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जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

MAGADI TALUK,

RAMANAGARA DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region, Bengaluru

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GOVERNMENT OF INDIA
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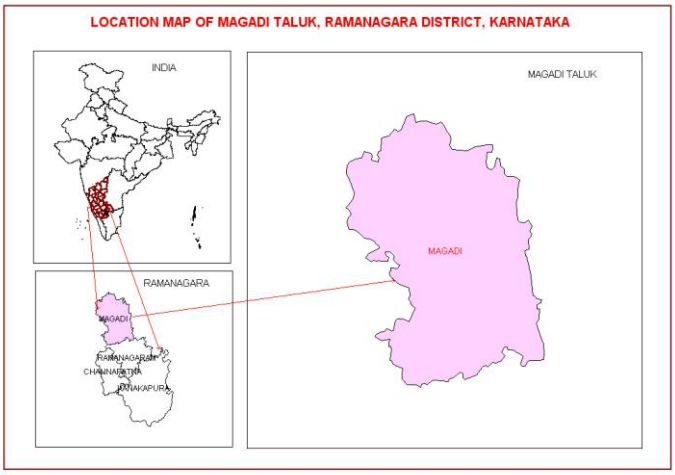
CENTRAL GROUND WATER BOARD

AQUIFER MANAGEMENT PLAN OF MAGADI TALUK, RAMANAGARA DISTRICT, KARNATAKA STATE



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AQUIFER MANAGEMENT PLAN OF MAGADI TALUK, RAMANAGARA DISTRICT, KARNATAKA STATE

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AQUIFER MANAGEMENT PLAN OF MAGADI TALUK, RAMANAGARA DISTRICT, KARNATAKA STATE

1. SALIENT INFORMATION

Name of the taluk: **MAGADI**

District: Ramanagara

State: Karnataka

Area: 801 sq.km.

Population: **203,841** (as per 2011 census)

Annual Normal Rainfall: 919 mm

1.1 Aquifer management study area

Aquifer mapping studies were carried out in Magadi taluk, Ramanagara district o f Karnataka, covering an area of 801 sq.kms under National Aquifer Mapping Project. Magadi taluk is located between north latitude 12.824^{o} and 13.19^{o} & east longitude 77.072^{o} and 77.532^{o} and is bounded by Tumkur taluk on North West, Nelmangala taluk on north East to East, Bangalore South on South East, Ramanagara on South, Kunigal on West. Location map of Magadi taluk of Ramanagara district is presented in **Fig.1.**

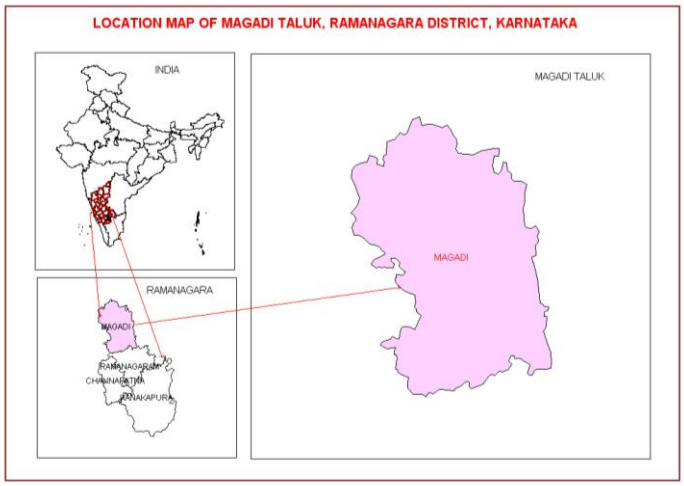

Fig.1: Location Map of Magadi taluk, Ramanagara district

Administration of Magadi taluk is divided into 5 Hoblies, 32 Gram Panchayaths and one town. There are 274 inhabited and 12 uninhabited villages in the taluk.

