



केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga

Rejuvenation

Government of India

Report on

AQUIFER MAPPING AND MANAGEMENT PLAN

Badami Taluk, Bagalkot District, Karnataka

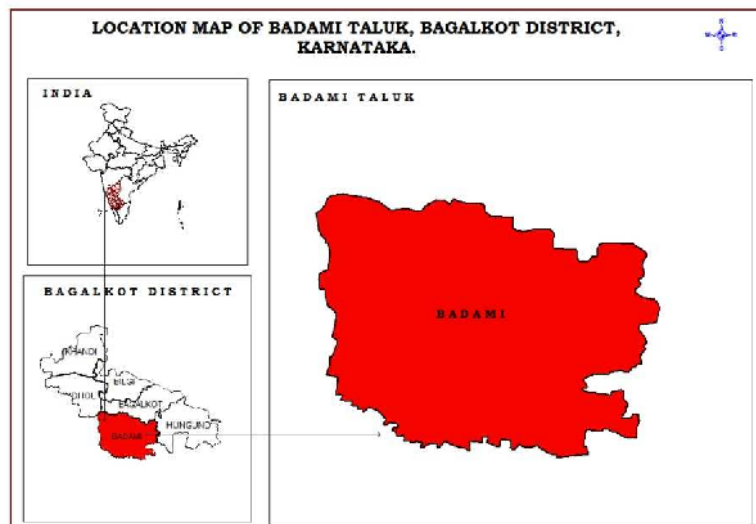
दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region, Bengaluru



**GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES,
RIVER DEVELOPMENT AND GANGA REJUVENATION
CENTRAL GROUND WATER BOARD**

**BADAMI TALUK AQUIFER MAPS AND MANAGEMENT PLANS,
BAGALKOT DISTRICT, KARNATAKA STATE**



By

SANDHYA YADAV
SCIENTIST - D

**CENTRAL GROUND WATER BOARD
SOUTH WESTERN REGION
BANGALORE
MARCH 2017**



**BADAMI TALUK AQUIFER MAPS AND MANAGEMENT PLANS,
BAGALKOT DISTRICT, KARNATAKA STATE**

CONTENTS

Sl. No.	Chapter Title	Page No.
1	SALIENT INFORMATION	1
2	AQUIFER DISPOSITION	6
3	GROUND WATER RESOURCE, EXTRACTION, MINATION AND OTHER ISSUES	8
4	GROUND WATER RESOURCE ENHANCEMENT	9
5	DEMAND SIDE INTERVENTIONS	11
6	SUMMARY	13

BADAMI TALUK AQUIFER MAPS AND MANAGEMENT PLANS, BAGALKOT DISTRICT, KARNATAKA STATE

1. SALIENT INFORMATION

Name of the taluk : **BADAMI**
District : Bagalkot
State : Karnataka
Area : 1,388 sq.km.
Population : 3,30,860 (2011)
Annual Normal Rainfall : 546 mm

1.1 Aquifer management study area

Aquifer mapping studies have been carried out in Badami taluk, Bagalkot district of Karnataka, covering an area of 1,388 sq.kms under National Aquifer Mapping Project. Badami taluk of Bagalkot district is located between north latitude 15°48'48.6" and 16°09'19.9" & east longitude 75°24'40.3" and 75°52'36.8", and is covered in parts of Survey of India Toposheet Nos. 48P/8, 48P/12, 48P/16, 48M/5, 48M/9 and 48M/13. Badami taluk is bounded by Bagalkot taluk on north, Ron & Nargund taluks of Gadag district on south, Hungund taluk on east and Ramdurg taluk of Belgaum district on western side. Location map of Badami taluk of Bagalkot district is presented in Fig-1.

