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

Srirangapatna Taluk, Mandya District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

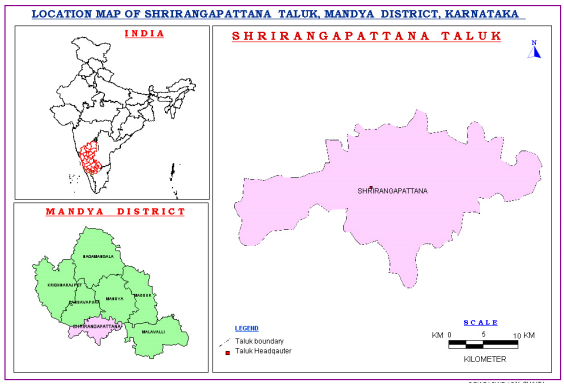
FOR OFFICIAL USE ONLY
No. *SWR/RP/NQM/2022-23/29*

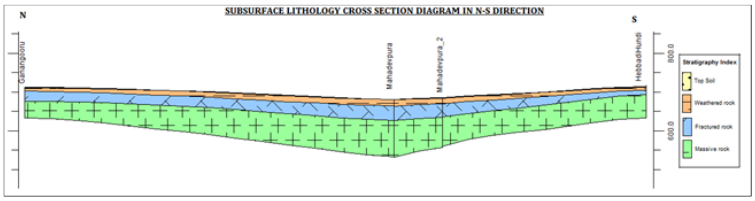
भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास
एवं गंगा संरक्षण विभाग
केन्द्रीय भूमिजल बोर्ड
दक्षिण पश्चिम क्षेत्र, बेंगलुरु

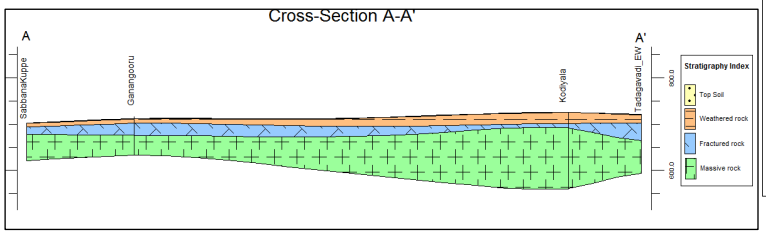
Government of India
Ministry of Jal Shakti
Department of Water Resources,
River Development &
Ganga Rejuvenation
Central Ground Water Board
South Western Region, Bengaluru

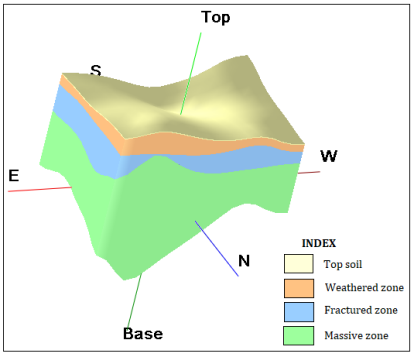
AQUIFER MAPS AND MANAGEMENT PLAN, SRIRANGAPATNA TALUK, MANDYA DISTRICT, KARNATAKA STATE

(AAP :– 2021-2022)









By

Dr.Suchetana Biswas, Scientist 'B', CGWB, SWR, Bengaluru

AUGUST 2022

AQUIFER MAPS AND MANAGEMENT PLAN, SRIRANGAPATNA TALUK, MANDYA DISTRICT, KARNATAKA STATE

Contents

AQUIFER MAPS AND MANAGEMENT PLAN, PANDAVAPURA TALUK, MANDYA DISTRICT, KARNATAKA STATE

1 SALIENT INFORMATION

Name of the Taluk: **SRIRANGAPATNA**

District: Mandya

State:Karnataka

Area:374sq.km

Population:180191

Annual Normal Rainfall: 658mm

1.1 Aquifer Management study area

Aquifer mapping studies were carried out in Srirangapatna taluk, Mandya district of Karnataka, covering an area of 374sq.kms under National Aquifer Mapping Project. Srirangapatna taluk of Mandya district is located between North latitude 12°18'8.28" – 12°30'6.84" & East longitude 76°33'25.92" – 76°54'27.36"and is covered in parts of Survey of India Toposheet Nos.57D/11 and 57D/15. Srirangapatna taluk is bounded by Mandya taluk and Pandavapura taluk on North, Mysore taluk of Mysore district on South-West and T.Narasipura taluk of Mysore district on South-East side. Location map of Srirangapatna taluk of Mandya district is presented in **Figure 1.** Taluk administration of Srirangapatna is divided into 04Hoblies and 21 Gram Panchayats. There are 90 inhabited and 06 uninhabited villages in the taluk.

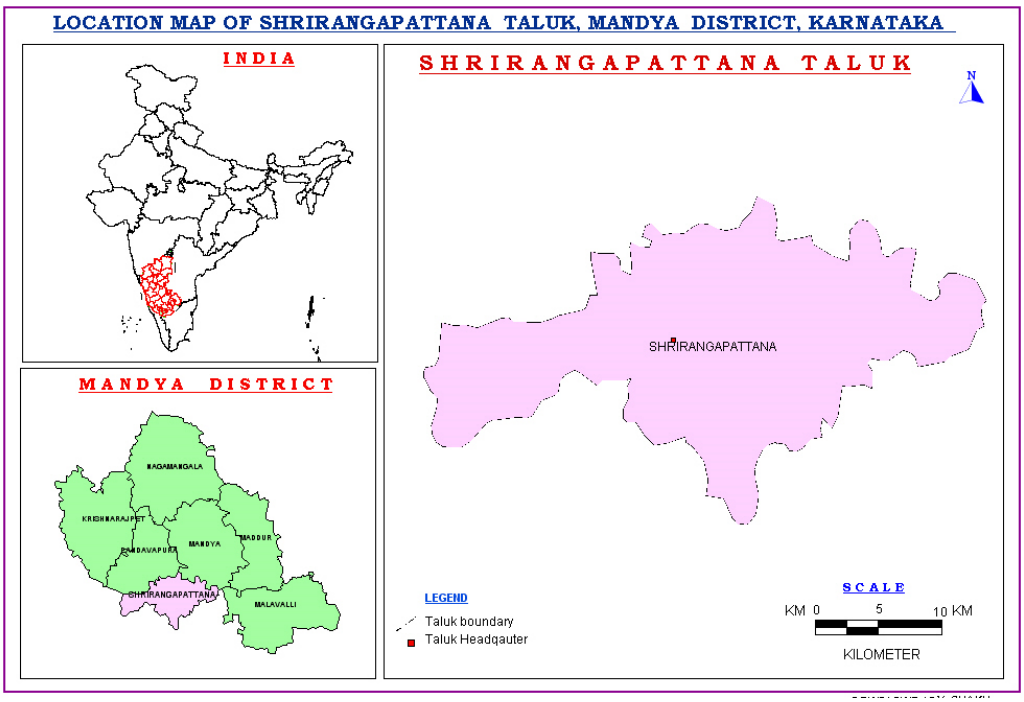


Figure 1: Location Map

1.2 Population

According to 2011 census, the population in Srirangapatnataluk is 1,80,191 of which 89940 male and 90251 female population.

