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

Byadgi Taluk, Haveri District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

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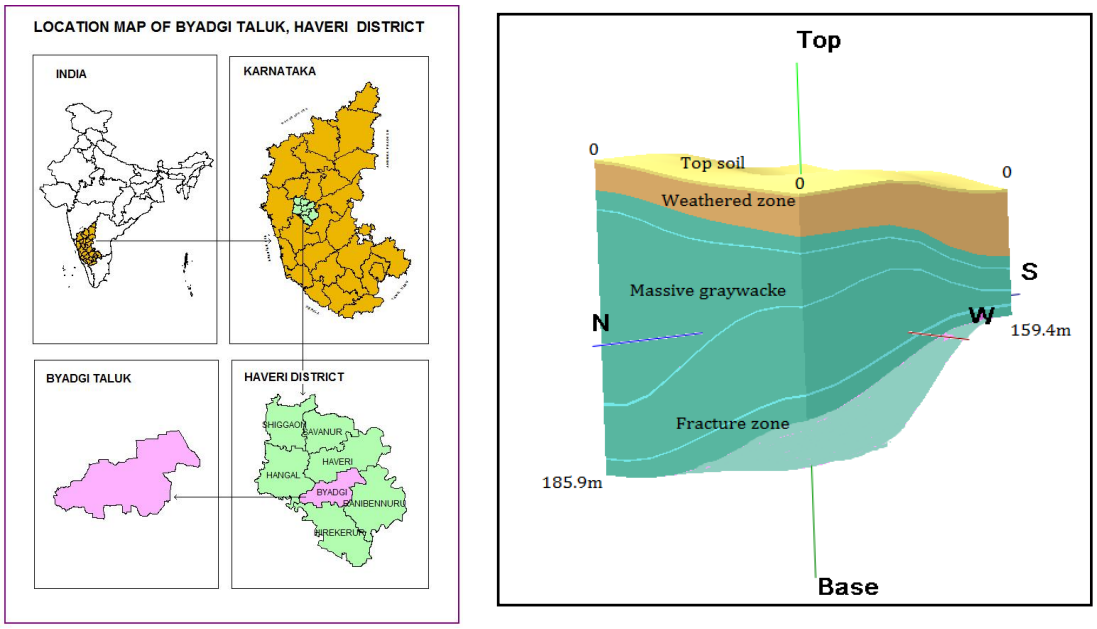
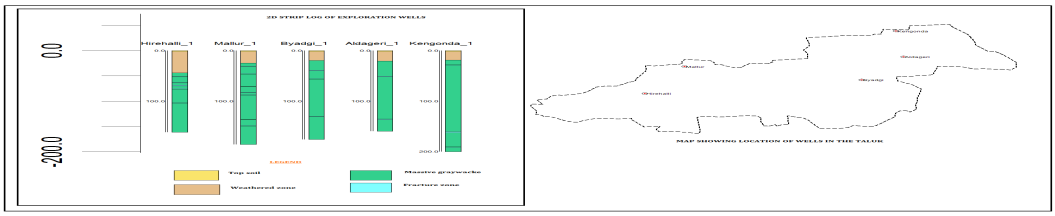
AQUIFER MAPS AND MANAGEMENT PLAN, BYADGI TALUK, HAVERI DISTRICT, KARNATAKA STATE

(AAP: – 2020-2021)





By

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AUGUST 2022

AQUIFER MAPS AND MANAGEMENT PLAN, BYADGI TALUK, HAVERI DISTRICT, KARNATAKA STATE

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AQUIFER MAPS AND MANAGEMENT PLAN, BYADGI TALUK, HAVERI DISTRICT, KARNATAKA STATE

1 SALIENT INFORMATION

Name of the taluk:BYADGI

District:Haveri

State:Karnataka

Area:434 sq.km

Population:141024

Annual Normal Rainfall:692mm

1.1 Study area

Aquifer mapping studies were carried out in Byadgitaluk, Haveri district of Karnataka, covering an area of 434sq.kms under National Aquifer Mapping Project. Byadgi talukof Haveri district is located between North latitude 14^{o}34'35.22"and 14^{o}47'3.45" & East longitude 75^{o}14'51.52" and 75^{o}36'19.37"and is covered in parts of Survey of India Toposheet Nos.48N/6, 48N/9 and 48N/10. Byadgi taluk is bounded by Haveri taluk of Haveri districton North, Ranibennur taluk of Haveri district on East, Hangal taluk of Haveri district on North-West and West and Hirekerur taluk of Haveri district on South side. Location map of Byadgi taluk of Haveri district is presented in **Figure 1.**

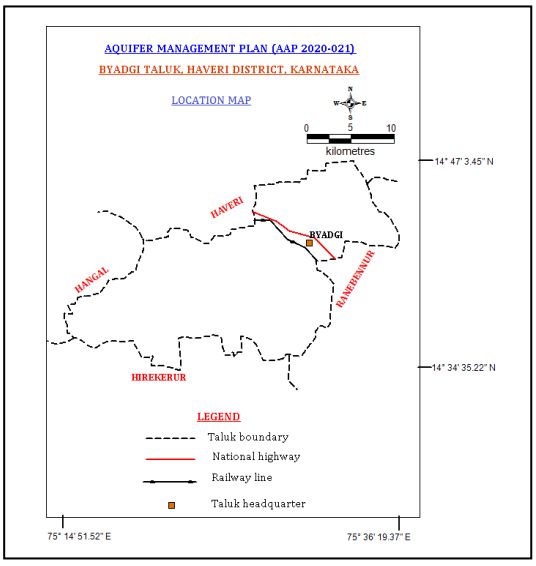


Figure 1: Location Map

Taluk administration of Byadgi is divided into 2 Hoblies and 21 Gram Panchayats. There are 64 inhabited and 2 uninhabited villages in the taluk.