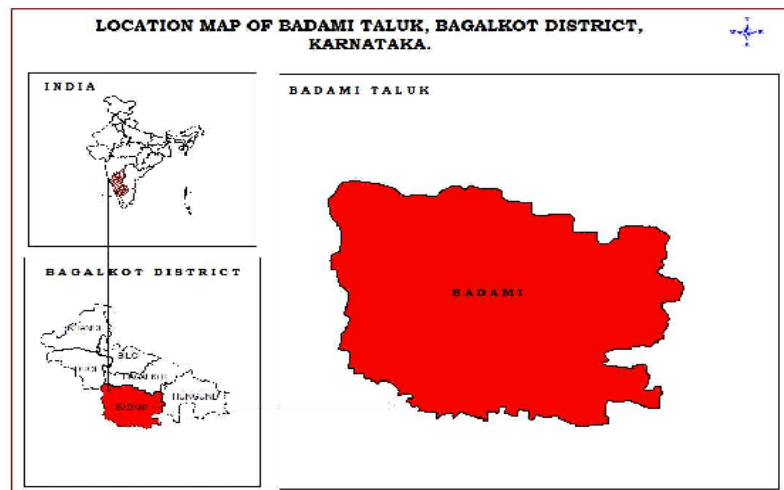


Fig 1: Location Map of Badami taluk, Bagalkot district

Badami town is taluk head quarters and there are other two towns in this taluk. There are 149 inhabited and no uninhabited villages in Badami taluk.

1.2 Population

According to 2011 census, the population in Badami taluk is 3,30,860, in which 2,46,804 constitute the rural population and 84,056 is the urban population, which works out to 75% (rural)

and 25% (urban) of the total population of taluk. The study area has an overall population density of 238 persons per sq.km. The decadal variation in population from 2001-2011 is 13.3% in Badami taluk.

1.3 Rainfall

Badami taluk enjoys semi-arid climate. Dry and hot weather prevails in major part of the year. The area falls under Northern Dry agro-climatic zone of Karnataka state and is categorized as drought prone. The normal annual rainfall in Badami taluk for the period 1981 to 2010 is 546 mm. Seasonal rainfall pattern indicates that, major amount of (298 mm) rainfall was recorded during South-West Monsoon seasons, which contributes about 55% of the annual normal rainfall, followed by North-East Monsoon season (147 mm) constituting 27% and remaining (102 mm) 18% in Pre-Monsoon season (Table-1).

Computations were carried out for the 30 year blocks of 1981-2010, the mean monthly rainfall at Badami taluk is ranging between 1 mm during January to 106 mm during October. The coefficient of variation percent for premonsoon, monsoon and post monsoon season is 66, 32 & 56 percent respectively. Annual CV at this station works out to be 29 percent (Table-1). The frequency of occurrence of drought is once in 5 years at Badami taluk

Table 1: Statistical Analysis of Rainfall Data of Badami taluk, (1981 to 2010)

STATION		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
BADAMI	NRM	1	5	6	25	66	65	61	76	96	106	34	7	546
	ST.DEV	3	13	14	26	59	44	41	38	56	69	47	14	156
	CV%	369	290	251	105	90	67	67	50	58	65	137	204	29

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Badami taluk. Major Kharif crops are maize, bajra, jowar, wheat, tur and vegetables. Main crops of Rabi season are jowar, maize, horse gram, pulses, groundnut and sunflower (Table-2). Water intensive crop sugarcane is grown in 6% of total crop area. Jowar is grown in 21%, maize in 20% and bajra in 9% of total crop area of taluk. Pulses & oil seeds account 18% of total crop area.

Table 2: Cropping pattern in Badami taluk 2014-2015

Year	Paddy	Maize	Bajra	Jowar	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
	Area under cultivation (Ha)									
2014-2015	25	21700	10050	22450	18920	516	4553	19158	6900	1200

It is observed that net sown area accounts 62% and area sown more than once is 16% of total geographical area in Badami taluk (Table-3). Forest covers 22% of total geographical area.

Area not available for cultivation and Fallow land cover 9% & 5% respectively. 62% of net area irrigated is only from bore wells, 8% from canals and 28% from other sources (Table-4).