1.3 Rainfall

There are five (05) rain gauge station located in Srirangapatna taluk. Normal annual rainfall is 658mm.Actual annual rainfall for 2019 was 852mm. The annual rainfall data from 2001 to 2019 is given in **Table 1.** Highest rainfall of 1176 mm was received in 2017 and lowest rainfall of 348mm was received in 2002. The year wise rainfall variability graph is given in **Figure-2.**

Table 1: The annual rainfall data from 2001 to 2019 of Srirangapatna taluk, Mandya district

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Rainfall in mm	737	348	537	676	862	437	597	724	846	1019	767	612	554	659	889	**365**	1176	694	851.8

Source:KSNDMC

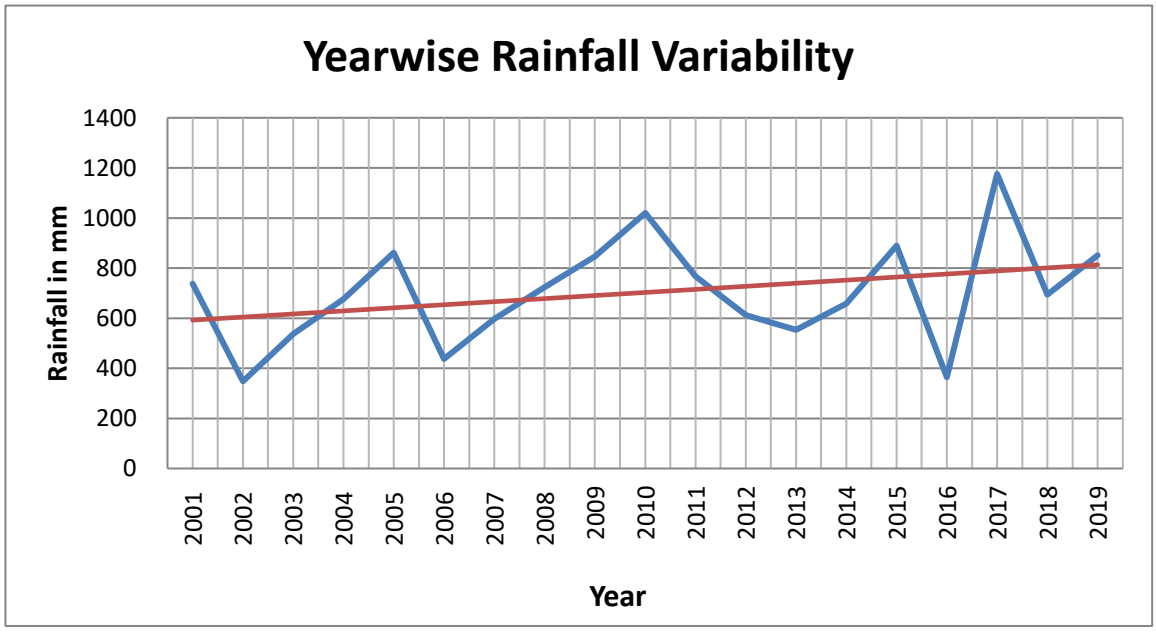


Figure 2: Yearwise annual rainfall graph of Srirangapatna taluk, Mandya district

Srirangapatna taluk experiences semi-arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Southern Dry agro-climatic zone of Karnataka state and is categorized as drought prone.

The climate of the study area is quite agreeable and free from extremes. The year is usually divided into four seasons: 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.

1.4 Agriculture and Irrigation

Agriculture is the main occupation in Srirangapatna taluk. Paddyis the major crop grown in the talukin 7697 ha area, followed by sugarcane (3585 ha),pulses(2854),ragi (2014 ha), and vegetables (1549 ha) **(Table 2)**.

Table2: Cropping pattern in Srirangapatna taluk2015-2016(Ha)

Paddy	Jowar	Maize	Ragi	Other minor millets	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
7697	32	44	2014	0	2854	141	1549	413	3585	0

Source: Mandya District at a Glance 2015-16, Govt. of Karnataka

It is observed that net sown area accounts for about 37.58% of total geographical area, while area sown more than once is 13.24% of total geographical area in the taluk **(Table 3).** As per the data available, 8205ha net area is irrigated through canal water,19 tanks irrigate 235ha net area, 697 dug wells irrigate 225ha net area and 1338 borewells irrigate 850 net area. Lift irrigation irrigates 01ha net area and other sources irrigate 236ha net area. The net area irrigated through surface water is 8440ha and net area irrigated through groundwater is 1075ha. Canals are the main source for irrigation in the taluk **(Table 4).** Landuse pattern of the taluk is represented as **Figure 3**.

Table 3: Details of landuse in Srirangapatna taluk 2015-2016(Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Srirangapatna	37400	725	5640	11203	14057	4950

Source: Mandya District at a Glance 2015-16, Govt. of Karnataka

Table 4: Irrigation details in Srirangapatna taluk (Ha)

Source of Irrigation	Nos./Length	Net area irrigated (Ha)	Gross area Irrigated (Ha)
Canals	80.2km	8205	9481
Tanks	19	235	734
Total surface water irrigated area		**8440**	**10215**

Wells	697	225	325
Bore wells	1338	850	1074
Total ground water irrigated area		**1075**	**1399**
Lift Irrigation	--	01	01
Other Sources	--	236	236
Total		**9752**	**11851**

Source: Mandya District at a Glance 2015-16,Government of Karnataka

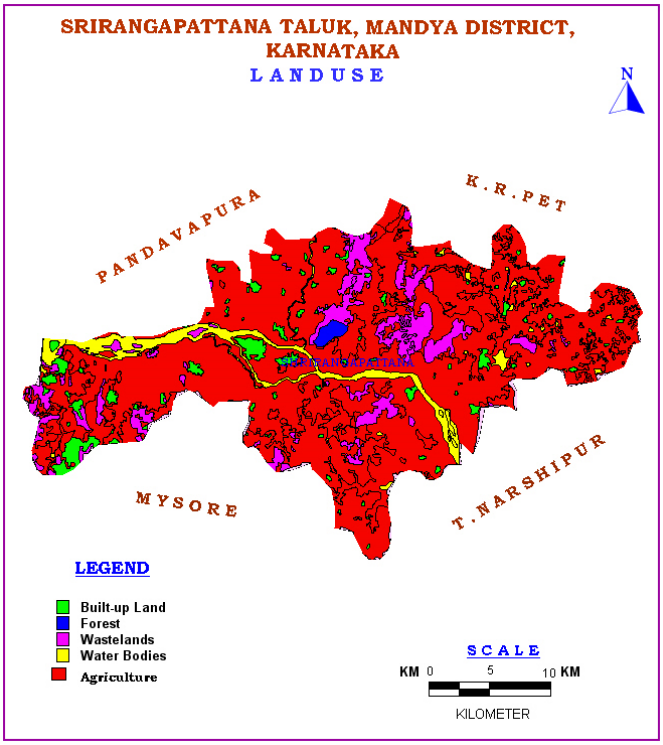


Figure 3: Landuse Map

1.5 Geomorphology, Physiography and Drainage

The taluk is located in the southern maidan region of the state. The surface topography is in the form of undulating plain situated at an average elevation of 680- 750m amsl. There are few sporadic out crops of rocks as hills and few fertile shallow valleys **(Figure 4)**. The Hulikere-Karigatta hill range near Srirangapatna has elevation of 2967 mamsl. The general slope in the taluk is in southeast direction.The taluk is drained by Cauvery river. The famous Krishnarajasagara Dam is situated in this taluk **(Figure 5).**