1.2 Population

According to 2011census, the population in Byadgi taluk is 1,41,024 of which rural population is 1,11,010 constituting about 78.72%, and the urban population is 30,014 constituting only about 21.28% of the total population. There are 72143 male and 68881 female. Population density/sq.km is 323.

1.3 Rainfall and Climate

There are three (03) rain gauge station located in Byadgi taluk. Normal annual rainfall is 692mm. Actual annual rainfall for 2019 was 1065mm.The annual rainfall data from 2001 to 2019 is given in **Table 1.** Highest rainfall of 1068.4 mm was received in 2014 and lowest rainfall of 512mm was received in 2001. The yearwise rainfall variability graph is given in **Figure-2.**

Table 1: The annual rainfall data from 2001 to 2019 of Byadgi taluk

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Rainfall in mm	512	599	564	600	852	633	860	855	1066.2	852.6	700	687	530	1068.4	618	496	752.01	550	1065

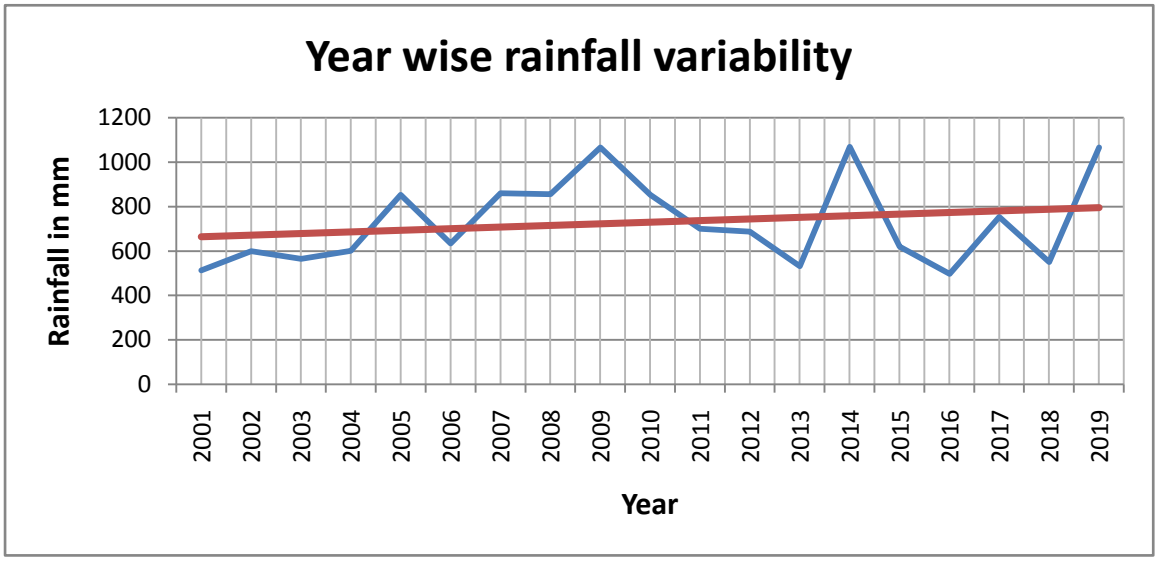


Figure 2: Yearwise annual rainfall graph

Byadgi taluk experiences semi-arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Northern transition 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 Byadgi taluk. Maize is the major crop grown in the taluk accounting for almost 60.91% of the total crop area, followed by Cotton (20.25%), Jowar (6.15%), Vegetables (3.67%), Sugarcane(2.58%) and Pulses (2.47%) of the total crop area respectively **(Table 2)**.

Table 2: Cropping pattern in Byadgi taluk 2015-2016 (Ha)

Paddy	Jowar	Bajra	Maize	Ragi	Wheat	Other minor millets	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
819	2309	0	22862	8	0	2	927	235	1377	429	967	7600

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

It is observed that net sown area accounts for about 76.53% of total geographical area, while area sown more than once is about 13.30% of total geographical area in the taluk **(Table 3).** As per the data available, the taluk uses 6412 Borewells for irrigation purpose. Ground water is the source for irrigation in the taluk **(Table 4).** Landuse pattern of the taluk is represented as **Figure 3**.

Table 3: Details of landuse in Byadgi 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
Byadgi	43400	4889	2653	1580	33215	5773

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

Table 4: Irrigation details in Byadgi taluk (Ha)

Source of Irrigation	Nos.	Net area irrigated (Ha)	Grossarea irrigated (Ha)
Canals	0	0	0
Tanks	241	0	0
Wells	19	0	0
Bore wells	6412	6810	7691
Lift Irrigation		----	---
Other Sources		----	----
Total		6810	7691

