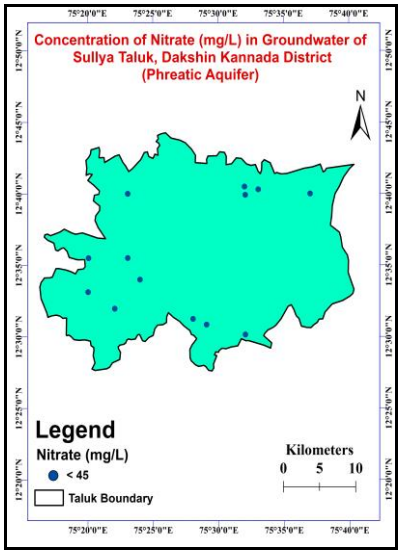

Fig-23. Distribution of Nitrate (Phreatic Aquifer)

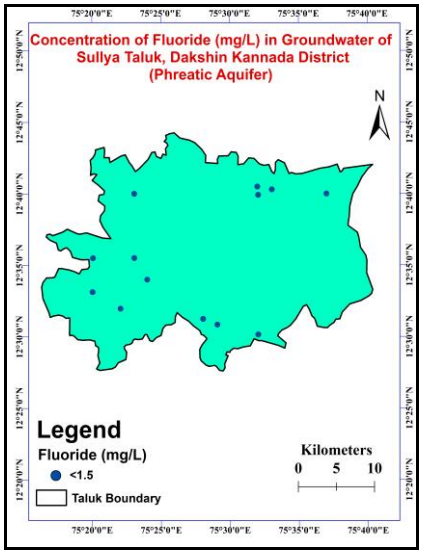

Fig-24. Distribution of Fluoride (Phreatic Aquifer)

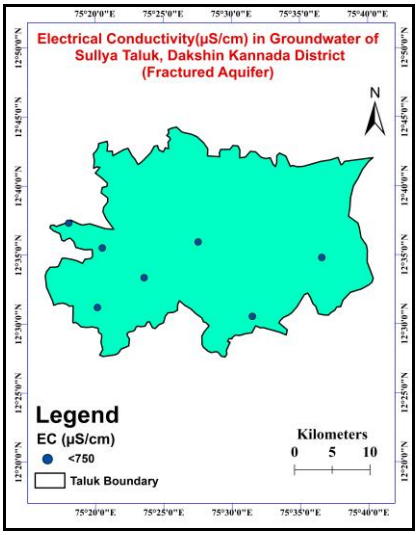

Fig-25. Distribution of EC (Fractured Aquifer)

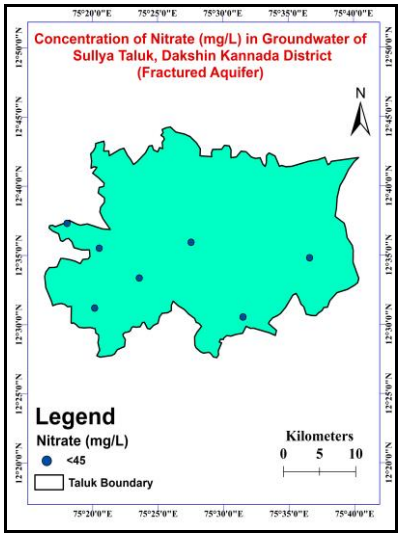

Fig-26. Distribution of Nitrate (Fractured Aquifer)

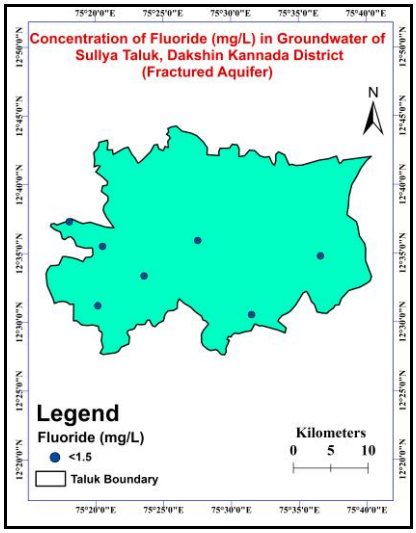

Fig-27. Distribution of Fluoride (Phreatic Aquifer)

4. GROUND WATER MANAGEMENT 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-13**) 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 is given in **Fig.28.**

The entire area of Sullya taluk is feasible for recharge i.e., **369** sq.km. and the surface surplus non-committed runoff availability is **26.076** MCM, which is considered for planning of AR structures. For this, a total of **1** sub-surface dyke and **23** percolation tanks are proposed. The volume of water expected to be conserved/recharged **@75%** efficiency is **19.557** MCM through these AR structures. The approximate cost estimate for construction of these AR structures is **483.27** lakhs. The additional area which can be brought under assured ground water irrigation will be about **2400** hectares. The tentative list of the proposed Percolation Tanks is listed in Annexure-I. **However, the figures given are tentative and pre-field studies / DPRs are recommended prior to implementation of these recharge structures**.