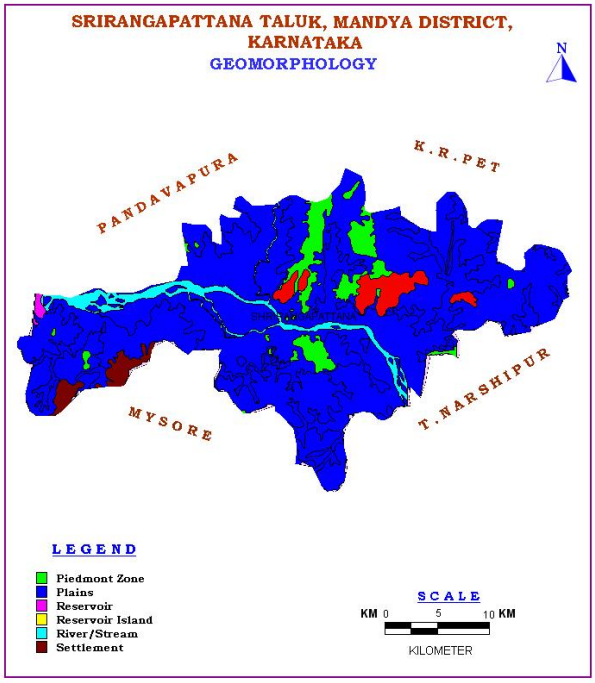


Figure 4:Geomorphology map

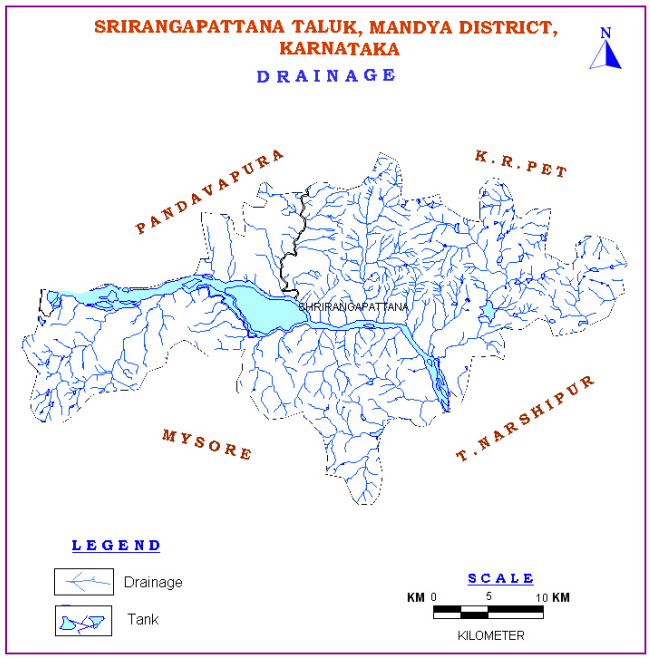


Figure 5:Drainage map

1.6 Soil

The soils range from red sandy loams to red clay loam very thin in ridges and higher elevations and comparatively thick in valley portions. The soil under the old channel areas are high in clay. **(Figure6).**

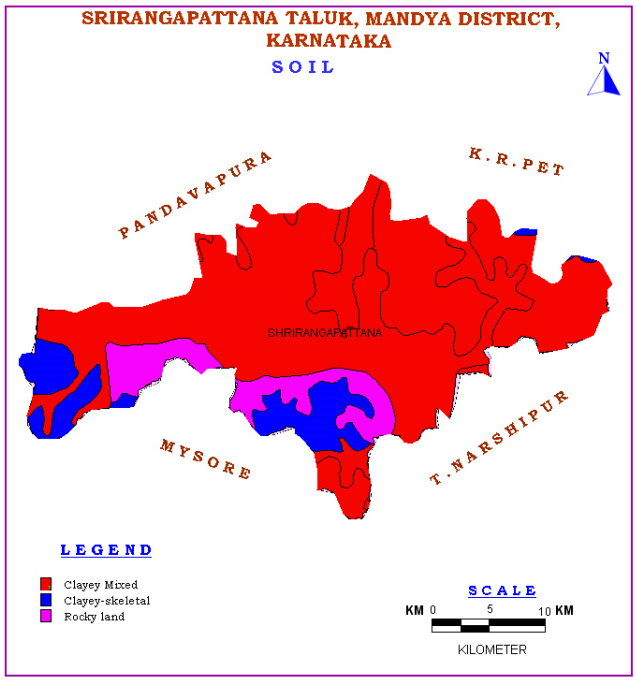


Figure 6: Soil map

1.7 Existing and future water demands (as per GWRA-2020)

The details of dynamic (Phreatic) ground water resources for Srirangapatna taluk as on March 2020 is shown in Table.5. The annual extractable water resource is 7132.67ham.Total groundwater extraction for irrigation and domestic use is 3222.90ham. Annual GW Allocation for domestic use as on 2025 is 445.73ham. Net Ground Water Availability for future use is 3858.09ham.

Table.5 Detail of Dynamic Ground Water resource, Srirangaptna taluk, (March 2020)

Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)
7132.67	2828.84	0.00	394.05	3222.90	445.73	3858.09	45.19

1.8 Water level behaviour

The water level data have been monitored from the representative dug well and borewells for both pre and post-monsoon seasons (Table 6). During pre-monsoon season in i) aquifer-I (phreatic) water level ranges from 0.44 to 6.68 mbgl, ii) aquifer-II (fractured) water level ranges from 5.35 to 7.51 mbgl , whereas in post-monsoon it varies from 0.71 to 6.10 m bgl in aquifer-I (phreatic) and 4.42 to 4.85 mbgl in aquifer-II (fractured) . The seasonal water level fluctuation in aquifer-I is fall in the range of 0.34 m to 0.27 m and rise in the range of 0.47m to 4.49m. The seasonal water level fluctuation in aquifer-II is rise in the range of 0.98m to 2.66m. The pre-monsoon decadal average water level for aquifer-I varies from 0.40 to 8.55mbgl. The post-monsoon decadal average water level for aquifer-I varies from 0.33 to 10.65mbgl.

(a) Depth to water level

Aquifer-I

Pre-monsoon: 0 .44-6.68 mbgl (May 2019) **(Figure 7)**

Post-monsoon: 0.71-6.10 mbgl (Nov 2019) **(Figure 8)**

Aquifer-II

Pre-monsoon: 5.35-7.51 mbgl (May 2019)

Post-monsoon: 4 . 4 2 - 4 . 8 5 mbgl (Nov 2019)

(b) Water level fluctuation

Aquifer-I

Seasonal Fluctuation: Fall in the range of 0.34 m to 0.27m and rise in the range of 0.47m to 4.49m. **(Figure 9)**

Aquifer-II

Seasonal Fluctuation: Rise in the range of 0.98m to 2.66m.

Table 6: Depth to water level (Pre & Post monsoon 2019)

Sl. No.	Well type	Village name	DTWL (m bgl) (Pre-monsoon 2019)	DTWL (m bgl) (Post-monsoon 2019)
1	Dug Well	Arakere1	2.16	1.56
2	Dug Well	Chikapalya	1.16	1.43
3	Dug Well	Kodiyala1	5.12	2.42
4	Dug Well	Mahadevapura1	7.45	2.96
5	Dug Well	Mandya koppalu	0.44	0.78
6	Dug Well	Naguvanahalli	1.18	0.71
7	Dug Well	Sreenivasa Agrahara	6.68	6.10
8	Dug Well	Srirangapatna	4.14	3.30
9	Dug Well	Tadagavadi	2.83	2.24
10	Borewell	Srirangapatna	5.35	4.42
11	Borewell	Arakere	7.51	4.85