Source: Haveri District at a Glance 2015-16,Governmentof Karnataka

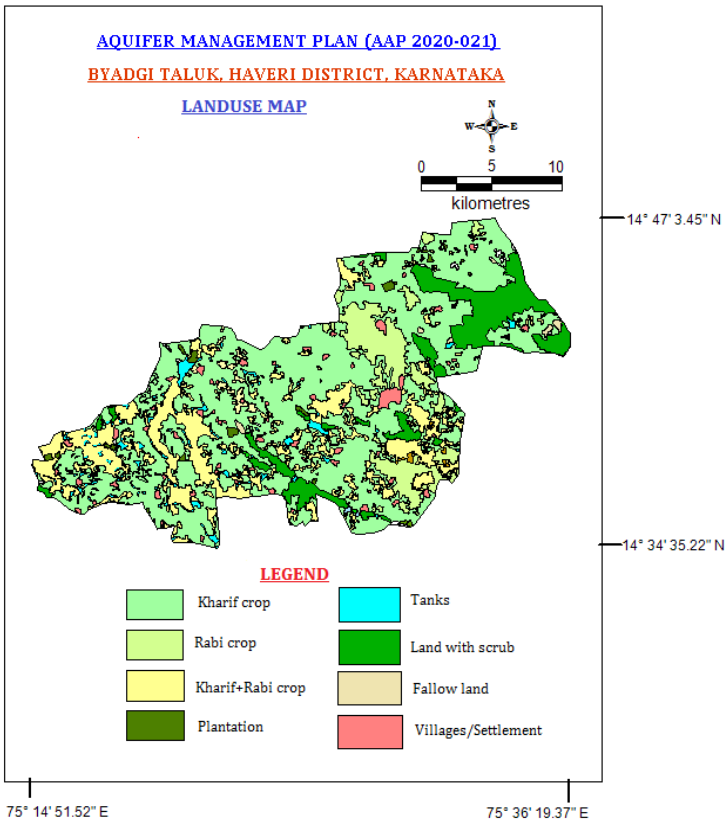


Figure 3: Landuse Map

1.5 Geomorphology, Physiography and Drainage

The entire taluk is a part of Deccan Plateau, categorised as "Semi-Malnad" and "Northern Maidan" region with mostly rugged plains and some undulating hills **(Figure 4).** Geomorphologically, it can be divided into four physiographic units viz. pediplains, pediments, inselberg complex and hills. The general slope is from South-West towards North-East. The taluk is drained by tributaries of Varada river and Kumdavati river. **(Figure 5).**

1.6 Soil

The taluk is occupied by Alfisol:soil with aluminium and iron, Vertisol:inverted soil and Inceptisol soils:young soil. The soils are clayey and clayey-skeletal in nature. These are medium black to reddish brown in colour. Formation of various types of soils is a complex function of chemical weathering of bedrocks, vegetative decay and circulation of precipitated water. Soils are mostly in-situ in nature **(Figure 6).**

