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

Sandur Taluk, Bellary District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

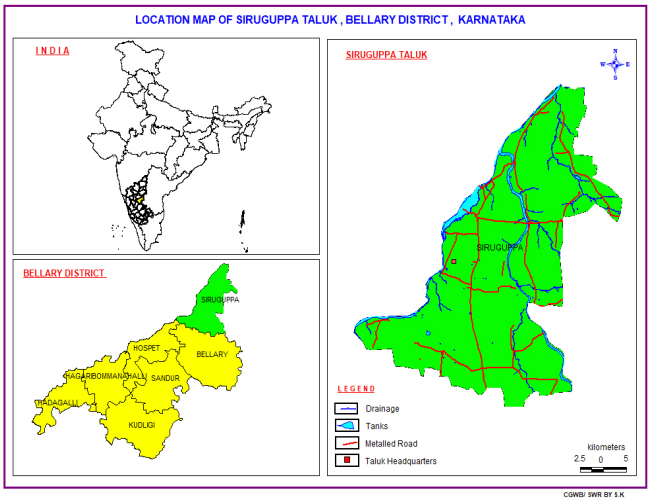
FOR OFFICIAL USE ONLY
No. *SWR/RP/NQM/2022-23/23*

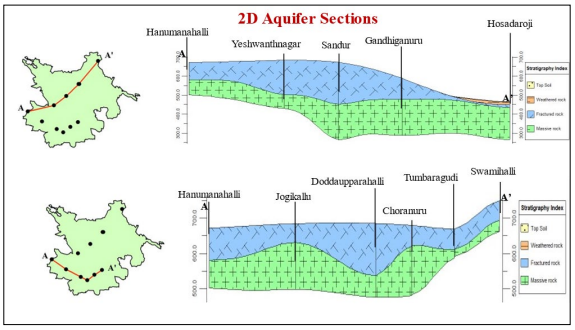
भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास
एवं गंगा संरक्षण विभाग
केन्द्रीय भूमिजल बोर्ड
दक्षिण मध्य क्षेत्र, बेंगलुरु

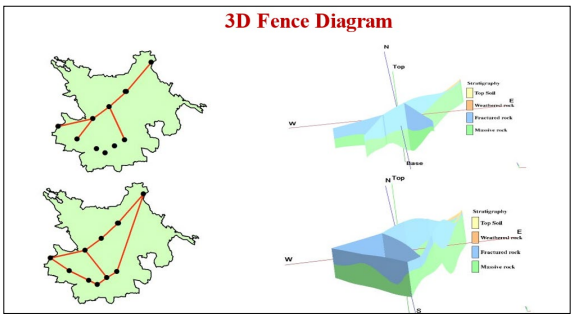
Government of India
Ministry of Jal Shakti
Department of Water Resources,
River Development &
Ganga Rejuvenation
Central Ground Water Board
South Western Region, Bengaluru

AQUIFER MAPS AND MANAGEMENT PLAN, SANDUR TALUK, BELLARY DISTRICT, KARNATAKA STATE

(AAP – 2021-2022)







By

Sangita P Bhattacharjee, Scientist 'B', CGWB, SWR, Bengaluru

AUGUST 2022

AQUIFER MAPS AND MANAGEMENT PLAN, SANDUR TALUK, BELLARY DISTRICT, KARNATAKA STATE

(AAP – 2021-2022)

Contents

AQUIFER MAPS AND MANAGEMENT PLAN, SANDUR TALUK, BELLARY DISTRICT, KARNATAKA STATE

1 SALIENT INFORMATION

Name of the Taluk: **Sandur**

District: Bellary

State: Karnataka.

Area: 1245 sq.km.

Population: 260213 (Census 2011)

Normal Annual Rainfall: 817 mm

1.1 Study area

Aquifer mapping studies have been carried out in Sandur Taluk, Bellary district of Karnataka, covering an area of 1245 sq. kms under National Aquifer Mapping (NAQUIM) Project. Sandur taluk of Bellary district is located between North Latitudes 14°51'30" and 15°16' 40" and East Longitudes between 76° 21' 75" to 76°53'20 and is falling in Survey of India Toposheets No 57A/12, 16 and 57 B/5 and 9. The study area is bounded on the North and west by Hospet taluk and in the South by Kudligi taluk and in the eastern part by Bellary taluk. Location map of Sandur taluk of Bellary district is presented in **Fig-1**. Sandur is the taluk head quarter with 3 hoblies and there are 26 gram Panchayats and 87 villages in this taluk of which 11 villages are inhabited.

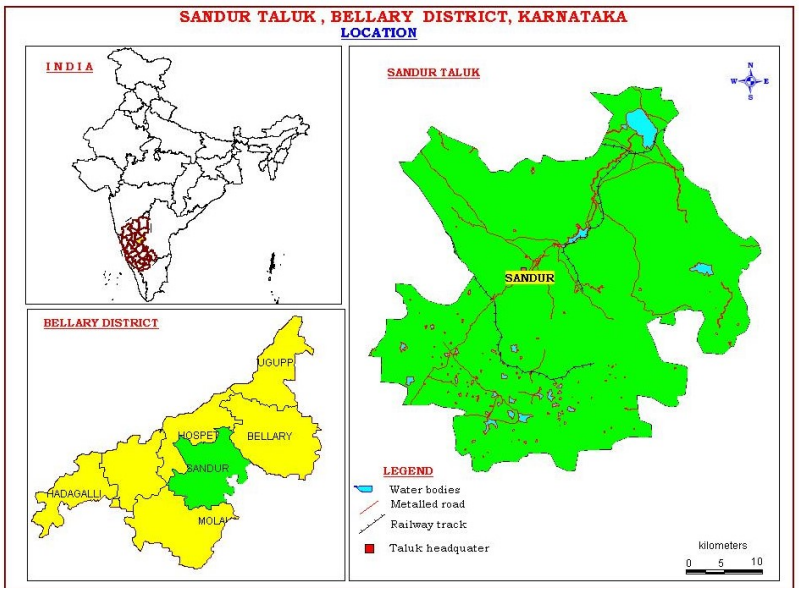


Fig 1: Location Map of Sandur Taluk, Bellary district

1.2 Population

According to 2011 census, the population in Sandur taluk is 260213. Out of which, 134034 are males and 126179 are females. Rural population is 181097 and urban population comprises of 79116. The average sex ratio of Sandur taluk is 941. The decadal variation in population from 2001-2011 is 44.45 %. Total households present in the taluk are 44505.