Table 3: Details of land use in Badami taluk 2014-2015 (Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Badami	139420	31263	13211	7412	86107	22084

Source: District at a glance 2014-15, Govt. of Karnataka

Table 4: Irrigation details in Badami taluk

Source of Irrigation	Net area irrigated (Ha.)	% of area
Canals	3531	8
Tanks	0	0
Wells	185	0.5%
Bore wells	26385	62%
Lift Irrigation	350	1%
Other Sources	12117	28.5%
Total	42568	

Source: District at a glance 2014-15, Govt. of Karnataka

1.5 Geomorphology, Physiography & Drainage

In general, the topography of Badami taluk the district is rugged and undulating, traversed by chains of detached hills trending in EW direction. The ortho-quartzites and the banded hematite quartzites have formed well defined linear ridges. The ground elevation ranges from 480 to 729 m amsl, sloping towards east-southeast (Fig.-2).

Badami taluk is drained by the Krishna River and its tributaries such as Ghatprabha and Malaprabha rivers. All these rivers enter the Bagalkot district on the western side and flow in an easterly direction to join the Bay of Bengal. The Ghataprabha River flows in the middle part of the district and joins the Krishna River in Chikkasangama village in Bilgi taluk. The Malaprabha River flowing in the taluk and joins the Krishna river at Kudal Sangama in Hungund Taluk. The Ghataprabha and Malaprabha canal system irrigates the western parts of the district. The canal system from Almatti Dam constructed across the Krishna River irrigates the eastern part of the district (Fig.-3).

1.6 Soil

The soils of the Badami taluk are moderate and deep black cotton soils derived from basalt, dark grey clayey and calcareous soil from limestone, clayey soil from schist and sandy loam soil from gneiss.

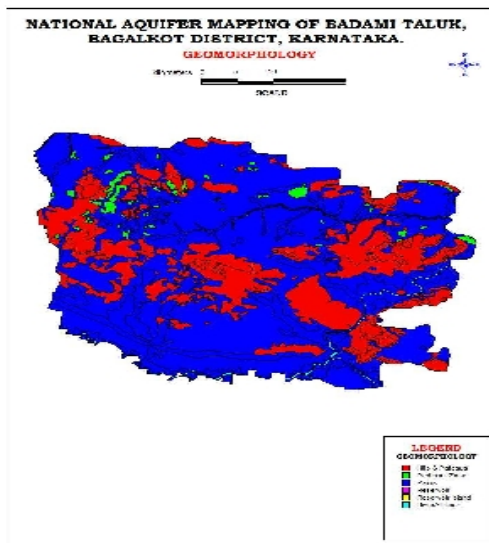


Fig 2: Geomorphology Map

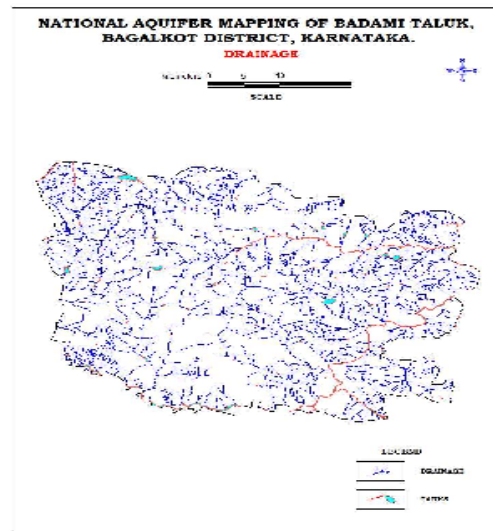


Fig 3: Drainage Map

1.7 Ground water resource availability and extraction

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

Table 5: Total Ground Water Resources (2013) (Ham)

Taluk	Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources Dynamic + phreatic in-storage + fractured
		Phreatic	Fractured (Down to 200m)	
Badami	4241	4503	1624	10368