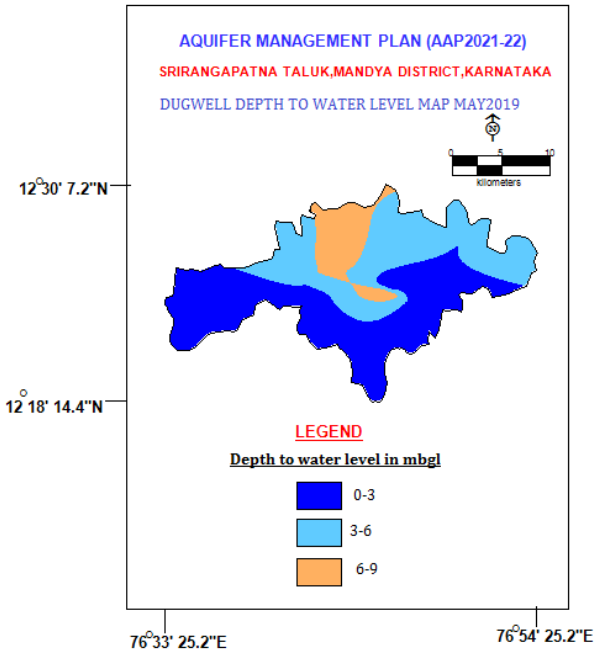


Figure 7: Aquifer-I
Depth to water level May 2019

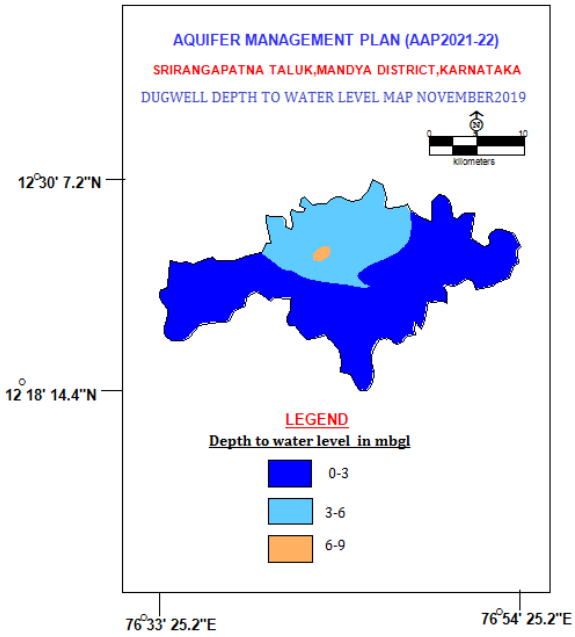


Figure 8: Aquifer-I
Depth to water level map November 2019

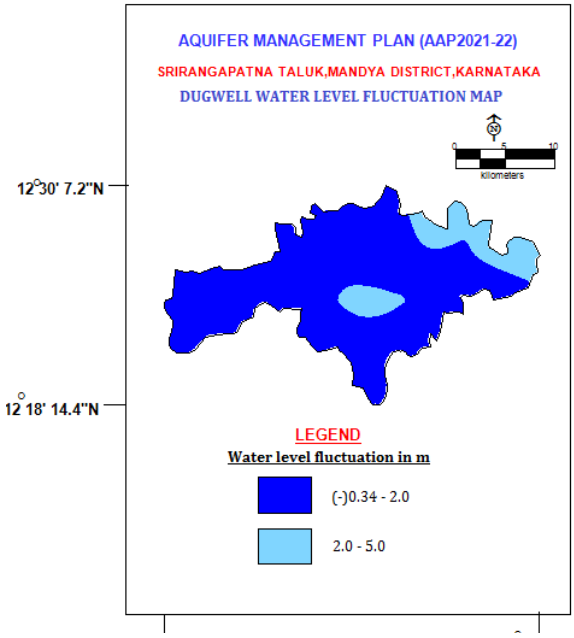


Figure 9: Aquifer-I Water level fluctuation map

The long term groundwater trend (2011-2020) for pre-monsoon period shows a fall in the range 0.05m/year to 0.25m/year and rise in the range of 0.022m/year to 0.16m/year (Table 7). The long term groundwater trend (2011-2020) for post-monsoon period shows a fall in the range 0.010m/year to 0.093m/year and rise in the range of 0.136m/year to 0.1641m/year (Table 8). During pre-monsoon period monitoring stations are mostly showing falling trend and during post-monsoon period monitoring stations are mostly showing rising trend.

Table 7: Pre-monsoon Trend of Groundwater monitoring stations (2011 to 2020)

SL_NO_	LOCATION	RISE (M/YEAR)	FALL (MYEAR)	AQUIFER_TYPE
1	Arakere1		0.0505	Unconfined
2	Chikapalya	0.1359		Unconfined
3	Kodiyala1	0.1641		Unconfined
4	Mahadevapura1		0.2546	Unconfined
5	Mandya koppalu	0.0228		Unconfined
6	Naguvanahalli		0.0774	Unconfined
7	Srirangapatna	0.0530		Unconfined

Table 8: Post-monsoon Trend of Groundwater monitoring stations (2011 to 2020)

SL_NO_	LOCATION	RISE (M/YEAR)	FALL(M/YEAR)	AQUIFER_TYPE
1	Arakere1		0.0522	Unconfined
2	Chikapalya		0.0669	Unconfined
3	Kodiyala		0.4738	Semi-Confined
4	Kodiyala1	0.1641		Unconfined
5	Mahadevapura1		0.0934	Unconfined
6	Mandya koppalu		0.0448	Unconfined
7	Naguvanahalli		0.0108	Unconfined
8	Srirangapatna	0.1368		Unconfined

2 AQUIFER DISPOSITION

2.1 Numberof aquifers

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

i. **Aquifer-I (Phreatic aquifer)** comprising of weathered granitic gneiss

ii. **Aquifer-II (Fractured aquifer)** comprising fractured granitic gneiss

In Srirangapatna taluk, fractured granitic gneiss is the major water bearing formation. A small portion is covered with granite, charnockite and schist **(Figure 10)**. Groundwater occurs within the jointed and fractured granitic gneiss under semi-confined to confined conditions. In Srirangapatna taluk borewells were drilled from a minimum depth of 70.75 mbgl to a maximum of 202.3mbgl **(Table 9)**.

Depth of weathered zone (Aquifer-I) ranges from 6.2mbgl to 20.8mbgl. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depth of 30 to 100m bgl**.** Yield ranges from 0.2 to 2.4lps. Subsurface lithology cross-section is given in **Figure 11a,b.** 3D aquifer disposition is shown in **Figure 12a,b.** Fence diagrams are shown in **Figure 13.**

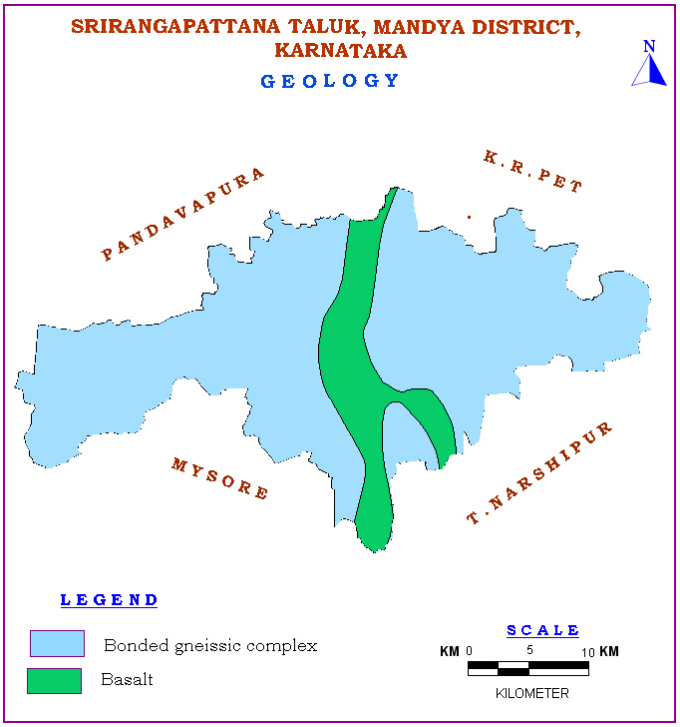


Figure 10: Geology Map

Table 9: Details of Ground water Exploration

Sl. No.	Location	Latitude(N)	Longitude (E)	Depth Drilled (m bgl)	Casing Depth (m bgl)	Fracture Zones (mbgl)	SWL (mbgl)	Q (lps)	DD (m)
1.	Kodiyala	12.4555556	76.838889	200	14.5	20.2-22.2, 30.4-31.0, 53, 56.9, 58.9	11.05	1.75	35.49
2.	Mahadevpura	12.3875	76.783333	200	20.0	17.2-18.2, 30.4-31.0, 53, 56.9, 58.9, 63.5-65.5	4.95	1.24	No data
3.	TadagavadiEw	12.44	76.85	90	14.7	17.2-18.2, 30.4-31.0, 53, 56.9, 58.9, 84.8	2.757	2.75	32.77