1.3 Rainfall

The climate of the taluk is characterized by dryness in the major part of the year and a hot summer. The period from December to February is the dry, comparatively cold season. The summer season which starts from March to May is followed by the South-West monsoon season from June to September. October and November form the retreating monsoon or post monsoon season. In December the mean temperature is the lowest, the mean daily minimum temperature is 16.7^0C and the average maximum temperature is 29.7°C. By almost February, temperature begins to rise rapidly and by April which is the hottest month, the mean daily minimum temperature is 25.2° C and the mean daily maximum temperature is 39.2° C.

The area falls under Northern 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. The actual annual rainfall data in respect of Sandur station from the year 2007 to 2017 is analyzed and presented in **Table-1**.

The data pertaining to gauges is of long-term nature and are well maintained. It is presumed that they are representative of the taluks and the same is used for analysis. Normal annual rainfall in Sandur taluk for the period 2007 to 2017 is 810 mm **(Table-1).** Seasonal rainfall pattern indicates that major amount (510 mm) of rainfall was recorded during South-West Monsoon seasons, which contributes about 63% of the annual normal rainfall, followed by North-East Monsoon season (182 mm) constituting 22% and remaining (118 mm) 15% in Pre-Monsoon season. Overall, the rainfall is scanty and unevenly distributed.
Computations were carried out for the 30-year blocks of 1981- 2010, the mean monthly rainfall at Sandur taluk is ranging between 17 mm during pre-monsoon period to 262 mm during September in North East monsoon. The coefficient of variation percent for pre-monsoon, SW monsoon and NE monsoon are 62, 30 & 54 percent respectively. Annual CV at this station works out to be 25 percent. Standard Deviation for pre-monsoon, SW monsoon and NE monsoon are 73,153 and 98 respectively.

Table1: Statistical Analysis of Actual Annual Rainfall Data of Sandur taluk, Bellary district (2007 to 2017)

Station	Rainfall (mm)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Sandur		668.7	753.3	1009.7	1053.3	1191.4	811.8	776.6	728.2	760.1	421.7	622.88

Source: District at a Glance, 2017-18

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Sandur taluk. Major Kharif crops are Maize, Jowar, Bajra, Paddy and Vegetables. Main crops of Rabi season are Maize, Jowar, and Bajra **(Table 2).** Water intensive crops like paddy and sugarcane are not grown extensively and it covers an area of 1206 ha and 9.65 ha respectively. Among pulses, tur is grown extensively in an area of 429.89 ha.

Table 2: Cropping pattern in Sandur taluk 2017-2018 (Ha)

Year	Paddy	Jowar	Maize	Bajra	Pulses	Ragi	Oil seeds	Fruits	vegetables	Sugar cane	Cotton
2017-18	1206.1	2877.4	12807.47	2215.2	1455	1326.3	5311.6	390.91	2726.53	9.65	1706.82

Source: District at a Glance, 2017-18

It is observed that net sown area accounts 21 % and area sown more than once is 5% of total geographical area in Sandur taluk **(Table-3).** Area available for cultivation and Fallow land cover 25 % & 31% of total geographical area respectively. An area of 9098 ha is the net area irrigated is only from bore wells. There is no lift irrigation in the taluk. **(Table-4 & Fig.2).** Hence, ground water is an important source of irrigation than surface water accounting for meeting 86 %of irrigation needs. As per data (as on 31.03.21) obtained from CADA Govt. of Karnataka, the taluk has a command area of 1033 ha of which an area of 7500 ha is irrigated by canal as on 31.03.21. About 140 ha is water logged due to canal irrigation.

Table 3: Details of land use in Sandur taluk 2017-2018 (Ha)

Taluk	Total Geographical Area	Area under Forest	Area available for cultivation	Total Fallow land	Net sown area	Area sown more than once
Sandur	124500	24118	31030	38726	26413	6704

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

Table 4: Irrigation details in Sandur taluk (ha)

Source of Irrigation	Km in length /No.	Net area irrigated
Canals	6 km	658.00
Tanks	46	497
Wells	828	364
Tube/Bore wells	2341	9097.83
Lift Irrigation	---	---
Other Sources	---	---
Total		10616.83

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

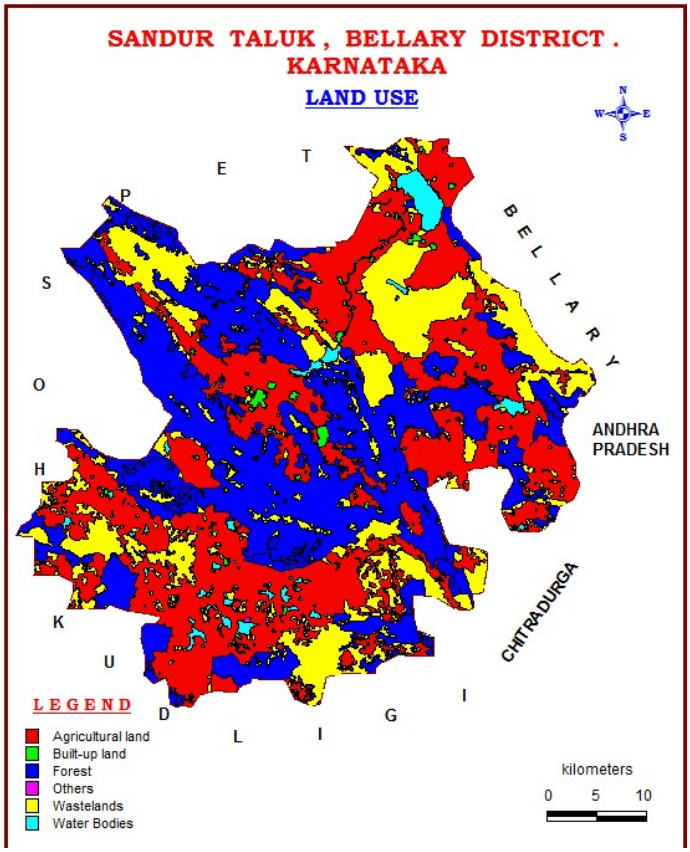


Fig. 2: Land Use and Land cover

1.5 Geomorphology, Physiography & Drainage

Sandur taluk falls in the northern dry region with flat terrain dotted by rocky hills. The taluk is highly rugged with elevation varying from 1750 ft to 3658 ft above mean sea level. The Sandur valley is situated at a height of 1800 ft above mean sea level and is surrounded by lofty mountains ranging in height from 3000 to 3500 ft above mean sea level. The Sandur hills are the most noticeable geomorphic feature which occupied in the central region of the taluk trending in North western –South eastern direction **(Fig.3)**.