1.8 Existing and future water demands (as per GEC-2013)

- Net ground water availability for future irrigation development : Nil
- Domestic (Industrial sector) demand for next 25 years : 5.02 MCM

1.9 Water level behavior

(a) Depth to water level

Aquifer - I

- Pre-monsoon: 2.83 – 25.96 mbgl (Fig.-4)
- Post-monsoon: 4.73 – 30.30 mbgl (Fig.-5)

Aquifer - II

- Pre-monsoon: 64.95 (5.0 - 40.0) mbgl (Fig.-6)
- Post-monsoon: 38.20 (2.0 - 40.0) mbgl (Fig.-7)

(b) Water level fluctuation

Aquifer-I (Fig.-8)

- Seasonal Fluctuation: Rise ranges 0.92 – 2.02 m;
Fall ranges 0.01 – 1.36 m

Aquifer-II (Fig.-9)

- Seasonal Fluctuation: Rise shows 26.75 m;
Fall ranges

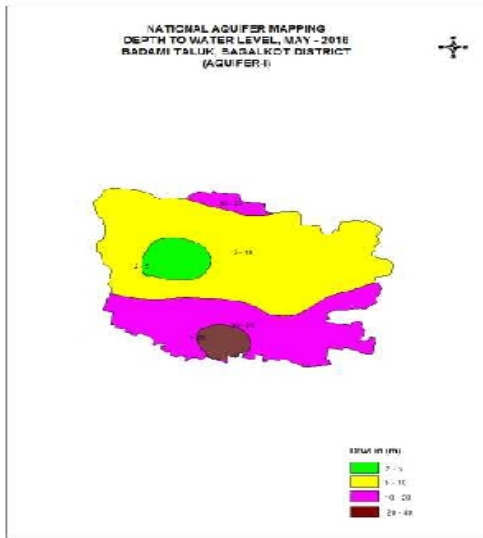


Fig 4: Pre-monsoon Depth to Water Level

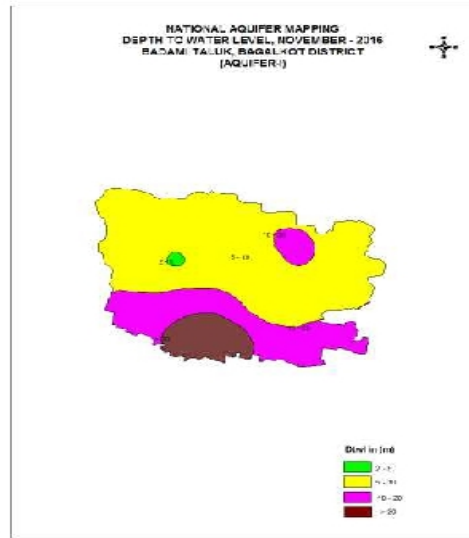


Fig 5: Post-monsoon Depth to Water Level

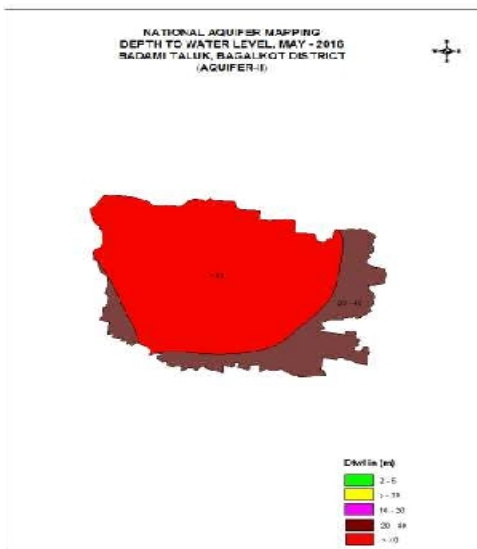


Fig 6: Pre-monsoon Depth to WLI (Aq-II)