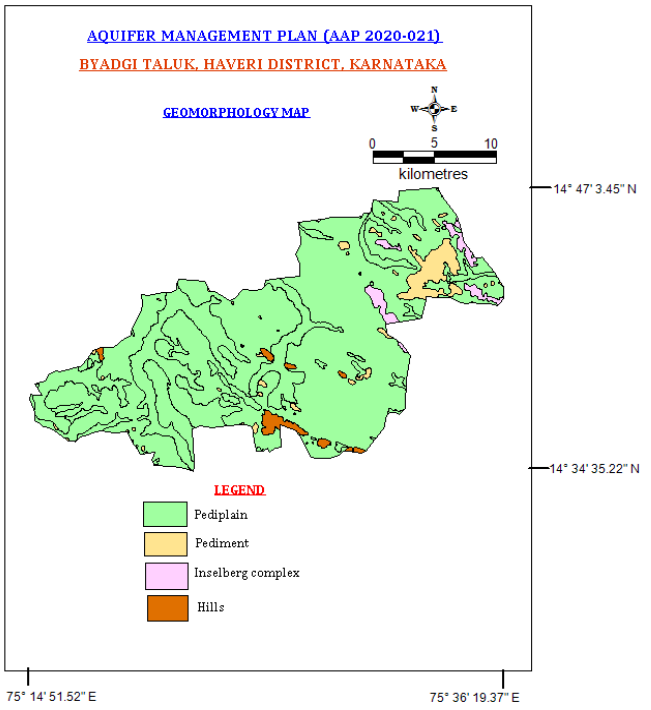


Figure 4:Geomorphology Map

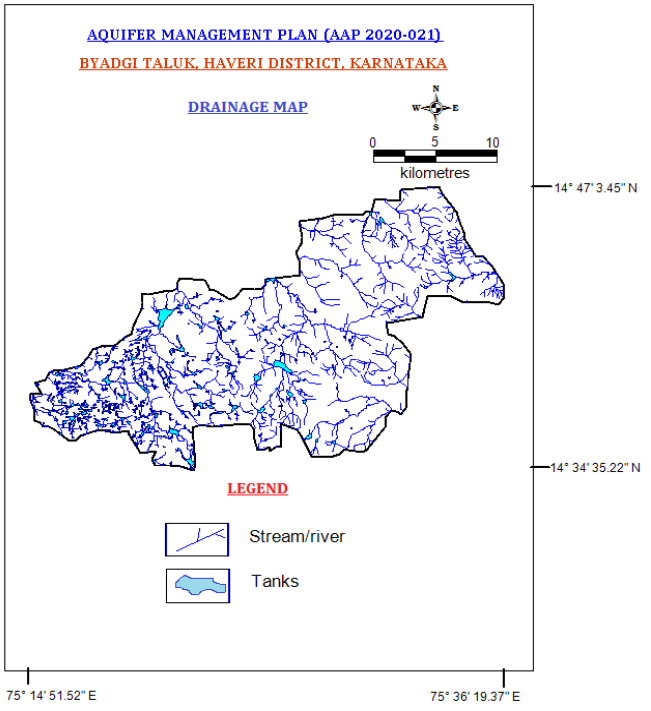


Figure 5:Drainage Map

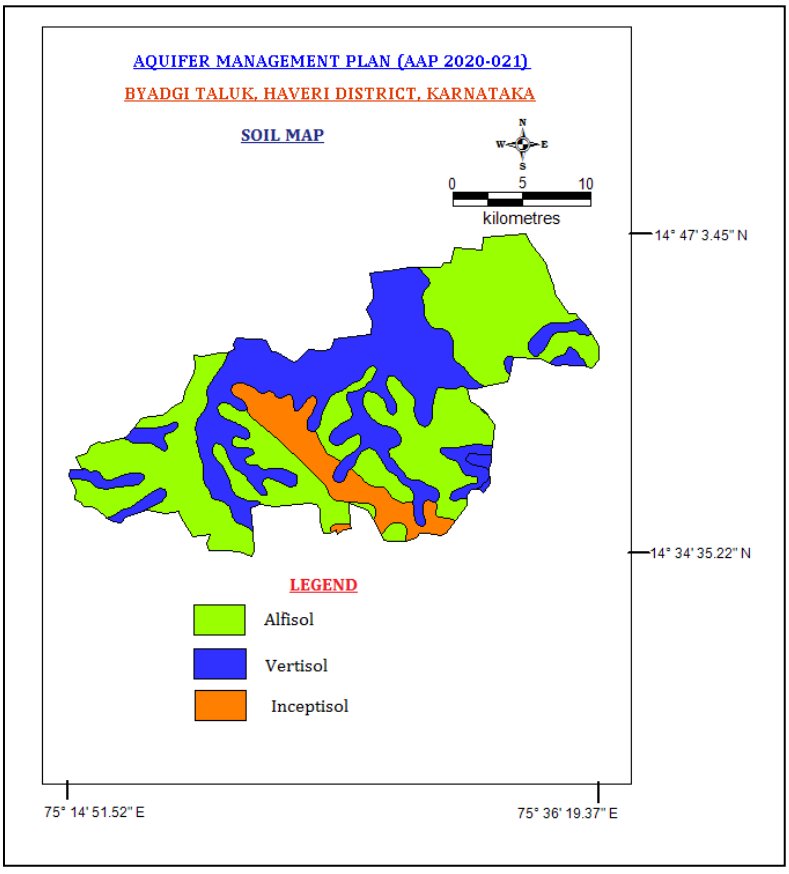


Figure 6: Soil map

1.7 Ground water resource availability and extraction

The details of dynamic (Phreatic) ground water resources for Byadgi taluk as on March 2020 is shown in Table.5. The annual extractable water resource is 4527.05ham.Total groundwater extraction for irrigation and domestic use is 3479.30ham. Annual GW Allocation for domestic use as on 2025 is 273.89ham. Net Ground Water Availability for future use is 1036.39ham.The dynamic groundwater resource availability and extraction details are given in **Table 5** below.

Table 5:Status of GW Resources (2020) (Ham)

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 for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization
4527.05	3225.31	NIL	253.99	3479.30	273.89	1036.39	**76.86**	**semi_critical**

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 13.50 to 23.59mbgl, ii) aquifer-II (fractured) water level ranges from 21.0 to 42.90mbgl , whereas in post-monsoon it varies from 3.15 to 12.61 m bgl in aquifer-I (phreatic) and 6.0 to 11.55mbgl in aquifer-II (fractured) . The seasonal water level fluctuation in aquifer-I is riseof 10.35m. The seasonal water level fluctuation in aquifer-II is rise in the range of 10.98m to 31.35m. The pre-monsoon decadal average water level for aquifer-I varies from 9.65 to 11.27mbgl. The post-monsoon decadal average water level for aquifer-I varies from 2.23 to 10.60mbgl.

(a) Depth to water level

Aquifer-I

Pre-monsoon:13.50 to 23.59 (May 2019) **(Figure7**)

Post-monsoon:3.15 to 12.61 (Nov 2019) (**Figure 8)**

Aquifer-II

Pre-monsoon:21.0 to 42.90(May 2019)

Post-monsoon:6.0 to 11.55 (Nov 2019)

(b) Water level fluctuation

Aquifer-I

Seasonal Fluctuation: Rise of 10.35m. **(Figure 9)**

Aquifer-II

Seasonal Fluctuation:Rise in the range of 10.98m to 31.35m.