The most famous hill is the Kumarswamy hill which lies in the southern portion of the taluk situated at a height of 3000 ft above mean sea level.

The entire Sandur taluk falls in Krishna River basin and Tungabhadra sub basin. Narihalla a seasonal river flowing in southwest- Northeast direction cut across the hill ranges forming picturesque gorges namely Bhemanagandi and Obalagandi. It finally drains into Daroji tank. The Drainage pattern is dendritic to sub-dendritic in nature **(Fig. 4).**

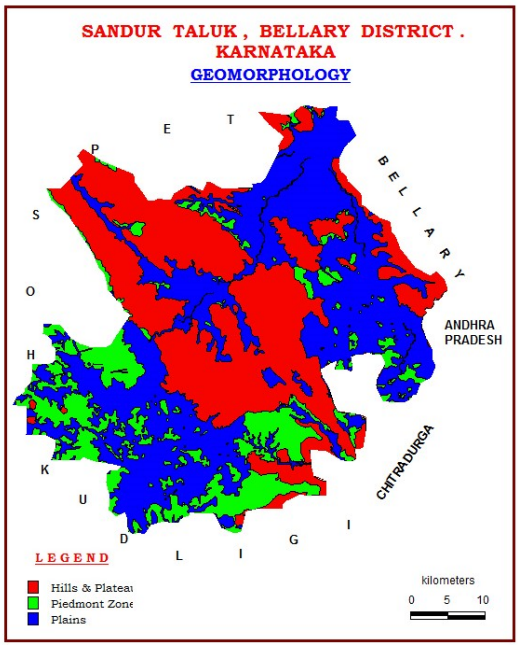


Fig-3: Geomorphology Map

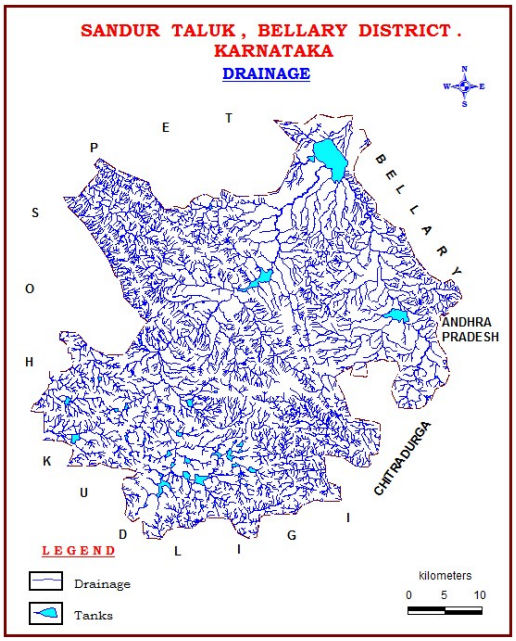


Fig-4: Drainage Map

1.6 Soil

The dominant soil type found in the taluk is loamy varieties **(Fig. 5).** Other part of the taluk is covered by different varieties of clayey soil. When wet, clay soils become slick and sticky and may also allow water to pool briefly before absorption due to the slow permeation. Visually, clay soils seem solid with no clear particles, and may have a distinct red or brown color when compared to the surrounding soil. Under rain fed condition, these soils yield the crops of jowar, groundnut and cotton and when suitably irrigated, yield paddy and sugarcane as well.

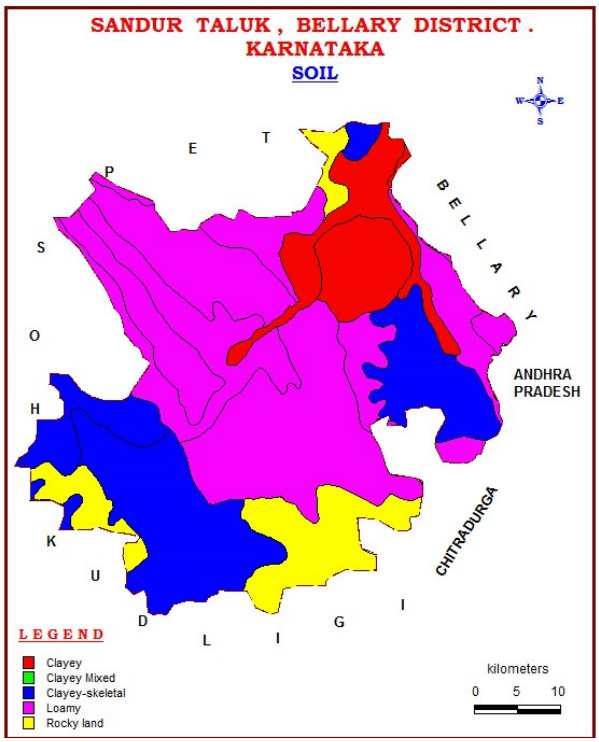


Fig. 5: Soil map

1.7 Ground water resource availability and extraction

Aquifer wise total groundwater resources up to 200 m depth are given in **Table-5** below.