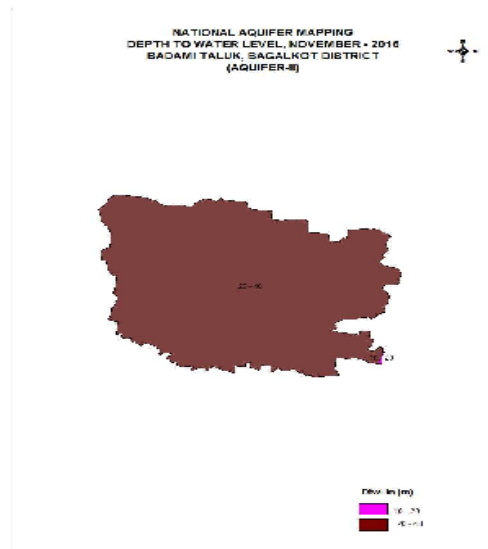


Fig 7: Post-monsoon Depth to WL (Aq-II)

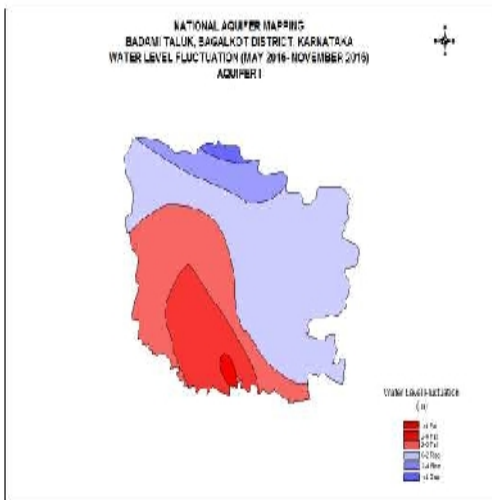


Fig 8: Water Level Fluctuation (Aq-I)

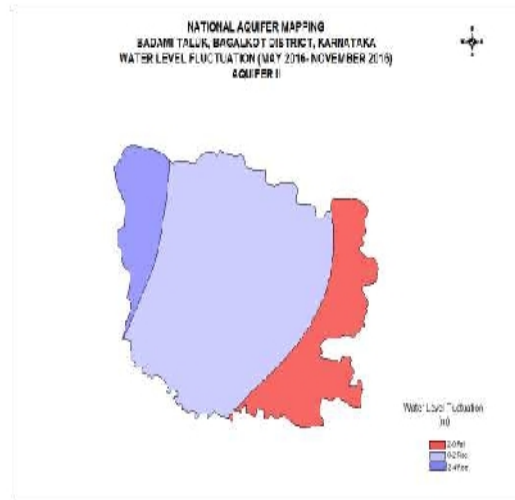


Fig 9: Water Level Fluctuation (Aq-II)

2. AQUIFER DISPOSITION

2.1 Number of aquifers: In Badami taluk, there are mainly two types of aquifer systems;

- i. **Aquifer-I (Phreatic aquifer)** comprising Weathered Granite Gneiss / Basalt / Limestone
- ii. **Aquifer-II (Fractured aquifer)** comprising Fractured Granite Gneiss / Basalt / Limestone

In Badami taluk, granitic-gneisses of Archaean age, limestone, sandstone, quartzites of Kaladgi formation (pre-cambrian) and basalts (Cretaceous) are the main water bearing formations (Fig-10). Ground water occurs within the weathered and fractured granitic-gneisses, basalt and Kaladgi group of rocks under water table condition and semi-confined condition. In the taluk bore wells were drilled from a minimum depth of 80 mbgl to a maximum of 200 mbgl (Table-6).

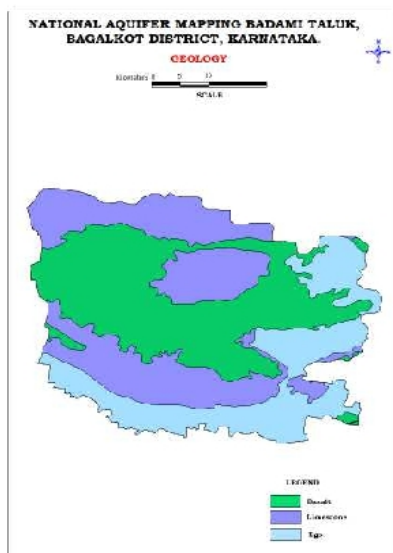


Fig 10: Geology Map

wells were drilled from a minimum depth of 80 mbgl to a maximum of 200 mbgl (Table-6).