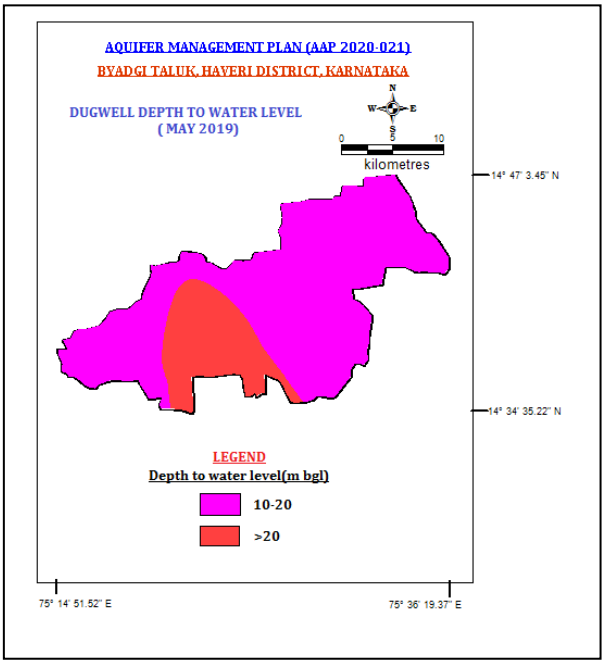


Figure 7: Aquifer-I

Depth to water level May 2019

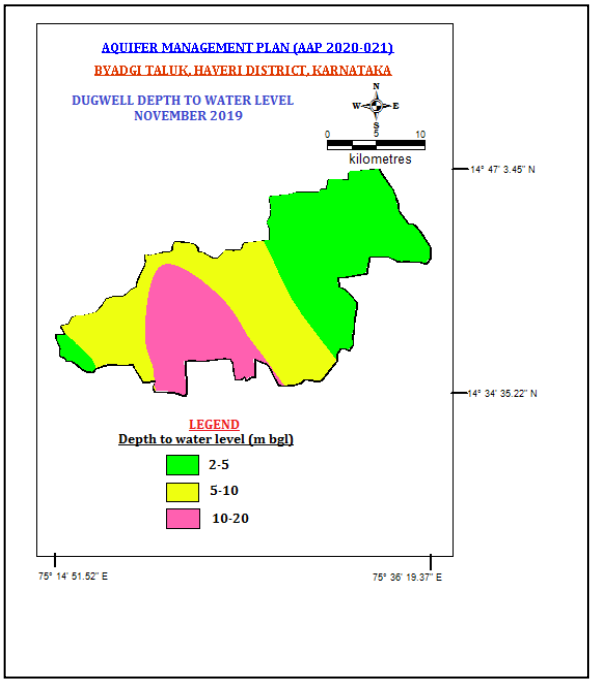


Figure 8: Aquifer-I

Depth to water level map November 2019

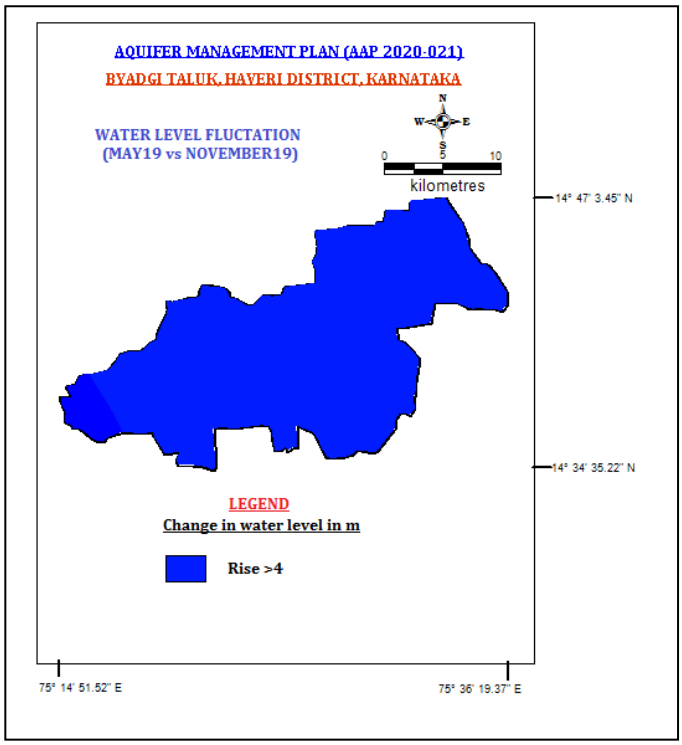


Figure 9: Aquifer-I Water level fluctuation map

The long term groundwater trend (2011-2020) for pre-monsoon period shows a fall in the range 0.174m/year for unconfined aquifer and 3.1188m/year for semi-confined aquifer **(Table 6).** The long term groundwater trend (2011-2020) for post-monsoon period shows a fall in the range 0.0837m/year for unconfined aquifer and1.2875m/year for semi-confined aquifer **(Table 7).** During both pre and post-monsoon period monitoring stations are showing falling trend.

Table 6:Pre-monsoon Trend of Groundwater monitoring stations (2011 to 2020)

SL_NO_	DISTRICT	TALUK	LOCATION	RISE (M/YEAR)	FALL (MYEAR)	AQUIFER_TYPE
1	Haveri	BYADGI	Dhundshi		0.1741	Unconfined
2	Haveri	BYADGI	Motebennur		3.1188	Semi-Confined

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

SL_NO_	DISTRICT	BLOCK_NAME	LOCATION	RISE (M/YEAR)	FALL(M/YEAR)	AQUIFER_TYPE
1	Haveri	BYADGI	Dhundshi		0.0837	Unconfined
2	Haveri	BYADGI	Motebennur		1.2875	Semi-Confined

2 AQUIFER DISPOSITION

2.1 Aquifer Types

In Byadgi taluk, there is mainly one type of aquifer system

i. **Aquifer-I(Phreaticaquifer)** comprising of weathered graywacke

ii. **Aquifer-II (Fracturedaquifer)** comprising of fractured greywacke

In Byadgi taluk, fractured graywacke is the major water bearing formation **(Figure 10)**. Groundwater occurs within the jointed and fractured greywacke under semi-confined to confined conditions. In Byadgi taluk borewells were drilled from a minimum depth of 159mbgl to a maximum of 200.0mbgl **(Table 8)**. Depth of weathered zone (Aquifer-I) ranges from 18.6mbgl to 44.0mbgl.Ground water exploration reveals that aquifer-II fractured formation was encountered between the depthof30 to 190m bgl **(Figure 11,12)**. Yield ranges from 0.96to 4.5lps.

Table 8: Detailsof 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.	Mallur	14.703333	75.361667	185.85	24.55	21.1-21.5, 23.5-24.15, 30.45-31.0 ,45.5-46.0, 70.95-71.5, 81.95-82.0, 87.25-88.0, 136.05-136.50, 148.25-149.25	19.12	3.5	8.3
2.	Kengonda	14.7717	75.5167	200	18.6	28.0-28.10, 160.5-162.5, 190.5-191.1	11.83	1.3	23.92
3.	Byadgi	14.6778	75.4917	175.7	19.36	38.9-39.0, 55.3-56.15, 130.0-130.45	31.537	0.96	6.863
4.	Hirehalli	14.6514	75.3322	161.5	44	51.0-51.65, 63.0-63.85, 68.0-69.95, 75.05-76.05, 103.0-104.0	13.09	4.5	9.86
5.	Aldageri	14.7222	75.5222	159.4	20.5	50.5-51.5, 135.5-136.5	17.78	3.55	7.62