Table-5: Total Ground Water Resources (2017) (Ham)

Taluk	Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
Sandur	7254	Phreatic	Fractured (Down to 200m)	Dynamic + phreatic in-storage + fractured
		13584	4053	24892

1.8 Existing and future water demands (GEC 2017)

- Net ground water availability for future irrigation development: **2989** ham
- Domestic and Industrial sector demand for next 25 years: **609** ham

1.9 Water level behavior

(a) Depth to water level

Aquifer - I

- Pre-monsoon: 4.25 to 14.20 mbgl (May, 2019) (**Fig.-6**)
- Post-monsoon: 2 to 4.92 mbgl (Nov. 2019) (**Fig.-7**)

Aquifer -II

- Pre-monsoon: 1.55 – 17.99 (May 2019)
- Post-monsoon: 1.1 – 15.38 (Nov 2019)

(b) Water level fluctuation

Aquifer-I Seasonal Fluctuation: Rise ranges from 0.33 to 0.45 m bgl

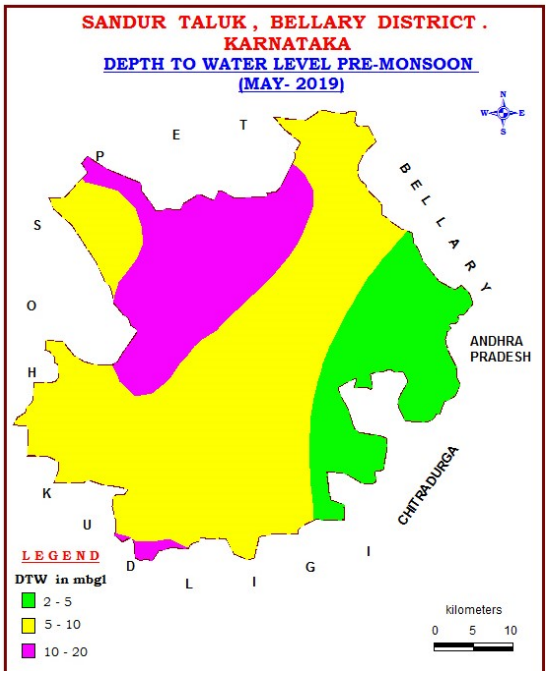


Fig-6: Pre-monsoon Depth to Water Level (Aq-I)

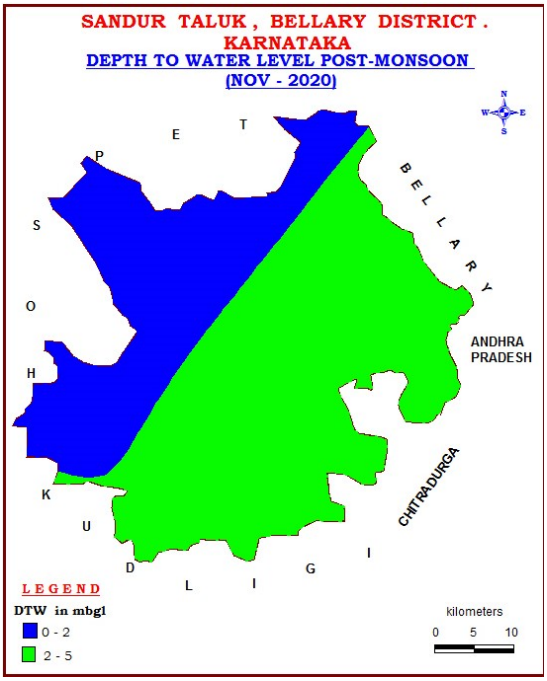


Fig-7: Post-monsoon Depth to Water Level (Aq-I)

2 AQUIFER DISPOSITION

2.1 Aquifers types

In Sandur taluk, there are mainly two types of aquifer systems;

i. **Aquifer-I (Phreatic aquifer)** Weathered Banded Gneissic Complex and Granite
ii. **Aquifer-II (Fractured aquifer)** Fractured Banded Gneissic Complex and Granite

In Sandur taluk, Banded Gneiss is the main water bearing formations **(Fig-8).** Ground water occurs within the weathered and fractured Granitic Gneiss under water table condition and in fractured Granitic Gneiss under semi-confined condition. In Sandur taluk, bore wells were drilled in the depth range of 50-200 mbgl. Depth of weathered zone ranges from 2 to 14 mbgl. Ground water exploration reveals that aquifer-II (fractured formation) was encountered mostly between the depth of 46 to 135.08 mbgl. Potential fracture zones are encountered beyond 50 mbgl. Yield ranges from 3.58 to 300 lpm. The basic characteristics of each aquifer are summarized in **Table-6.**

Totally, 11 Exploratory wells (EW) and 2 Observation Wells(OW) were drilled in the taluk as in-house groundwater exploration programme. The basic characteristics are illustrated in **Table 7**.

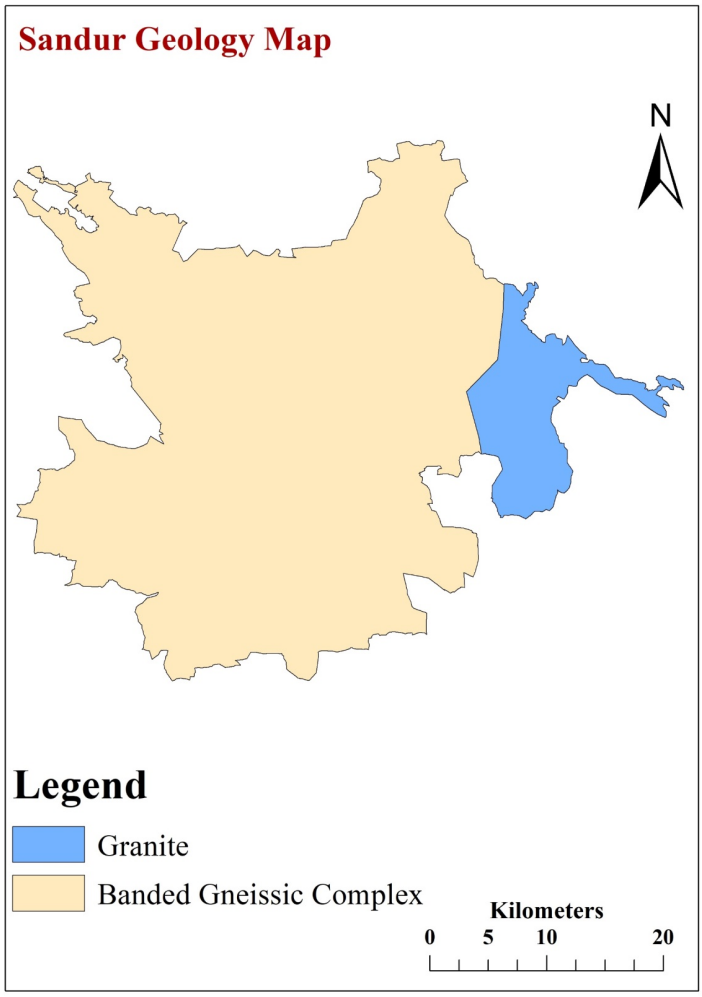


Fig-8: Geology Map

Table-6 Basic characteristics of each aquifer in Sandur taluk, Bellary district

Aquifers	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Weathered Granitic Gneiss	Fractured
Thickness range (mbgl)	2 – 14.14	46 – 135.08
Depth range of occurrence of fractures (mbgl)	6-12	Potential beyond 50 upto135.08
Range of yield potential (lpm)	Poor yield	3.58 - 300
T (m^2/day)	-	0.18 – 43
Quality Suitability for Domestic & Irrigation	Suitable with sporadic occurrence of salinity, fluoride and nitrate. Iron contamination is also observed in mining area	Suitable with sporadic occurrence of salinity, fluoride and nitrate. Iron contamination is also observed in mining area