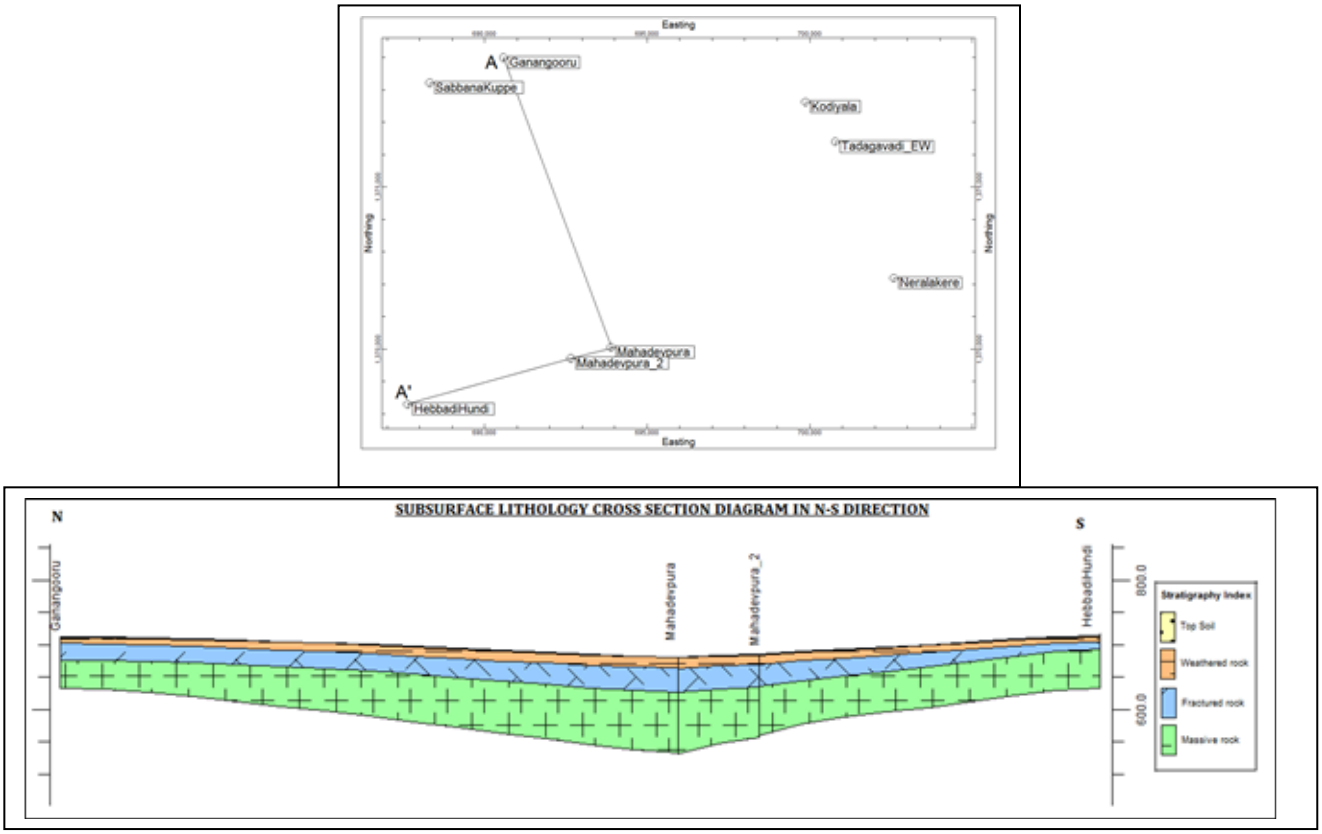


Figure 11a: N-S Cross section of wells drilled in Srirangapatna taluk

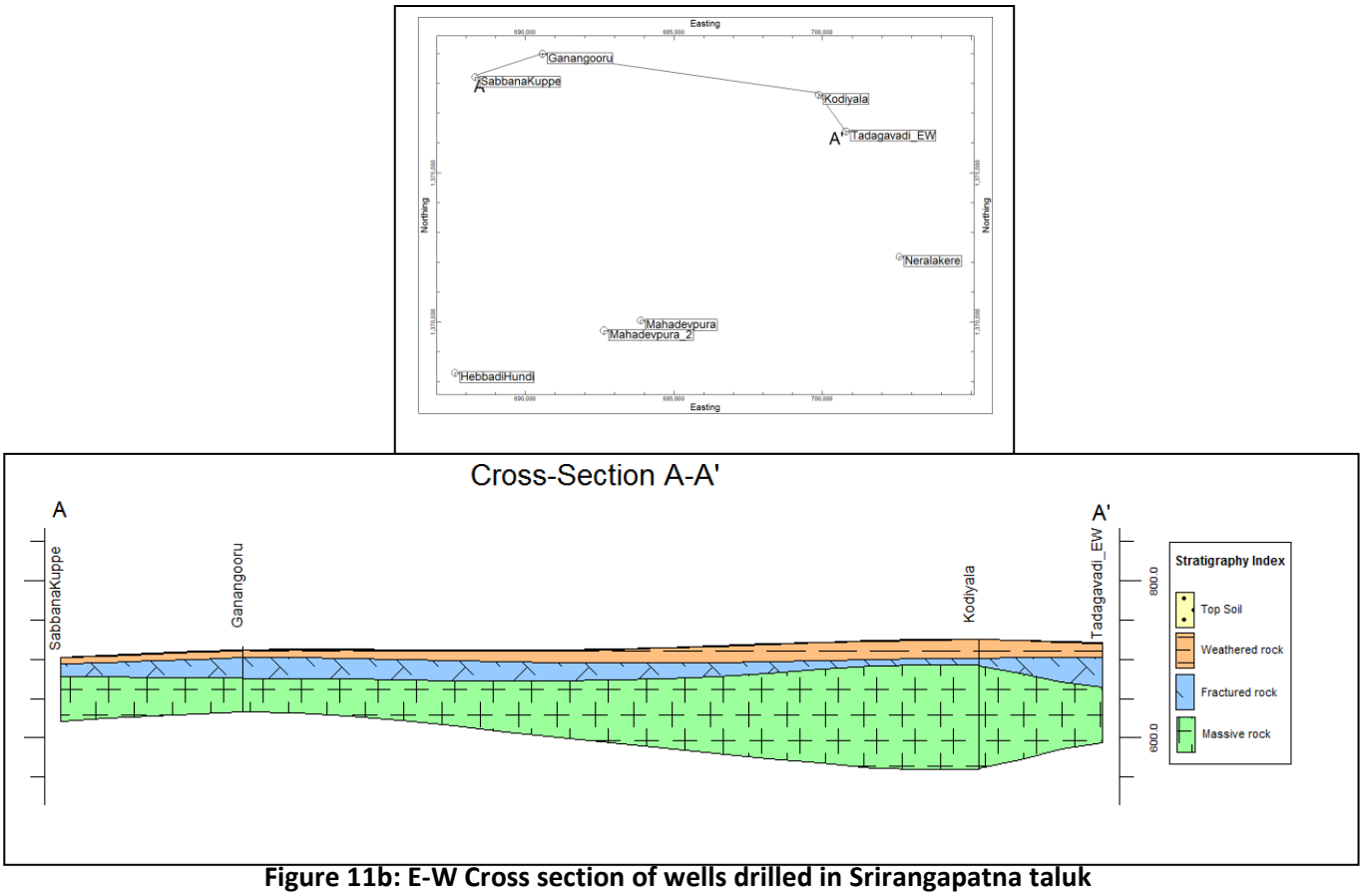


Figure 11b: E-W Cross section of wells drilled in Srirangapatna taluk

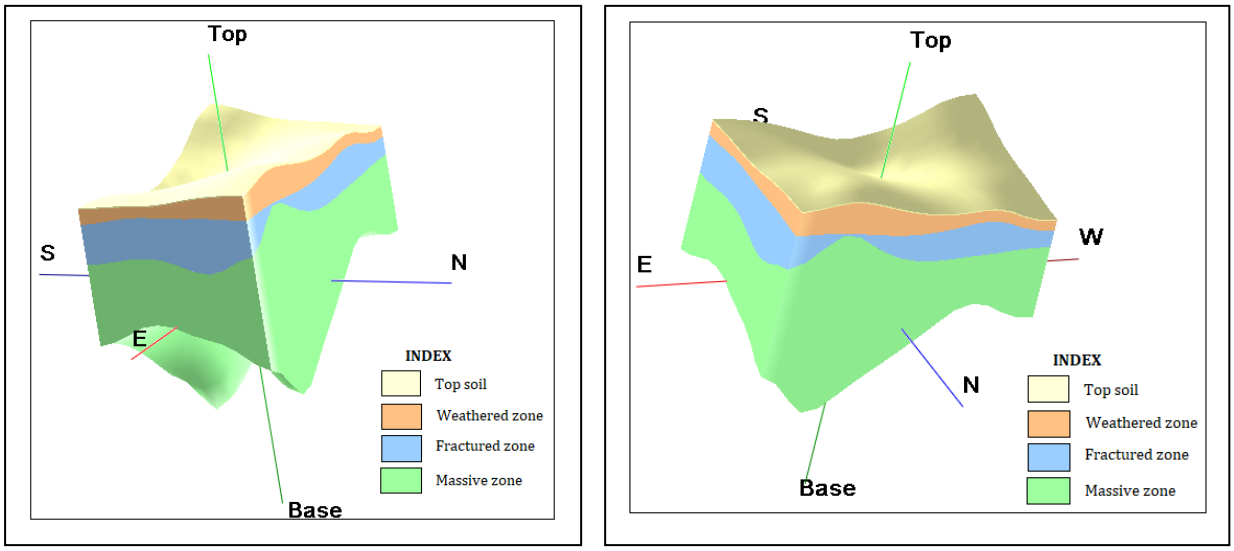


Figure 12(a,b):3D aquifer disposition

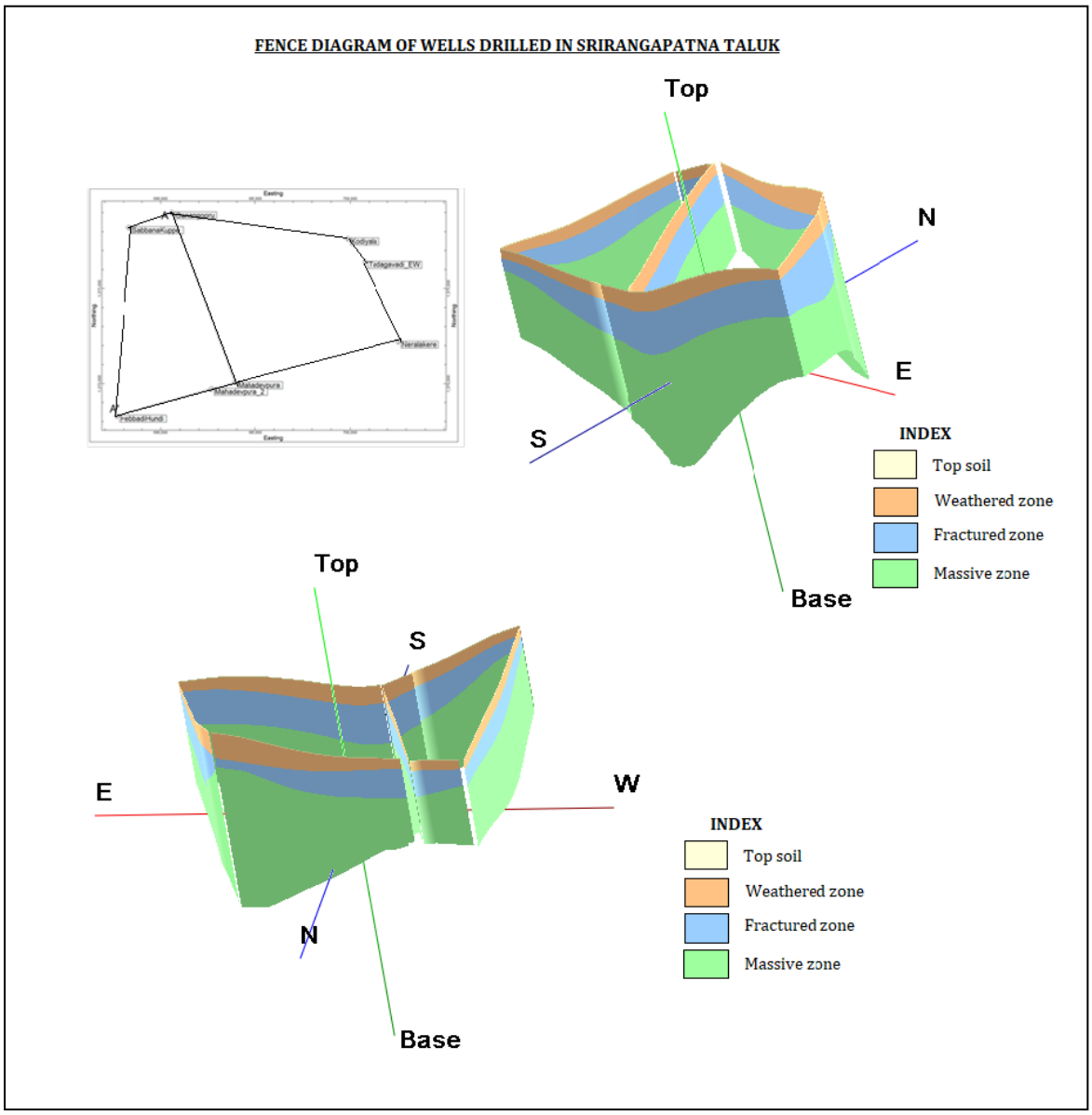


Figure 13: Fence diagram of wells drilled in Srirangapatna taluk

3 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

3.1 Comparison of Ground Water Resource and Extraction

The comparison of the resource as on 2013, 2017 and 2020 are summarised below in Table 10. It is observed that the ground water availability is more during the year 2020 as compared to 2017. It is attributable to good rains, the improvement in 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 10: Comparison of Ground Water Availability and Draft Scenario in Srirangapatna taluk

Taluk	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development (%)	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development (%)	Annual extractable GW resource (Ham)	Total GW Extraction (Ham)	Stage of GW Extraction (%)
	2013			2017			2020		
Srirangapatna	7602	2298	30	6770	2960	44	7132.67	3222.90	45.19

3.2 Chemical Quality of Ground Water and Contamination

Ground Water Quality (Pre-monsoon 2019 and 2022)

Interpretation from Chemical Analysis of Aquifer - I results in Srirangapatna taluk **(Table 11)** shows that the Electrical Conductivity ranges from 310 to 1034 µ/mhos/cm in the aquifer-I at 25°C (Fig. 12) while Total Hardness concentration ranges from 45 to 225 mg/L. The Nitrate value ranges from 14 to 78 mg/l and Fluoride concentration in groundwater ranges between 0.32 – 1.47 mg/l. Nitrate >45mg/L is found in dugwell water of Mahadevapura1 and Tadagavadi.