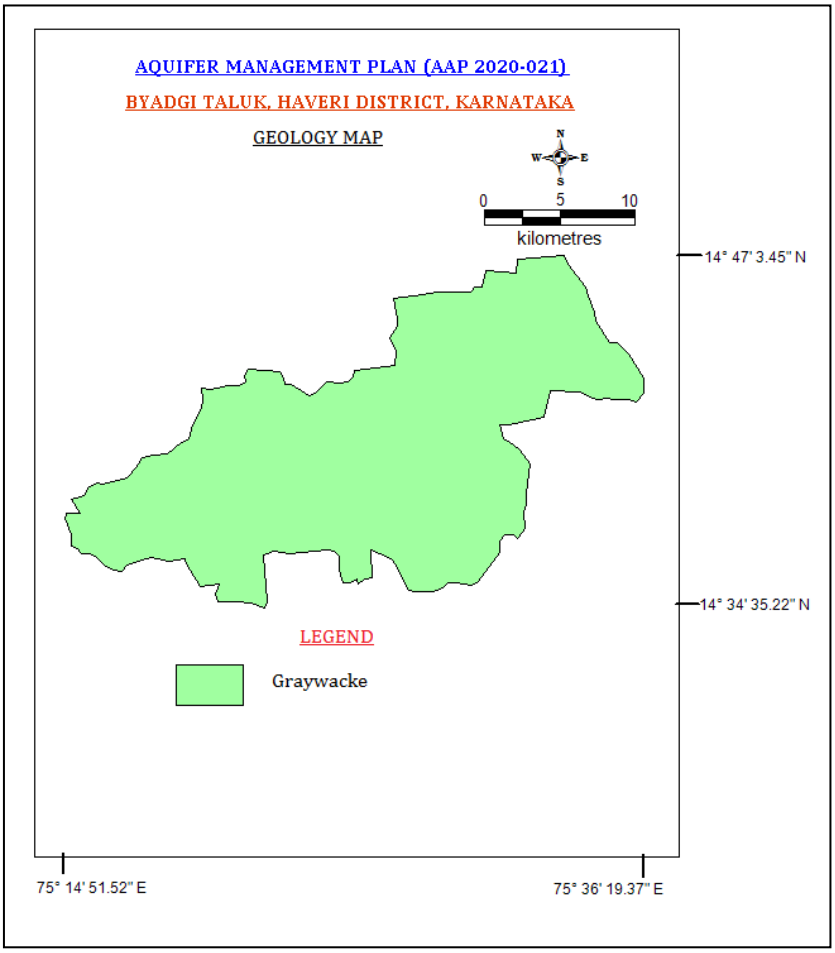


Figure 10: Geology Map

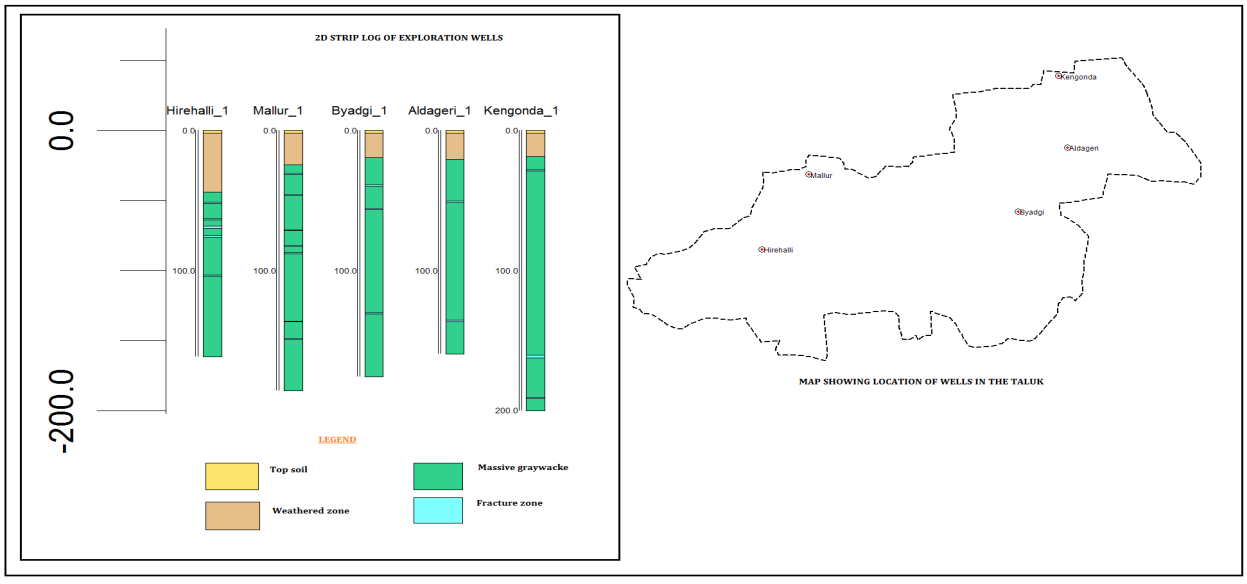
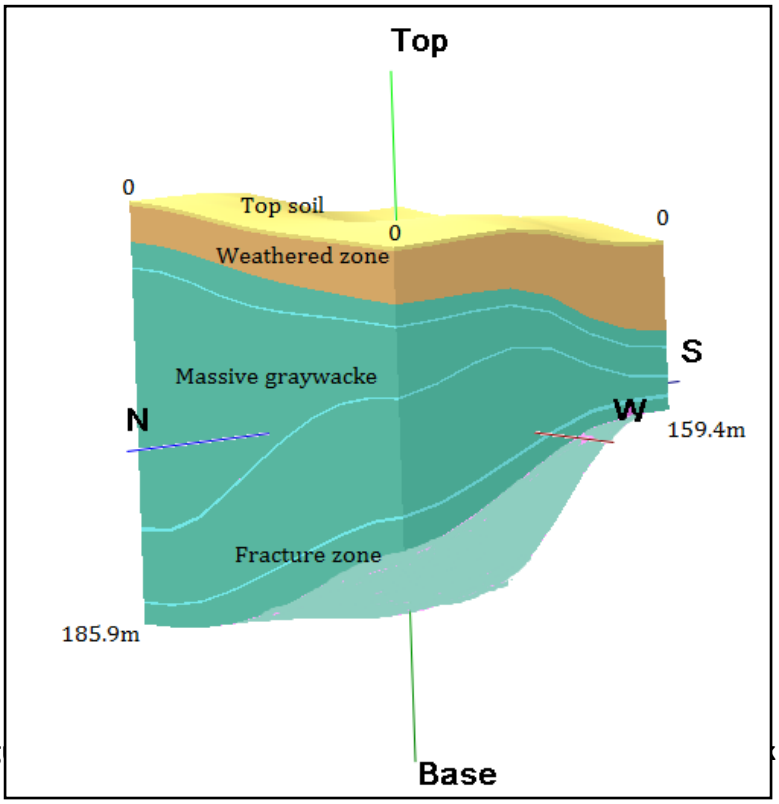


Figure 11 : 2D striplogs of the exploratory wells drilled in Byadgi taluk



Fig

3 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATIONAND OTHER ISSUES

3.1 Comparison of Groundwater resources and Extraction

The comparison of the resource as on 2013, 2017 and 2020 are summarised below in **Table 9**. It is observed that the ground water availability is lesser during the year 2020 as compared to 2017. It is attributable to more abstraction and erratic rainfall pattern.