Table-14: Quantity of Non-committed Surface Runoff & Expected Recharge through AR Structures

District	Taluk	Area feasible for AR (Sq.km)	Number of Proposed Recharge Structures				Cost of Recharge structures (Rs. In lakhs)				Availability of surface non-committed monsoon run off (MCM)
			Sub surface dykes	Percolation Tanks	Check Dam	Filter Bed	SSD (@ 20 lakhs)	PT (Rs. @ 20 lakhs)	CD (@ Rs.10 (lakhs)	Filter Bed@ 1.5 lakhs	
Dakshin Kannada	Sullya	369	1	23	0	0	13.91	469.36	0	0	26.076

Recharge from each structure (MCM)				Total Recharge (MCM)	Total cost in lakhs	Expected Benefit of Artificial Recharge and RWH	
Subsurface dykes	Percolation Tanks	Check Dam	Filter Beds			Volume of water likely to be recharged (MCM)	Additional Irrigation Potential likely to be created (hectares)
6.519	19.557	0	0	26.076	483.27	19.557	2400

(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.)

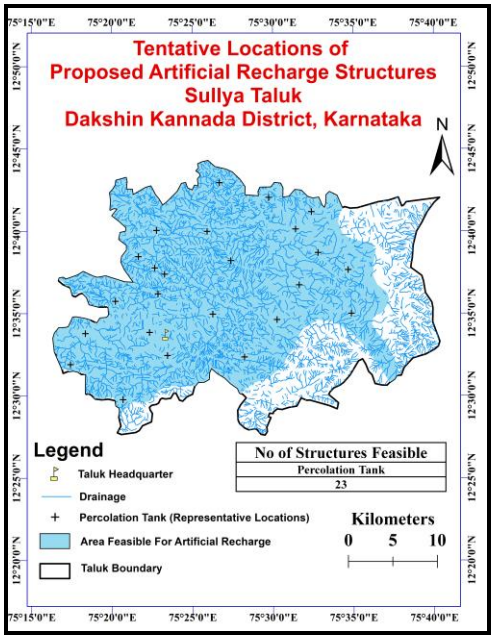

Fig.28: Tentative Locations of proposed Artificial Recharge Structures

4.2. Resource Savings by Demand Side Interventions

4.2.1. Advanced Irrigation Practices

It is observed that dug wells and borewells contribute 75% of the source for irrigation in Sullya taluk. Water intensive crops like paddy is grown only in 2.46% of the net irrigated area while coconuts and arecanuts are grown in 46% in the taluk. Water Use Efficiency (WUE) practices like Drip Irrigation, Sprinkler Irrigation needs to be strengthened to save irrigation water (appx.20%) of the existing ground water draft for irrigation .

4.3. Ground Water Development Plan

In Sullya taluk, the present stage of ground water extraction (2022) is merely 49.66% with net ground water availability for future use of **2486.49** ham and total extraction of **2466.70** ham. The ground water draft for irrigation purpose is estimated to be **2138.4** ham and there is further scope for developing the resource for irrigation as a part of development with appropriate scientific backing. The implementation of the plan should be based on site specific detailed hydrogeological and scientific surveys for pinpointing the sites for construction of additional abstraction structures. As per tentative estimates, **205 dug wells and 245 bore wells** are recommended to be constructed in feasible areas which is likely to create about **600 hectares** of additional irrigation potential (Table.14).

Table – 15: Feasibility of Additional GW abstraction structures based on GWRA 2022 availability

Annual Extractable GW Resource (Ham)	4966.71
Total Extraction / Draft (Ham)	2466.70
Stage of GW Extraction (%)	49.66
GW Resources available to increase SOE to 60% (Ham)	2980.026
Balance GWR available to enhance SOE 60% (Ham)	513.326
DW unit draft (Ham)	1.00
BW unit draft (Ham)	1.25
No. of DW feasible considering 40% of balance GWR with unit draft of 1 ham	205
No. of BWs feasible considering 60% of balance GWR with unit draft of 1.25 ham	245
GW Resource to be developed through Dugwell (ham)	205
GW Resource to be developed through Borewell (ham)	308
Additional Irrigation Potential created by Dug Wells (Ha)	240
Additional Irrigation Potential created by Bore Wells (Ha)	360
Total additional Irrigation Potential created by Borewells and Dugwells (ha)	600

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

4.4. Regulation and Control

Sullys taluk has been categorized as **"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.
- Water quality data shows, there is no quality issue in the taluk, but periodical monitoring of water samples is highly recommended to decipher long term quality issue.