Table 11: Hydro-chemical data of water samples analysed 2019

BLOCK_NAME	SITE_NAME	PH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F
Srirangapatna	Arakere1	9.54	890	110	10	21	130	20	0	257	89	87	15	0.96
Srirangapatna	Chikapalya	9.14	936	170	12	34	113	1	18	252	67	75	20	1.07
Srirangapatna	Mahadevapura1	9.14	1034	215	16	43	133	33	17	247	82	154	78	1.03
Srirangapatna	Mandyakoppalu	10.70	825	80	14	11	145	6	12	248	67	87	14	1.47
Srirangapatna	Naguvanahalli	9.98	310	85	8	16	45	2	18	78	36	23	20	0.64
Srirangapatna	SreenivasaAgrahara	9.51	1031	140	14	26	155	37	22	254	145	83	28	0.86
Srirangapatna	Srirangapatna	10.83	891	45	14	2	75	25	24	96	39	58	15	0.32
Srirangapatna	Tadagavadi	8.23	2014	225	26	39	169	39	0	224	195	130	56	0.77

Interpretation from Chemical Analysis of Aquifer - I results in Srirangapatna taluk **(Table 12)** shows that the Electrical Conductivity ranges from 470 to 1380 µ/mhos/cm in the aquifer-I at 25°C **(Fig. 14)** while Total Hardness concentration ranges from 155 to 400 mg/L. The Nitrate value ranges from 3 to 128 mg/l and Fluoride concentration in groundwater ranges between 0.2 – 0.4 mg/l. Interpretation from Chemical Analysis of Aquifer - II results in Srirangapatna taluk (Table 12a) shows that the Electrical Conductivity ranges from 600 to 1800 µ/mhos/cm in the aquifer-I at 25°C while Total Hardness concentration ranges from 215 to 560 mg/L. The Nitrate value ranges from 4 to 113 mg/l and Fluoride concentration in groundwater ranges between 0.34 – 1.0 mg/l.