Table 7: Basic summarized characteristics of Aquifer

Status of GW exploration:	Particulars	Exploratory wells (In-house)
	• No. of wells (EW&OW):	11 EW, 2 OW
	• Depth range (mbgl)	50 - 200
	• Weathering range (mbgl)	2 – 14.14
	• Yield range (lpm)	3.58 - 300
	• Fractures (mbgl)	46 – 135.08 (Most of the fractures are encountered beyond the depth ranges of 50m bgl)
	• Transmissivity (m^2/day)	0.18 – 43
	• Static Water Level (mbgl)	1.1 – 17.99

2.2 2 D, 3 D aquifer disposition and basic characteristics of each aquifer

The sub-surface aquifer disposition of the study area were prepared based on the drilling data obtained from exploratory drilling programme for generating 2D and 3D sections and fence diagrams/models through Rock works software. The outputs thus generated are presented in depicted in Fig 9 (a) and Fig 9 (b).

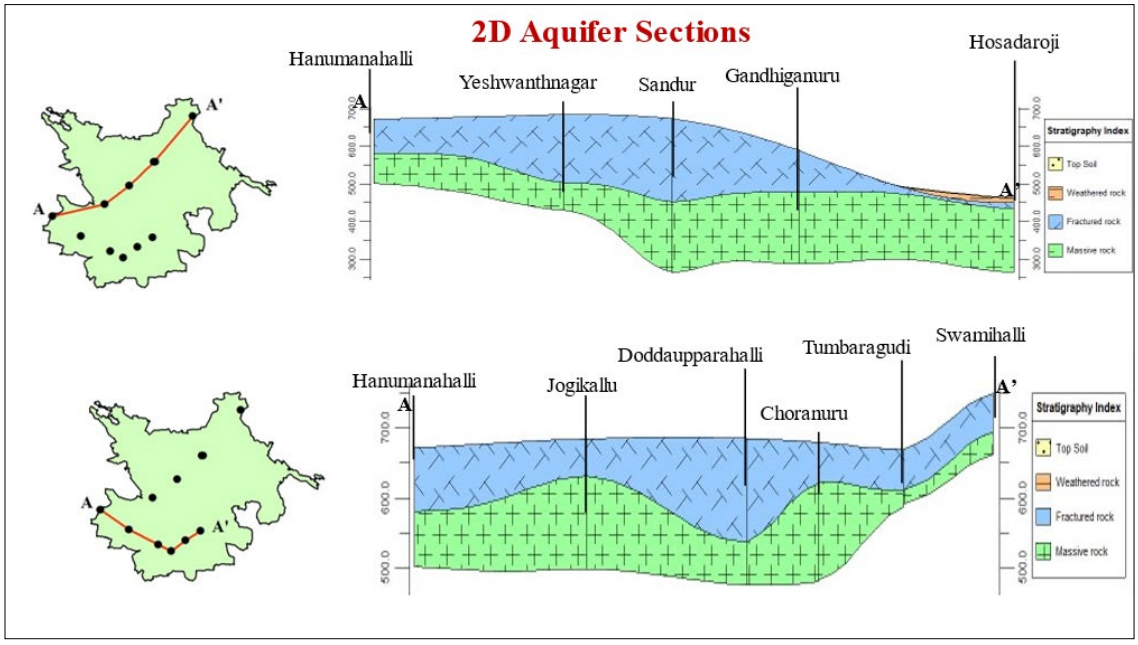


Fig 9 (a): The 2D aquifer dispositon in Sandur taluk, Bellary district

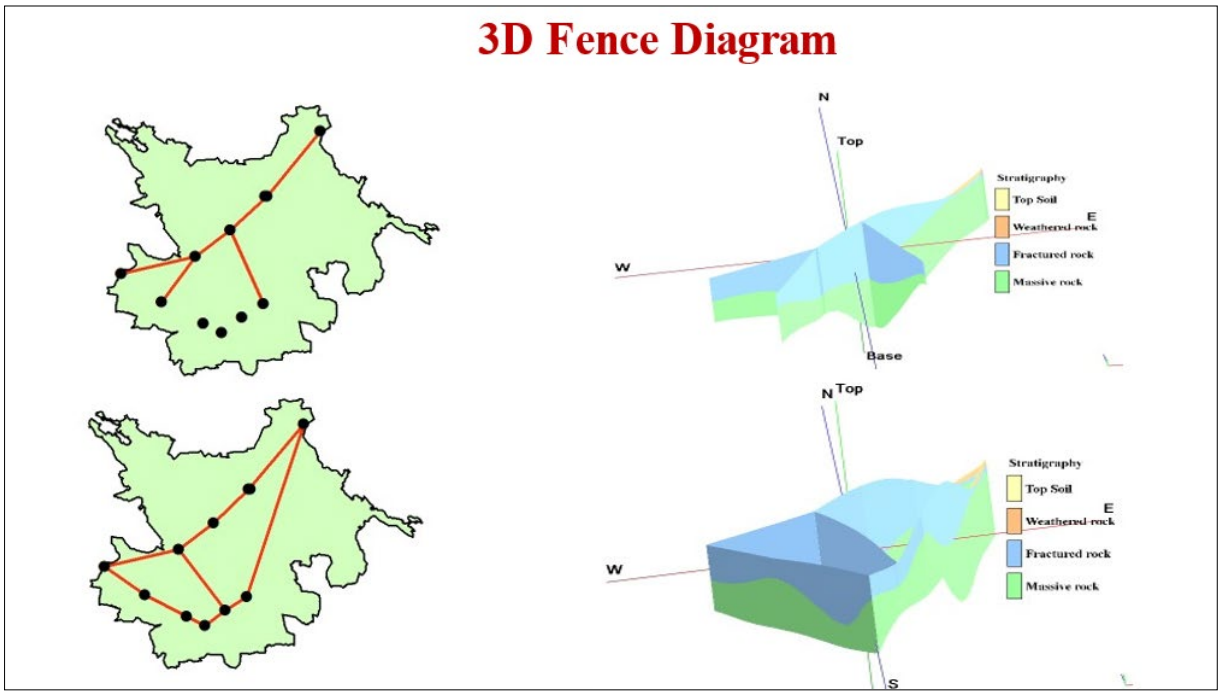


Fig 9 (b): The 3D aquifer dispositon in Sandur taluk, Bellary district

3 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

3.1 Groundwater Resource and Extraction

a) The ground water resource estimated as on 2017 is summarised below in **Table.8 (a)**. The taluk is categorised as "Safe" with stage of ground water extraction of 58%. As mentioned above, Total Availability of Ground Water Resource (Phreatic + Phreatic In-storage + fractured In-storage)is estimated to be 24892 ham for the taluk.

Table.8 (a) Dynamic Ground Water Resource (2017) ham

Taluk	Net Annual Ground Water Availability	Existing Gross Ground Water Draft For Irrigation	Existing Gross Ground Water Draft For Domestic And Industrial Water Supply	Existing Gross Ground Water Draft For All Uses	Allocation For Domestic & Industrial Use For Next 25 Years	Net Ground Water Availability For Future Irrigation Development	Existing Stage Of Ground Water Development	Category
Sandur	7254	3657	551	4207	609	2989	58%	Safe

b) Ground Water Resource availability and Stage of extraction as on 2020