Table 9: 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 (%)	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development (%)
	2013			2017			2020		
Byadgi	6304	5946	94	6385	5698	89	4527.05	3479.30	76.86

3.2 Chemical Quality of Ground Water and Contamination

Ground Water Quality (May 2019)

Based on the hydro chemical data, the portability of these samples has been assessed as per the Standards prescribed by the Bureau of Indian Standards (IS 10500: 2012) and categorized into 'Desirable', 'Permissible' and 'Unsuitable' classes.

The perusal of the data indicates that the distribution of electrical conductivity in the Taluk shows variations from 340 to 660μS/cm at 25˚ C.The BIS has recommended a drinking water standard for total dissolved solids a limit of 500mg/l (corresponding to about EC of 750 μS/cm at 25^0C) can be extended to a TDS of 2000mg/l (corresponding to about 3000 μS/cm at 25^0C) in case of an alternate source. Water samples having TDS more than 2000mg/l are not suitable for drinking.

Distribution of fluoride in the Taluk ranges from 0.1mg/l to 0.2 mg/l. Thus majority of samples in the Taluk shows fluoride concentration below 1.0 mg/l rendering them suitable for drinking purpose.

The distribution of nitrate in the Taluk indicated that the values are in the range of 7 mg/l to 18mg/l.Nitrate in drinking water should not exceed 45 mg/l as per BIS (ISO: 10500: 2012) standard.Thus samples collected from the Taluk indicates that the ground water is suitable for drinking purposes.

Table 10:Hydrochemical data of samples belonging to Byadgi taluk

Sl No	District	Taluk	Village	Concentration in mg/L		
				Fe mg/L	F mg/L	NO_3 mg/L
1	Haveri	Byadgi	Tadasa	0.02	0.1	7
2	Haveri		Kaginele	0.02	0.2	8
3	Haveri		Motebennur	0.03	0.1	17
4	Haveri		Byadagi	0.02	0.2	18

3.3 Overall Issues

- The taluk is drought prone due to erratic and deficient rainfall.
- Phreatic aquifer is mostly dry in major part of the taluka.
- Yield from borewells is negligible. So there is acute scarcity of water.
- Long-term term ground water level trend for phreatic aquifer shows decline for both pre-monsoon and post monsoon period **(Figure 13)**.

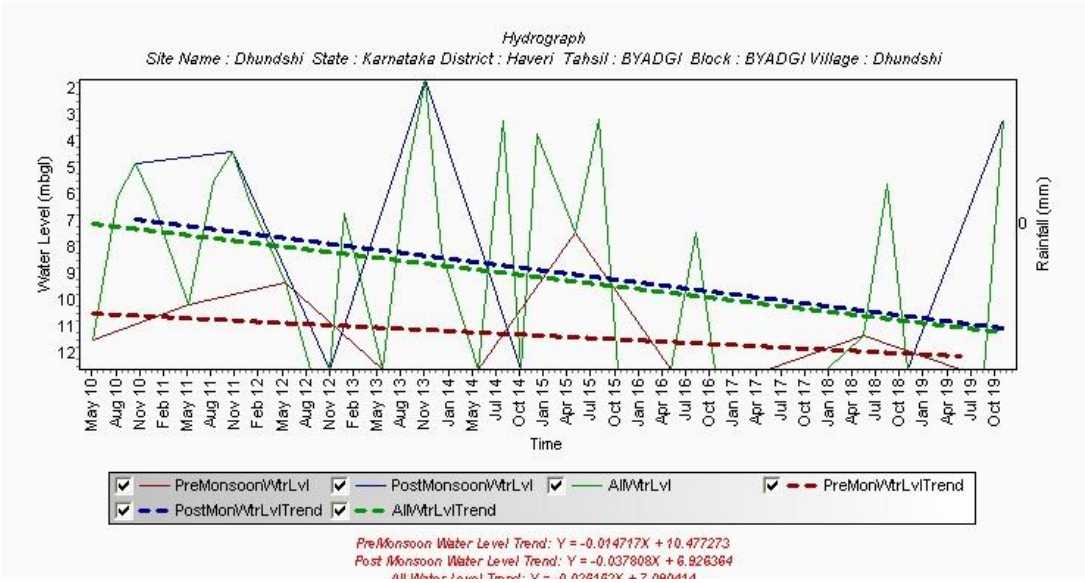


Figure 13: Hydrograph showing declining trend of dugwell water level in Byadgi taluk

- Sugarcane grown in 967 ha area by traditional irrigation method.
- Natural reservoirs are not well managed.

4 GROUNDWATER RESOURCE ENHANCEMENT

4.1 Resource Enhancement by Supply Side Interventions

The overall stage of ground water development is 76.86% as per GEC 2020. The area feasible for recharge in the taluk is worked out as 426 sq.km and the surface surplus non-committed runoff availability is 60.967mcm. As per Master Plan on Artificial Recharge, Karnataka and Goa, 2020; 255 check dams, 21 percolation tanks and 5 subsurface dykes are proposed in the taluk. However, the figures given are tentative and pre-field studies / DPR are recommended.

The details pertaining to proposed recharge structures, cost estimates and likely Recharge benefits for Byadgi taluk have been carried out and given in below **Table 11**.