Interpretation from Chemical Analysis of river water results in Srirangapatna taluk shows that the Electrical Conductivity ranges between 530 to 600 µ/mhos/cm in the aquifer-I at 25°C, while Total Hardness concentration ranges from 180 to 200 mg/L. The Nitrate value is 20-35 mg/l and Fluoride concentration in groundwater ranges between 0.27 – 0.33 mg/l.

Nitrate>45mg/L is found in dugwell water of Channankere and handpump water of Hullikere, Palahalli and Hebbadi Hundi.

Table 12: Hydro-chemical data of water samples analysed 2022

Sl. No.	Location	Type of well	pH (6.5-8.5)	E C in S/cm	TH @ (600)	Ca (200)	Mg (100)	Na	K	CO_3	HCO_3	Cl (1000)	SO_4 (400)	NO_3 (45)	F (1.5)	TDS	Uranium (ppb)
AQUIFER-I (DUGWELLS,PHREATIC)																	
1	Arekere	DW	7.75	1020	290	66	30	69	57	0	360	113	55	5	0.30	616	0.83
2	Channankere	DW	7.84	1380	400	92	41	101	42	0	366	106	110	**128**	0.40	845	7.27
3	Srirangapatna	DW	7.82	1350	400	96	39	89	76	0	476	135	90	3	0.38	818	1.36
4	Brahmapura	DW	7.74	470	155	32	18	35	2	0	171	25	40	20	0.25	275	0.68
5	Naguvanahalli	DW	8.10	1330	340	76	36	97	83	0	439	142	80	11	0.36	793	2.49
6	Sabbanakuppe	DW	7.80	1020	340	100	22	64	1	0	275	71	115	38	0.30	580	5.14
AQUIFER-II (BOREWELLS, FRACTURES)																	
7	Ganangooru	HP	7.76	1800	540	156	36	156	13	0	537	213	100	43	0.39	1046	12.71
8	Hulikere	HP	7.60	1770	560	68	95	138	5	0	488	142	160	**113**	1.00	1020	12.10
9	Palahalli	HP	7.63	2000	460	96	53	235	25	0	500	269	120	**90**	0.75	1195	4.61
10	Hebbadi Hundi	HP	7.56	1290	430	84	53	97	1	0	378	135	60	**89**	0.47	750	2.30
11	Mahadevapura	BW	7.43	1650	470	128	36	156	4	0	512	184	90	33	0.38	945	4.11
12	Kodiyala	HP	7.06	840	250	50	30	74	1	0	244	89	70	5	0.46	468	0.61
13	Neralakere	BW	7.60	600	215	50	22	37	1	0	220	35	55	4	0.34	338	5.37

RIVER WATER																	
14	Mahadeva pura bridge	Cauvery River water	7.86	530	180	42	18	41	4	0	214	28	25	20	0.33	310	1.18
15	Hosur Canal	Cauvery River water	7.67	600	200	42	23	41	2	0	195	46	35	35	0.27	344	0.83

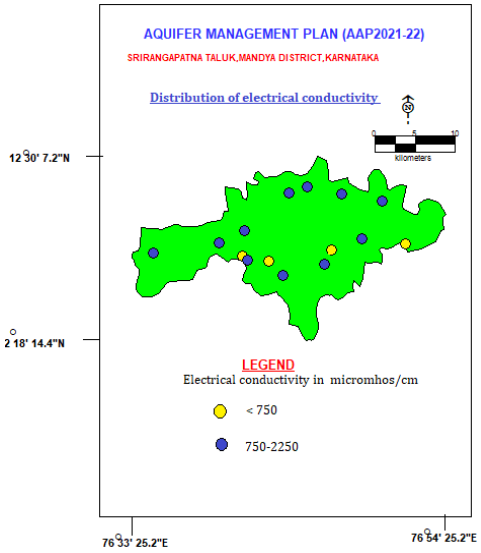


Figure 14:Distribution of EC

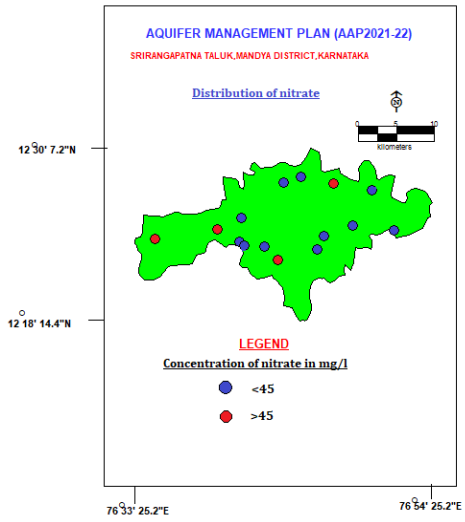


Figure 15:Distribution of Nitrate

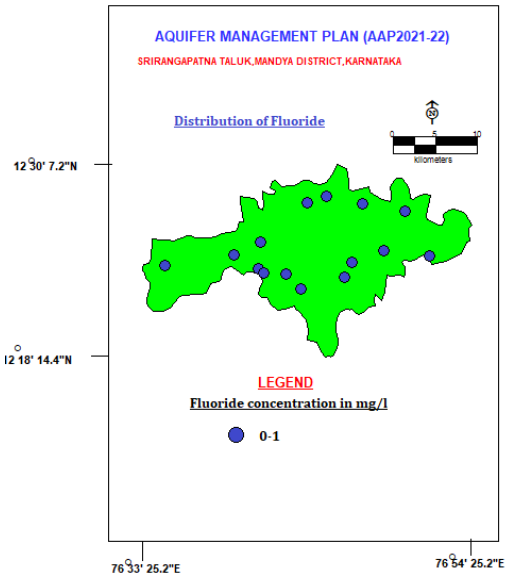


Figure 16:Distribution of Fluoride

4 GROUND WATER RESOURCE ENHANCEMENT AND SUPPLY SIDE INTERVENTIONS

4.1 Resource Enhancement by Supply Side Interventions

The overall stage of ground water development is 45.19% as per GEC 2020. The area feasible for recharge in the taluk is worked out as 28 sq.km and the surface surplus non-committed runoff availability is 0.7 ham. As per Master Plan on Artificial Recharge, Karnataka and Goa, 2020 no artificial recharge structures are proposed in the taluk. However, the figures given are tentative and pre-field studies / DPR are recommended. prior to implementation of these recharge structures.

The details pertaining to proposed recharge structures, cost estimates and likely Recharge benefits for Srirangapura taluk, Mandya district have been carried out and given in below **Table 13.**

Table 13: Quantity of non-committed surface runoff and expected recharge through AR structures

Artificial Recharge Structures	**Srirangapatna taluk**
Area Feasible for Artificial Recharge	28sq.km
Non-committed monsoon run off available(Ham)	0.7
Number of Check Dams proposed	0
Number of Percolation Tanks proposed	0
Number of Point Recharge structures proposed	0
Tentative total cost of the project(Rs.In lakhs)	0
Expectedrecharge(MCM)	0.6
Cost Benefit Ratio(Rupees /cu.m of water harvested)	nil

Table 14: Improvement in GW availability due to Recharge, Srirangapatna taluk

Sl.no.	**Resource Details**	**As per GWRA 2020 Estimation**
1.	Annual extractable GW resource in HAM	7132.67
2.	Total GW extraction for all uses in HAM	3222.90
3.	Existing stage of groundwater extraction in percentage	45.19
4.	Expected recharge from artificial recharge structures already existing in HAM	0.6
5.	Cumulative groundwater availability for extraction in HAM	7133.27
6.	Expected improved stage of groundwater extraction in percentage	45.18%

After groundwater recharge, the net annual groundwater availability will increase from 7132.67 ham to7133.27ham and the expected improvement in stage of development is 0.01% from 45.19% to 45.18%. (**Table 14**)

Conjunctive use of both surface water and groundwater:

The total canal command area is 468 ha. Water logged area under Cauvery project is 140 Ha. 12 Ha area has been reclaimed, so balance area to be reclaimed is 128 Ha. Conjunctive use plan is recommended to benefit the water deficit and tail end area of the irrigation command as a part of management. Raised Bed Farming, surface and sub-surface drainage and bio drainage are some of the interventions proposed to combat water logging problem.