Depth of weathered zone (Aquifer-I) ranges from 11.7 mbgl to 16.9 mbgl. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depths of 22 and 200 mbgl. Yield ranges from 0.01 to 6.5 lps. The basic characteristics of each aquifer are summarized in Table-7.

Table 6: Details of Ground water Exploration

S. NO.	Location	Lat / Long	Depth drilled (m)	Thickness of weathering (m)	Zones tapped	Aquifer	Q (lps)	SWL (m bgl)	DD, (m)	T, (m ² /day)	Specific Capacity, lpm/m/dd
1	HANAPUR (EW)	16°01'12" 75° 45'10.8"	200.20	3.5	65.00, 79.00	Sand stone/ Quartzite	5.54	2.93	5.84		76
2	KELWADI(EW)	16°05'9.6" 75° 45'43.2"	200.20	24.5	26.00	Shale/ limestone	0.078	10.41			
3	KERUR(EW)	16°01'15.6" 75° 32'42"	200.20	17.50	39.00	Sand stone/ Quartzite	0.078	>100			
4	KAINIKATTA(EW)	16°04'37.2" 75° 26'56.4"	200.20	9.50	61.04- 62.04	Quartzite	0.014	51.96			
5	JAMMANKATI-EW	16°04'8.4" 75° 36'21.6"	200.20	25.50	116-118	Sand stone/ Quartzite	0.215	65.55			
6	GOVINKOPPA- EW	15°51'54" 75° 30'3.6"	200.20	32.25	40.00, 54.00 70.00	Sand stone/ Quartzite Fractured Granitic gneiss	4.36	13.96	7.26		31.52
7	GOVINKOPPA- OW	15°51'54" 75° 30'3.6"	200.20	34.50	37.12- 38.12, 83.96- 84.96	Quartzite Fractured Granitic gneiss	3.08	15.25	15.5 5	8.12	12.11
8	HEBBALI EW	15°50'36.7" 75° 36'31.8"	200.20	38.00	53.40- 54.40, 104.88- 105.88	Quartzite Fractured Granitic gneiss	4.03	18.26	10.4 1	11.18	23.23
9	HEBBALI- OW	15°50'36.1" 75° 36'31.9"	200.20	47.40	51.40- 52.40, 118.16- 119.16	Quartzite Fractured Granitic gneiss	3.00	18.25	8.56	12.49	21.02

Table 7: Basic characteristics of each aquifer

Aquifers	Weathered Zone (Aq-I)	Fractured Zone (Aq-II)
Prominent Lithology	Weathered Gneiss / Schist	Fractured / Jointed Gneiss / Schist
Thickness range (mbgl)	20	Fractures upto 200 mbgl
Depth range of occurrence of fractures (mbgl)	-	22 - 200 80% between 50 - 200
Range of yield potential (lps)	Poor yield	1 - 5
Specific Yield	2%	0.2%
T (m ² /day)	-	0.4 – 243
Quality Suitability for Irrigation	Suitable	Suitable
Suitability for Domestic purposes	Suitable	Suitable
Remarks	Over exploited	Ground water potential fractures, 1 to 3 sets likely up to the depth of 200 m bgl.