Table11: Quantity of non-committed surface runoff and expected recharge through proposed artificial recharge structures (As per Master Plan Artificial Recharge Karnataka and Goa,2020)

Artificial Recharge Structures	**Byadgi taluk**
Area feasible for artificial recharge	426 sq.km
Non-committed monsoon runoff available (MCM)	60.967
Number of Check Dams	255
Number of PercolationTanks	21
Number of subsurface dykes	5
Tentative total cost of the project (Rs.Inlakhs)	3001.486
Expectedrecharge(MCM)	45.725
Expected increase in water level(m)	7.15

Table 12: Improvement in GW availability due to Recharge, Byadgi taluk

Taluk	Net annual ground water availability (1)	Existing gross ground water draft for all uses (2)	Existing stage of ground water development (3)	Expected recharge from implementing proposed artificial recharge structures and ground water recharge schemes	Cumulative annual ground water availability (5) = (1)+(4)	Expected New Stage of ground water development after the implementation of artificial recharge structures (6) = {(2)/(5)}*100	Expected improvement in overall stage of ground water development
	Ham	Ham	%	Ham	Ham	%	%
Byadgi	4527.05	3479.30	76.86	4572.5	9099.55	38.24	38.62

After implementation of artificial recharge structures, the net annual groundwater availability will increase from 4527.05ham to 9099.55ham and the expected improvement in stage of development is 38.62% from 76.86% to 38.24%. (**Table 12**)

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 7691 ha of gross irrigated area. Presently, draft through irrigation is 3225.31 ham. Implementation of efficient irrigation techniques will contribute in saving groundwater by 967.59 ham and thus, will improve stage of development by 42.3% from 76.86% to 34.56 % **(Table13).**

Table 13: Improvement in GW availability due to saving by adopting water use efficiency

Taluk	Cumulative annual ground water availability	Existing gross ground water draft for all uses	Cumulative annual ground water availability after implementing artificial recharge structures	Stage of ground water development after implementing proposed AR structures	Saving due to adopting WUE measures	Cumulative annual ground water availability	Expected improvement in stage of ground water development after the implementation of all the projects	Expected improvement in overall stage of ground water development
	Ham	Ham	Ham	%	Ham	Ham	%	%
Byadgi	4527.05	3479.30	9099.55	38.24	967.59	10067.14	34.56	42.3

4.2.2 Change in cropping pattern

In Byadgi taluk the water intensive crops grown are cotton, paddy and sugarcane. Farmers might be reluctant to change their cropping pattern. Making alternative crops profitable, providing incentives in cash and kind to take up efficient irrigation practices, developing infrastructure in rural areas might bring an interest in farmers to change to less water intensive crops.

4.2.3 Additional area of irrigation

After adopting various water use efficiency techniques and recharge measures and its resultant savings, the stage of development is expected to be 34.56% in the taluk.Canal Command area needs to be built in the taluk. Additional area of 0.055 lakh hectares irrigation potential is likely to be generatedafter implementation of proposed artificial recharge structures.

4.2.4 Regulation and Control

The overall stage of development in the Taluk is 76.86%. Karnataka Ground Water Authority has to take necessary action for controlling the over exploitation of ground water in the taluk.

Groundwater recharge component needs to be made mandatory in the taluk to save the situation from deteriorating further.

4.2.5 Other interventions proposed

- The rejuvenation of the existing tanks by desilting and construction of additional percolation tanks will help in recharging the phreatic zone.
- Abandoned bore wells/dug well can be used to recharge the aquifer utilizing the surplus surface runoff available during rainy days.
- The existing dugwells may be deepened and deep dugwells may be converted into dug-cum-borewells to increase the yield.
- Water use efficiency practices like tensiometer device in paddy cultivation and point irrigation for sugarcane and cotton 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 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 and inferior ground water quality due to nitrate contamination in some pockets. The summary of ground water management plan of Byadgi taluk is given in Table-14.

The summary of Management plan of Byadgi is given in Table 14:

Table 14: Summary of Management plan of Byadgi taluk

Byadgi taluk is 'Semi-critical' and present stage of GW Development (2020)	76.86%
Net Annual Ground Water Availability (MCM)	45.27
Existing Gross Ground Water Draft for all uses (MCM)	34.79
Expected additional recharge from monsoon surplus runoff (MCM)	60.967
Change in Stage of GW development, %	76.86 to 38.62
Expected Saving due to adopting WUE measures (MCM)	9.67
Change in Stage of GW development, %	89 to 34.56

As per the resource estimation – 2020, Byadgi taluk falls under semi-critical category with the stage of ground water extraction is 76.86 %. So 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.

Ground water resource enhancement by supply side interventions: Quantity of surface water available through non-committed surface run-off is estimated to be 6096.7ham. This can be used to recharge the aquifer mainly through percolation tanks (21), check dams (255), and sub-surface dyke structures (05). The volume of water expected to be conserved/recharged @ 75% efficiency is 4572 ham through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 3001.4 lakhs. The additional area which can be brought under assured ground water irrigation will be about 0.055 lakh 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: At present about irrigation is mostly by bore wells (ground water). The micro irrigation practices like drip and sprinkler irrigation are comparatively less practiced in comparison with traditional surface flooding mode of irrigation. The micro irrigation water efficient methodology needs to be adopted for growing water intensive cotton crop which is grown in 7600 ha area and efficient irrigation techniques will contribute in saving ground water by 967.59ham and thus will improve stage of development marginally. However, in long run the practice of efficient irrigation techniques will add to the ground water resource in large extent.

Change in cropping pattern: Water intensive crops like paddy, cotton& sugarcane are grown in 819 ha, 7600 ha and 967 ha of net cropped area of 84143 ha. However, paddy is grown during kharif period and sugarcane grown only in 3% of the cropped area. Farmers might be reluctant to change their cropping pattern. Making alternative crops profitable, providing incentives in cash and kind to take up efficient irrigation practices, developing infrastructure in rural areas might bring an interest in farmers to change to less water intensive crops.

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