- The taluk is irrigated by water from Krishnarajasagar dam and other small tanks. Most distributaries/ field channels are unlined and there is great scope to improve the irrigation efficiency by proper lining to these structures, and attending to other canal maintenance works timely.

Ground Water Development Plan:

In Srirangapatna taluka, the present stage of ground water extraction (2020) is 45.19 % with annual extractable resource of 7132.67 ham and total extraction of 3222.90 ham. The ground water draft for irrigation purpose is @ 2828.84 ham, thus indicating that ground water irrigation needs to be encouraged in the area. Also the less ground water development is most probably linked to the extensive availability of canal water irrigation and limited aquifer thickness in Aquifer-II. To overcome these, 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 45.19% to 60% in a systematic way by adopting scientific approach. About 359 dugwells (15-30 m depth; 3 to 5 m diameter @ Rs. 3.00 lakh/dugwell) are recommended to be constructed in feasible areas. Further 558 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 1411 ha. The total expenditure proposed to be incurred will Rs. 21.93 Cr. The detailed ground water development strategy to uplift the ground water use in the feasible areas is presented in **Table15**.

Table – 15: Feasibility of additional GW abstraction structures based on GWRA 2020 availability

Balance GWR available to make SOE 60%	DW unit draft	BW unit draft	No. of DW feasible @ 34% with unit draft of 1 ham	No. of BWs feasible @ 66% with unit draft of 1.25 ham	Cost of Proposed DW's/year @ unit cost of Rs. 3 lakhs	Cost of Proposed BW's @ unit cost of Rs. 2 lakhs	Additional irrigation potential created by DW's considering crop water requirement of 0.65 m (Ha)	Additional irrigation potential created by BW's considering crop water requirement of 0.65 m (Ha)	Total irrigation potential created by DW's and BW's (Ha)
1056.7	1	1.25	359	558	1077	1116	553	858	1411

4.2 Demand Side Interventions

4.2.1 Advanced irrigation practices

It is observed that presently in the command areas, canals are the source of irrigation and in non-command areas ground water through dug wells and borewells is used for irrigation purpose in the taluk. Water use efficiency measures have to be adopted for saving the ground water resources.

Efficient irrigation practices like drip irrigation and sprinkler has to be adopted by the farmers in the existing 1399ha of gross irrigated area. Presently, draft through irrigation is 2828.84ham. Implementation of efficient irrigation techniques will contribute in saving groundwater by 848.52ham and thus, will improve stage of development 4.81% from 45.19% to 40.38% **(Table 16).**

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

Sl.no.	Resource Details	As per GWRA 2020 Estimation
1.	Annual extractable GW resource in HAM	7132.67
2.	Total GW extraction for all uses in HAM	3222.90
3.	Existing stage of groundwater extraction in percentage	45.19
4.	Expected recharge from artificial recharge structures in HAM	0.6
5.	Cumulative groundwater availability for extraction in HAM	7133.27
6.	Expected improved stage of groundwater extraction in percentage	45.18%

7.	Saving due to using Water Use Efficiency technique in HAM	848.52
8.	Cumulative groundwater availability for extraction in HAM	7981.79
9.	Expected improved stage of groundwater extraction after implementation of project	40.38%

4.2.2 Change in cropping pattern

In Srirangapatna taluk the water intensive crops grown are paddy and sugarcane. Paddy is grown in 7697 hectares and sugarcane is grown in 3585 hectares which can be reduced by using less water intensive crops.

- **Additional area of irrigation**

After adopting various water use efficiency techniques and recharge measures and its resultant savings, the stage of extraction is expected to be 40.38% in the taluk, indicates the taluk will continue to remain in safe category. Additional irrigation potential which can be created considering crop water requirement of 0.65 m (Ha) will be 1626 ha.

4.2.3 Regulation and Control

Groundwater recharge component needs to be made mandatory in the taluk to manage the aquifer.

4.2.4 Other interventions proposed:

- Water use efficiency practices like tensiometer device in paddy cultivation and point irrigation for sugarcane cultivation, plastic mulching should be adopted to prevent soil erosion and evaporation**.**
- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Build up awareness among local village/urban community about proper disposal of sewage/runoff from chemical fertilizers contributing to nitrate.
- Mandatory roof top rain water harvesting in urban and semi-urban areas.

5 SUMMARY AND RECOMMENDATIONS

The main ground water issues are limited ground water potential / limited aquifer thickness / sustainability, deeper water levels particularly in aquifer-ii in some parts, inferior ground water quality due to nitrate contamination in some pockets and water logging in canal command areas. The summary of ground water management plan of Srirangapatna taluk is given in **Table-17**.

Table 17: Summary of Management plan of Srirangapatna taluk

Stage of GW Extraction and Category (2020)	45.19 %, Safe
Annual Extractable GW Resource (Ham)	7132.67
Total Extraction (Ham)	3222.90
Ground Water Draft for Irrigation (Ham)	2828.84
Ground Water Resource Enhancement by Supply side Interventions	
No of Proposed AR structures SSD PT CD Filter Beds	 0 0 0 0
Expected Additional Recharge to GW due to AR (Ham)	0
Additional Irrigation Potential that can be created (Ha)	0.001
Total Estimated Expenditure (Rs. in lakhs)	28.4
Ground Water Resource Savings by Demand side Interventions	
Expected Saving due to adopting WUE (Ham)	848.52
Change in Stage of GW development (%)	45.19 to 40.38
Ground Water Resource Development Plan	
Balance GWR available to enhance SOE 60% (Ham)	1056.7
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 – 1.00 ham **BW** – Depth: 40 to 100 m, Dia: 150 mm, Unit Cost – Rs. 2.00 lakh, Av. Annual Gross draft – 1.50 ham	 359 558
Additional irrigation potential created considering crop water requirement of 0.65 m (Ha)	1411
Total Estimated Expenditure (Rs. in Cr.)	21.93
Increase in Stage of GW Extraction (%)	45.19 to 60
Ground Water Quality – Nitrate contamination	Improving quality by proper drainage of sewage and Limited usage of Nitrogenous fertilizers

As per the resource estimation – 2020, Srirangapatna taluk falls under safe category with the stage of ground water extraction is 45.19 %. But there is need to formulate management strategy to tackle the water scarcity related issues in the taluk in the summer 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 .

Conjunctive use of both surface water and groundwater:

Conjunctive use plan is recommended to benefit the water deficit and tail end area of the irrigation command as a part of management. Raised Bed Farming, surface and sub-surface drainage and bio drainage are some of the interventions proposed to combat water logging problem. The taluk is irrigated by water from Krishnarajasagar and Hemavathi dams and other small tanks. Most distributaries/ field channels are unlined and there is great scope to improve the irrigation efficiency by proper lining to these structures, and attending to other canal maintenance works timely.

Ground water resource development: In Srirangapatna taluka, the present stage of ground water extraction (2020) is 45.19 % with annual extractable resource of 7132.67 ham and total extraction of 3222.90 ham. In view of above, the focus of proposed ground water development plan is to up the ante of ground water development from the present 45.19% to 60% in a systematic way by adopting scientific approach. About 359 dugwells (15-30 m depth; 3 to 5 m diameter @ Rs. 3.00 lakh/dugwell) are recommended to be constructed in feasible areas. Further 558 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 1411 ha.

Ground water resource enhancement by demand side interventions: At present maximum irrigation is by canal water. In non-command areas, borewells are extensively used for irrigation. The micro irrigation practices like drip and sprinkler irrigation is practiced to less extent in comparison with traditional mode of irrigation. However, in long run the practice of efficient irrigation techniques will add to the ground water resource in large extent.

Change in cropping pattern: In Pandavapura taluk the water intensive crops grown are paddy and sugarcane. Paddy is grown in 5075 hectares and sugarcane is grown in 5566 hectares which can be reduced by using less water intensive crops.

Finally, Roof top rain water harvesting, mass awareness programmes and participatory groundwater management are suggested for better management of groundwater resources.