5. SUMMARY AND RECOMMENDATIONS

The summary of ground water management plan of Sullya taluk is given in **Table-15.**

Table 16: Summary of Management Plan of Sullya taluk

Net Ground Water Availability(ham) as per GWRA 2022	4966.71
Existing Ground Water Draft for all uses (ham)	2466.7
Existing Ground Water Draft for Irrigation Use (ham)	2138.40
Existing Stage of Ground Water Development (%)	49.66%, safe
Expected Recharge from Artificial Recharge Structures (ham)	1955.70
Additional Irrigation Potential Created (Ha)	2400
Cumulative Ground Water Availability (ham)	6922.41
Expected Improvement in Stage of Ground Water Development (%)	35.63
Saving Due to adopting Water Use Efficiency in Ham (20 % of existing Irrigation Draft)	427.68
Net Ground Water availability after AR & WUE (ham)	7350.09
Expected Improved Stage of Ground Water Development after implementation of AR & WUE (%)	33.56
Cumulative Improved Stage of Ground Water Development after all implementation (%)	**16.09**
Ground Water Resource Development Plan	
GW Resources available to increase SOE to 60% of existing Net Groundwater availability (ham)	2980.026
Balance GWR available to enhance SOE 60% (Ham)	513.326
DW unit draft (Ham)	1.00
BW unit draft (Ham)	1.25
No. of DW feasible considering 40% of balance GWR with unit draft of 1 ham	205
No. of BWs feasible considering 60% of balance GWR with unit draft of 1.25 ham	245
GW Resource to be developed through Dugwell (ham)	205
GW Resource to be developed through Borewell (ham)	308
Additional Irrigation Potential created by Dug Wells (Ha)	240
Additional Irrigation Potential created by Bore Wells (Ha)	360
Total additional Irrigation Potential created by Borewells and Dugwells (ha)	600

As per the resource estimation–2022, Sullya taluk falls under **Safe category** with the stage of ground water extraction is 49.66 %. 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: The surface surplus non-committed runoff availability is 26.076 MCM, which is considered for planning of AR structures. For this, a total of 1 sub-surface dyke and 23 percolation tanks are proposed. The volume of water expected to be conserved/recharged @75% efficiency is 19.557 MCM through these AR structures. The approximate

cost estimate for construction of these AR structures is Rs. 4.83 Cr. The additional area which can be brought under assured ground water irrigation will be about 2400 hectares. However, the figures given are tentative and pre-field studies / 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 borewells contribute 75% of the source for irrigation in Sullya taluk. Water intensive crops like paddy is grown only in 2.46% of the net irrigated area while coconuts and arecanuts are grown in 46% in the taluk. Water Use Efficiency (WUE) practices like Drip Irrigation, Sprinkler Irrigation needs to be strengthened to save irrigation water (appx.20%) of the existing ground water draft for irrigation.

Ground Water Resource Development Plan: the present stage of ground water extraction (2022) is merely 49.66% with net ground water availability for future use of **2486.49** ham and total extraction of **2466.70** ham. The ground water draft for irrigation purpose is estimated to be **2138.4** ham and there is further scope for developing the resource for irrigation as a part of development with appropriate scientific backing. The implementation of the plan should be based on site specific detailed hydrogeological and scientific surveys for pinpointing the sites for construction of additional abstraction structures. As per tentative estimates, **205 dug wells and 245 bore wells** are recommended to be constructed in feasible areas which is likely to create about **600 hectares** of additional irrigation potential.

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.

Annexure-I:Tentative Locations of Proposed Percolation Tanks, Sullya Taluk, Dakshin Kannada District

S.No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	75.3448	12.4960	Aletty	Aletti	Sullya
2	75.2904	12.5316	Mandekolu	Mandekolu	Sullya
3	75.4705	12.5391	Aranthodu	Aranthodu	Sullya
4	75.3908	12.5408	Aletty	Aletti	Sullya
5	75.3058	12.5629	Mandekolu	Mandekolu	Sullya
6	75.3722	12.5641	Ajjavara	Ajjavara	Sullya
7	75.5043	12.5770	Marakanja	Markanja	Sullya
8	75.4377	12.5826	Ubaradka Mitthuru	Ubaradka Mithuru	Sullya
9	75.5813	12.5833	Madhappadi	Madappady	Sullya
10	75.3369	12.5956	Jalsuru	Jalsoor	Sullya
11	75.5273	12.6121	Gutthigaru	Guthigaru	Sullya
12	75.3878	12.6231	Aivarnadu	Aivarnadu	Sullya
13	75.5780	12.6275	Nalkuru	Guthigaru	Sullya
14	75.3777	12.6294	Aivarnadu	Aivarnadu	Sullya
15	75.4565	12.6368	Kalmadka	Kalmadka	Sullya
16	75.3608	12.6408	Aivarnadu	Aivarnadu	Sullya
17	75.5468	12.6448	Enekallu	Subrahmanya	Sullya
18	75.4319	12.6664	Kalmadka	Kalmadka	Sullya
19	75.3795	12.6674	Bellare	Bellare	Sullya
20	75.5235	12.6687	Balpa	Balpa	Sullya
21	75.5400	12.6861	Enekallu	Subrahmanya	Sullya
22	75.4957	12.7007	Kenya	Balpa	Sullya
23	75.4447	12.7156	Edamangala	Yedamangala	Sullya

(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)