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

a. Aquifer wise resource availability and extraction

(a) Present Dynamic Ground Water Resource (2013)

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 AND INDUSTRIAL USE FOR NEXT 25 YEARS	NET GROUND WATER AVAILABILITY FOR FUTURE IRRIGATION DEVELOPMENT	EXISTING STAGE OF GROUND WATER DEVELOPMENT	Category
Badami	4241	6303	499	6802	502	0	160	Over-exploited

(b) Present total Ground Water Resource (in ham)

Taluk	Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of GW resource
		Phreatic	Fractured	Dynamic + phreatic in-storage + fractured in-storage
Badami	4241	4503	1624	10368

(c) Comparison of ground water availability and draft scenario

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
	2009			2011			2013		
Badami	5816	8623	148%	4284	6911	161%	4241	6802	160%

b. Chemical quality of ground water and contamination

Interpretation from Chemical Analysis results in Badami taluk is mentioned as under:

Electrical Conductivity: In general, EC values range from 480 to 1230 μ /mhos/cm at 25°C which are within the permissible limit in both the aquifers. However, EC value is 4100 at Patadkal which is more than the permissible limit.

Fluoride: Fluoride concentration in ground water is of geogenic origin in areas underlain by younger granites/ gneisses containing minerals like Fluorspar & fluoroapatite. F value ranges between 0.5 – 1.3 mg/l which are also within the permissible limit of 1.5 mg/l.

Nitrate: Nitrate value ranges between 36 to 44 mg/l which are within the permissible limit of 45 mg/l, except at Patadkal where nitrate is 90 mg/l.

In general, ground water quality in Badami taluk is good for drinking purpose except in some areas as depicted in above illustrated maps, where nitrate & fluoride is found to be greater than the permissible limit as per “Indian Standard Drinking Water Specification 2009”. Ground water samples have also been tested and found suitable for agriculture & irrigation purposes.

4. GROUND WATER RESOURCE ENHANCEMENT

a. Aquifer wise space available for recharge and proposed 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-8). The choice of recharge structures should be site specific and such structures need to be constructed in areas already identified as feasible for artificial recharge.

Table 8: Quantity of non-committed surface runoff & expected recharge through AR structures

Artificial Recharge Structures Proposed	Badami taluk
Non committed monsoon runoff available (MCM)	11.35
Number of Check Dams	70
Number of Percolation Tanks	5
Number of Point Recharge structures	8
Tentative total cost of the project (Rs. in lakhs)	273.60
Expected recharge (MCM)	6.43
Expected rise in water level (m)	0.28
Cost Benefit Ratio (Rupees/ cu.m. of water harvested)	4.26

b. Improvement in GW availability due to Recharge, Badami 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	Additional potential from proposed irrigation development schemes through interbasin transfer	Cumulative annual ground water availability	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	HAM		%
Badami	4241	6802	160	643	7362	12246	56	104

c. Alternate water sources

- **Proposed GW Recharge and Assured Supply of Drinking Water Schemes (Inter basin Transfer):** Inter-basin transfer from Aphinashini & Bedti rivers under Project-4 service canal is proposed in the “Integrated Irrigation Development Schemes” by Shri.G.S.Paramashivaiah, Retd. CE, Irrigation Department and submitted to the Govt. of Karnataka.
- Under this project, it is proposed to fill 1486 Minor Irrigation tanks with 182 TMC of water to 35 taluks of Bagalkote, Bidar, Bijapur, Gulbarga, Yadgiri, Koppal and Raichur districts. 50% recharge is considered from the surface water proposed to fill the tanks for irrigation, which includes recharge from tanks, canal seepage and return flow from irrigation.
- For Badami taluk, it is calculated that about 7362 Ham can be considered as recharge from above project, if commenced.
- After implementation of Artificial Recharge structures and proposal of GW recharge scheme (inter-basin transfer), the annual ground water availability will increase from 4241 to 12246 ham and the expected improvement in stage of development is 104% from 160% to 56%

5. DEMAND SIDE INTERVENTIONS

a. Advanced irrigation practices

It is observed that bore wells are only the source for irrigation in the taluk. Thus, by adopting the below mentioned techniques will contribute in ground water resource enhancement in the long run.