The Ground Water Resource availability and stage of extraction as on 2020 is shown in **Table.8(b).**

Table.8(b) Ground Water Resource availability and stage of extraction as on 2020

Annual Extractable ground water resource (ham)	GW extraction for Irrigation use (ham)	GW extraction for Industrial use (ham	GW extraction for Domestic use (ham)	Total GW extraction (ham)	Stage of GW extraction (%)	Category	Annual GW allocation for Domestic use as on 2025 (ham)	Net GW availability for future use (ham)
8989	4155	0	615	4770	53	Safe	656	4183

c) Comparison of Ground Water Availability and Draft Scenario in Sandur taluk

The Comparison of Ground Water Availability and Draft Scenario in Sandur taluk during the period from 2017 to 2020 is summarised in **Table.8(c)**. In comparison to 2017, the stage of ground water extraction has slightly reduced from 58 to 53 % as on 2020. The ground water availability has slightly improved during the same period.

Table.8 (c) Comparison of Ground Water Availability and Draft Scenario in Sandur taluk

Taluk	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development
	2017			2020		
Sandur	7254	4207	58	8989	4770	53

3.2 Chemical quality of ground water and contamination

The summary of Chemical Analysis results from the monitoring stations of CGWB and borewell data of State Ground Water Department (SGWB) covering Sandur taluk is presented in **Table 9**.

Table 9: Summarized results of Ground water quality of Phreatic and Fractured aquifer

GW Quality:	Particulars	Phreatic Aquifer (Aquifer-I)	Fractured Aquifer (Aquifer-II)
	EC (µS/cm at 25°C)	1454 – 2990	590 – 3200
	F (mg/l)	0.28 – 4.6	0.09 – 3.2
	NO_3 (mg/l)	2 - 128	14 - 131

Electrical Conductivity: In general, EC values range from 1454 to 2990 µ/mhos/cm in the Aquifer-I at 25°C and from 590-3200 in Aquifer II. (**Fig 10**)

Fluoride: Fluoride concentration in groundwater ranges between 0.28 to 4.60 mg/l in the Aquifer-I whereas in Aquifer II the value ranges from 0.09 to 3.2. (**Fig 11)**

Nitrate: Nitrate value ranges from 2 and 128 mg/l in the Aquifer –I and from 14 to 132 mg/l in Aquifer II. (**Fig 12**)