- Efficient irrigation practices like Drip irrigation & sprinkler needs to be adopted by the farmers in the existing 29510 ha of gross irrigated area by wells & borewells.
- Present Irrigation draft is 6303 ham in Badami taluk.
- Efficient irrigation techniques will contribute in saving ground water by 1463 ham and thus will improve stage of development by 6% from 56% to 62% (Table-9).

b. Change in cropping pattern

Water intensive crop of sugarcane is grown in 6% (6900 ha) of total cropped area by surface water from canal, lift irrigation & other sources in the Badami taluk. Hence, change in cropping pattern has not been suggested.

Table 9: Improvement in GW availability due to saving by adopting water use efficiency

Taluk	Cumulative annual ground water availability after implementing AR structures & irrigation development schemes	Existing gross ground water draft for all uses	Stage of ground water development after implementing AR structures & proposed irrigation development schemes through interbasin transfer	Saving due to adopting WUE measures	Cumulative annual ground water availability	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		%
Badami	12246	6802	56	1463	13709	50	6

c. Water Logging and additional area of irrigation

Area prone for water logging falls between 2-5 m pre-monsoon water level contour is estimated (Table-10). In these areas, quantum of withdrawal of ground water is calculated considering specific yield of 2% and water column to be reduced to 5 mbgl. The volume of ground water withdrawn in Badami taluk is 1984 ham (0.0.701 TMC). Additional area of crop can be irrigated using 75% of irrigation efficiency is calculated on the basis of recommendation of Agriculture University, Bangalore. Accordingly, since maize is grown

in 37% of total crop area of taluk, it is suggested that additional area of 2977 ha can be irrigated for Maize or 4961 ha for Jowar crops (Table-10).

Table 10: Withdrawal of Ground Water and Increase in area of Irrigation in Badami taluk

Water Level Range (mbgl)	Water Level to be reduced to (mbgl)	Water Column (m)	Area (Ha)	Specific Yield	Volume of Ground Water to be withdrawn		Area of crop can be irrigated using 75% of Irrigation Efficiency (Ha)	
					(Ham)	(TMC)	Maize	Jowar
0 - 2	5	4	0	0.02	0	0.000	0	0
2 - 5	5	3	33071	0.02	1984	0.701	2977	4961
Total					1984	0.701	2977	4961

d. Regulation and Control

- Badami taluk has been categorized as **Overexploited**, since the Stage of ground water development has reached **160%** (GE March 2013). Hence, stringent action has to be taken up through Karnataka Ground Water Authority to control further ground water exploitation in the taluk.
- Ground water recharge component needs to be made mandatory in the non-command area of the taluk for further development of ground water.

e. Other interventions proposed

- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Excess nitrate & fluoride concentration is found in ground water samples require remedial measures viz.
 - Dilution of nitrate rich ground water through artificial recharge & water conservation.
 - Roof top rain water harvesting.
 - Micro irrigation.

6. SUMMARY

The summary of Management plan of Badami taluk is given in Table-11.

Table 11: Summary of Management plan of Badami taluk

Badami taluk is over-exploited & present stage of GW Development (2013)	160%
Net Annual Ground Water Availability (MCM)	42.41
Existing Gross Ground Water Draft for all uses	68.02
Groundwater development feasibility	0
Total GW Resources (Dynamic & Static upto the depth of 200 mbgl) (MCM)	103.68
Expected additional recharge from monsoon surplus runoff (MCM)	6.43
Change in Stage of GW development, %	160 to 139
Expected additional recharge from proposed GW recharge scheme through interbasin transfer (MCM)	73.62
Change in Stage of GW development, %	139 to 56
Expected Saving due to adopting WUE measures (MCM)	14.63
Change in Stage of GW development, %	56 to 50
Prone for Water Logging area	<ul style="list-style-type: none"> • Area prone for water logging is 33071 ham • volume of ground water withdrawn in Badami taluk is 1984 ham • additional area of 2977 ha can be irrigated for Maize or 4961 ha for Jowar crops