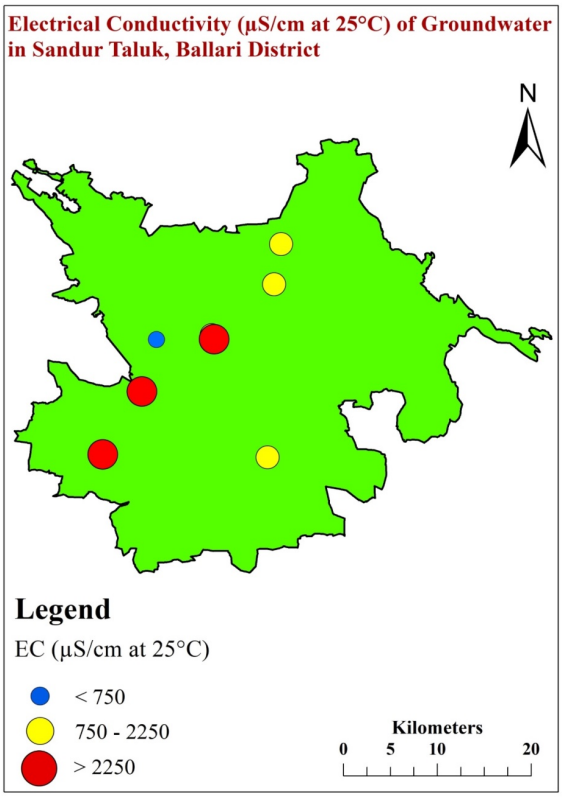


Fig10: Distribution of EC

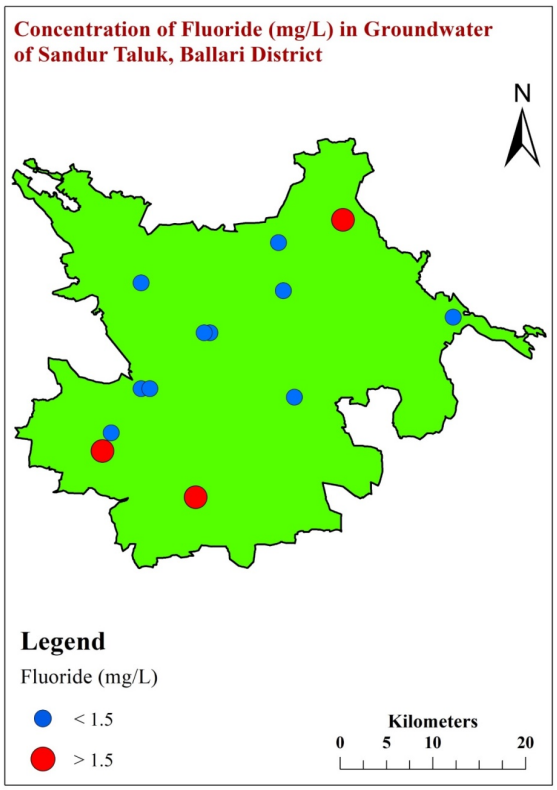


Fig 11: Distribution of Fluoride

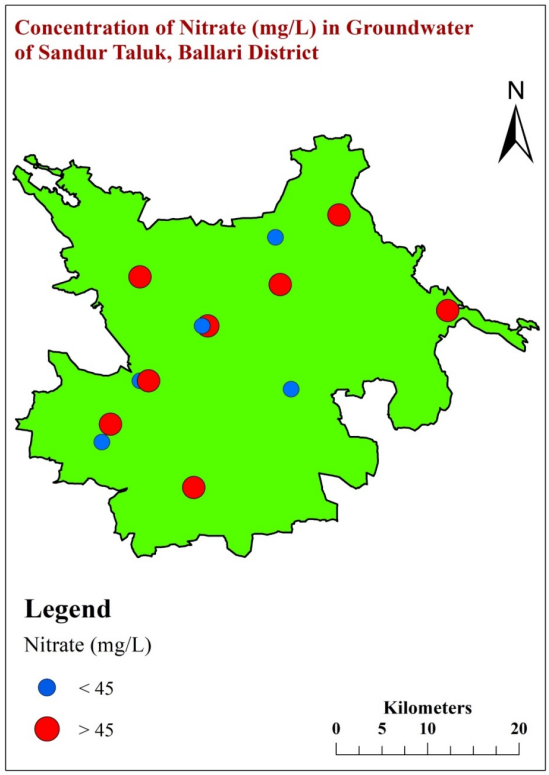


Fig12: Distribution of Nitrate

4 GROUND WATER RESOURCE ENHANCEMENT

4.1 Resource Enhancement by Supply Side Interventions

Recharge dry phreatic aquifer (Aq-I) in the taluk, through construction of artificial recharge structures, viz; check dams, percolation tanks & point recharge structures **(Table-10).** The choice of recharge structures should be site specific and such structures needs to be constructed in areas already identified as feasible for artificial recharge **(Fig.13)**. An area of 1224 sq km is found feasible for artificial recharge. The likely improvement in ground water availability on implementation of the recharge augmentation programme is summarized in **Table.11**.

Table-10: Quantity of non-committed surface runoff & expected recharge through AR structures

Artificial Recharge Structures Proposed	Sandur taluk
Non committed monsoon runoff available (MCM)	27.03
Number of Check Dams	116
Number of Percolation Tanks	0
Number of Point Recharge structures	0
Tentative total cost of the project (Rs. in lakhs)	1176.165
Expected recharge (MCM)	20.275
Additional irrigation potential (lakh hectare)	0.024

Table-11: Improvement in GW availability due to Recharge, Sandur taluk

Taluk	Net annual ground water availability	Existing gross ground water draft for all uses	Existing stage of ground water development	Expected recharge from proposed artificial recharge structures	Cumulative groundwater availability after implementation of artificial recharge scheme	Expected improvement in stage of ground water development after the implementation of the project	Expected improvement in overall stage of ground water development
	Ham	Ham	%	Ham	Ham	%	%
Sandur	7254	4207	58	2027.5	9281.5	45	13

After implementation of Artificial Recharge structures for GW recharge, the annual ground water availability will increase from 7254 to 9281.5 ham and the expected improvement in stage of development will be 13% i.e., from 58% to 45%.

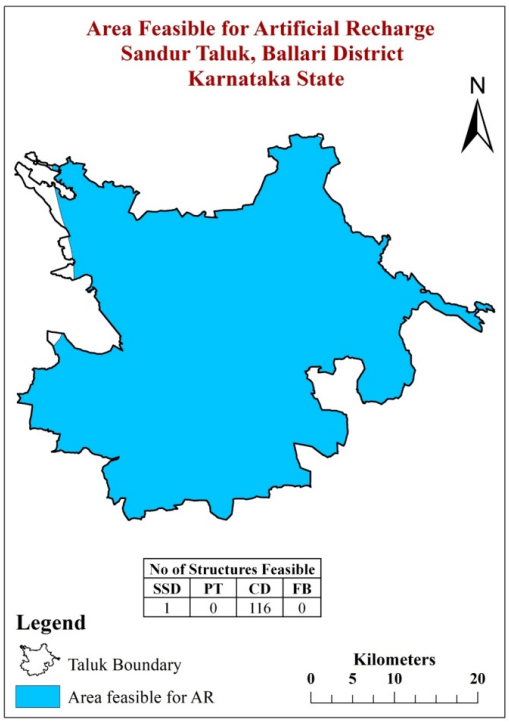


Fig 13: Map showing the area feasible for Artificial Recharge

4.2 DEMAND SIDE INTERVENTIONS

4.2.1 Advanced irrigation practices

Agriculture is the main occupation of the people which depends exclusively on ground water in the non-command areas. As per the prevailing hydro-geological conditions, the dug wells are mostly dry and bore wells are being used to extract ground water. The area is prone to frequent droughts, particularly during the years of low rainfall below the normal. Increase in agricultural activity, ground water withdrawal, depletion of ground water levels, reduction in yield and ground water quality related issues etc., suggests the need for scientific ground water management, enhancement of storage capacity of the aquifers and protection of ground water quality.

It is recommended to discourage water intensive crops. Water Use Efficiency (WUE) practices like Drip irrigation needs to be strengthened to save irrigation water by way of precision farming mechanism. This will help in enhancing a quantum of 1097.1 ham and will ultimately enhances the area under irrigation potential resulting a stage of groundwater development improvement from 45 % to about 40 %. Usage of organic manure may be encouraged in place of chemical fertilizers.

4.2.2 Change in cropping pattern

Farmers are facing inadequacy of groundwater for agriculture during summer and can opt for more rain-fed millets and water efficient Pulses for agricultural production. An area of 1206 ha is under paddy and a small area of 9.65 ha is under sugarcane. Farmers may be encouraged to go for less water intensive crops and awareness programme needs to be organized under IEC activity to educate the farmers to adopt WUE practices in agriculture.

Table-12: Improvement in GW availability due to saving by adopting Water Use Efficiency(WUE)

Taluk	Cumulative annual ground water availability after implementing AR structures	Existing gross ground water draft for all uses	Stage of ground water development after implementing of AR structures	Saving due to adopting WUE measures	Cumulative annual ground water availability after implementing AR structures & irrigation development schemes	Expected improvement in stage of ground water development after the implementation of the project	Expected improvement in overall stage of ground water development
	Ham	Ham	%	Ham	Ham	%	%
Sandur	9281.5	4207	45	1097.1	10378.1	40.5	5 (45 to 40)

4.2.3 Other interventions proposed

Ground Water resource: As per the resource estimation – 2017, Sandur taluk falls under "Safe" category with the stage of ground water extraction of 58 % and in 2020 also it falls under safe category with 53 % stage of groundwater development. However, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk during the summer and scarcity of water in the coming future days.

Water Conservation/Artificial Recharge Structures: Adopting soil and water conservation activities in the catchment of all water bodies and periodical maintenance of artificial recharge structures are also recommended. Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan for sustainability.

Groundwater Quality problem area: Excess EC, Nitrate & Fluoride concentration is noticed in ground water samples in some isolated patches. This requires attention and remedial measures viz.

- Dilution of nitrate rich ground water through artificial recharge & water conservation.
- Roof top rain water harvesting.

In view of ground water contamination, drinking water supply from surface water needs to be explored/ ensured.

Conjunctive use plan in water logged area: Out of the total 75 sq.km of the canal command area in the taluk about 1.40 sq.km is water logged which is already reclaimed, since inception. (Source: CADA as on March 2021). In addition to this reclamation, conjunctive use plan is also recommended to benefit the tail end area of the irrigation command.

Mining Activities: The need for sustainable water management within the mining industry has become as vital as the water itself. Now more than ever, measures need to be taken to manage this critical resource and to identify options and initiatives for water conservation and management. Water efficiency improvements may be made by adopting new technologies, more efficient processes, incorporating reuse and recycling, and finding alternative sources of water. This includes llimiting the volume of water required for mining operations, alternative sources of water like treated mining water, reject water from urban water supply for reuse and protecting the quality of water discharged after use.

The over burden should be systematically laid as benches on all sides of the mine. Rainwater harvesting and artificial recharge activities are recommended in the mining areas to promote ground water sustainability. The dumps should be fortified by afforestation, gardening and vegetal cover. Abandoned mine pits should be cleaned and used as recharge pits wherever feasible. These pits would facilitate recharge to low lying aquifers in the valley areas. It is

necessary to plan the mining and associated activities in such a manner that their impacts on the ground water regime are nil or minimal. Awareness programmes and training may be imparted to the people involved in the mining industries.

5 SUMMARY OF MANAGEMENT PLANS AND CONCLUSIONS

- **Ground Water resource**: As per the resource estimation – 2020, Sandur taluk falls under "**Safe"** category with the stage of ground water extraction of **53** %. However, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk during the summer and scarcity of water during the future days.
- **Ground water resource enhancement**: Agriculture is the main occupation of the people which depends exclusively on ground water in the non-command areas. As per the prevailing hydro-geological conditions, the dug wells were dry and bore wells are being used to extract ground water. The area is prone to frequent droughts, particularly during the years of low rainfall below the normal. Increase in agricultural activity, ground water withdrawal, depletion of ground water levels, reduction in yield and ground water quality related issues etc., suggests the need for scientific ground water management, enhancement of storage capacity of the aquifers and protection of ground water quality.
- **Quantity of water available through non-committed surface run-off:** The surplus non-committed monsoon run off is estimated to be 27.033 **MCM**. This can be used to recharge the aquifer mainly through about 116 check dams (as per Master Plan, CGWB 2020). Adopting soil and water conservation activities in the catchment of all water bodies and periodical maintenance of artificial recharge structures are also recommended. Once implemented, the stage of ground water extraction is likely to be improved to 45% from the present 53%.
- **Advanced irrigation practices**: It is recommended to discourage water intensive crops. Water Use Efficiency (WUE) practices like Drip irrigation needs to be strengthened to save irrigation water by way of precision farming mechanism. This ultimately enhances the area under irrigation potential. Once implemented, the stage of ground water extraction is likely to be improved by another 5%.
- **Conjunctive use plan in water logged area:** Out of the total 75 sq.km of the canal command area in the taluk about 140 ha is water logged which is already reclaimed, since inception. (Source: CADA as on March 2021). In addition to this reclamation, conjunctive use plan is also recommended to benefit the tail end area of the irrigation command.
- **Change in cropping pattern**: Farmers are facing inadequacy of groundwater for agriculture during summer and can opt for more rain-fed millets and water efficient Pulses for agricultural production.

- **Drinking water Supply**: In view of ground water contamination with mainly higher concentration Fluoride and Nitrate, drinking water supply from surface water needs to be explored/ ensured.
- **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.
- **Mining Activities:** The over burden should be systematically laid as benches on all sides of the mine. Rainwater harvesting and artificial recharge activities are recommended in the mining areas to promote ground water sustainability. The dumps should be fortified by afforestation, gardening and vegetal cover. Abandoned mine pits should be cleaned and used as recharge pits. These pits would facilitate recharge to low lying aquifers in the valley areas. It is necessary to plan the mining and associated activities in such a manner that their impacts on the ground water regime are nil or minimal.
- **Participatory management**: Awareness programmes and practice of participatory approach needs to be strengthened with the involvement of all the stake holders for sustainable management.
- **Water Linkages with other Activities:** Water sector has strong linkages with other developmental activities. Hence, the proposed management plans cannot be considered as static and needs to be reviewed and improved from time to time.