1.2 Population

According to 2011 census, the population in Magadi taluk is 203841, of which 82% people lives in rural areas and 18% lives in urban areas. In 2011 there were total 49,624 families

residing in Magadi Taluk. The taluk has an overall population density of 256 persons per sq.km.

1.3 Rainfall

Magadi taluk enjoys semi-arid climate. Dryness 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 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.

There is one rain gauge station located in Magadi taluk **(Table1).** The data in respect of this station from the year 1981 to 2010 is analysed and presented in **Table 2.** The data pertaining to these 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 Magadi taluk for the period 1981 to 2010 is 919 mm.

Table 1: Raingauge and its location in Magadi taluk

Station	Latitude	Longitude	Altitude
Magadi taluk	12.95	77.67	1068.8

Statistical analysis

Computations were carried out for the 30 year blocks of 1981- 2010 on Mean, Standard deviation and coefficient of variation of each month premonsoon, monsoon, post monsoon and annual and are shown in **Table 2**.

The mean monthly rainfall at Magadi taluk is ranging between 2 mm during January to 193 mm during September. The CV percent for premonsoon, monsoon and post monsoon season is 50, 34 & 45 percent respectively. Annual CV at this station works out to be 26 percent.

Assessment of Drought

Rainfall data has been analysed for 44 years using IMD method to assess the drought condition in Magadi taluk. The results of the classification are listed in the **Table 3**. It is observed that the Magadi taluk has experienced alternating no drought to acute drought conditions over the years.

Table 2: Statistical Analysis of Rainfall Data of Magadi Taluk, Ramanagara District, Karnataka for the Period 1981 to 2010

STATION		JAN	FEB	MAR	APR	MAY	PRE MONSOON	JUN	JUL	AUG	SEP	SOUTH WEST MONSOON	OCT	NOV	DEC	NORTH EAST MONSOON	ANNUALL
Magadi Taluk	Normal Rainfall (mm)	2	6	22	54	105	189	81	91	138	193	503	173	47	7	227	919
	STDEV	7	21	35	48	61	94	65	57	87	105	169	94	41	11	101	239
	CV%	386	379	162	89	58	50	80	63	63	54	34	55	87	152	45	26

Table 3: Classification of drought and its periodicity (IMD, 1971)

% Deviation (Di)		>0	0 to -25	-25 to -50	50 to 75	<-75	Probability of drought occurrences
Category		No drought	Mild (Normal)	Moderate	Severe	Acute	
		Years					
Taluk	Magadi	7	26	10	1	0	Once in 4 years

The details of drought assessment are discussed as herein under. Out of 44 years of analysis in Magadi taluk, "No Drought" condition is experienced in 7 years, "Mild Drought" condition is experienced in 26 years and "Moderate Drought" condition experienced in 10 years. Further it is observed that "Severe Drought" condition is experienced in 1 years i.e., during 2013 in Magadi taluk. Based on occurrence and frequency of past drought events, the probability of occurrence of various intensities of drought at each station has been studied. It has been observed that the frequency of occurrence of drought is **once in 4 years** at Magadi taluk.

1.4 Agriculture and Irrigation

Agriculture is the main occupation in Magadi taluk. Food grains are the major crop grown in the taluk accounting for almost 46 percent of the total crop area, followed by Cereals (35%), Pulses (10.4%), fruits (7.5%), Oil seeds (0.8%), Vegetables (42%) and Sugarcane (02%) of the total crop area respectively **(Table 4)**.

Table 4: Cropping pattern in Magadi taluk 2013-2014(Ha)

Year	Cereals	Pulses	Food Grains	Oil seeds	Fruits	Vegetables	Sugarcane	Cotton
	Area under cultivation (in ha)							
2016-17	24315	7216	31531	524	5159	291	17	0

It is observed that net sown area accounts for about 53% of total geographical area, while area sown more than once is 3.5% of total geographical area in the taluk **(Table 5).** As per the data available, the taluk uses 4221 dug wells and 7537 tube wells for irrigation purpose. Canals are the source for irrigation in the taluk **(Table 6).** Land use pattern of the taluk is represented as **Fig. 2**.

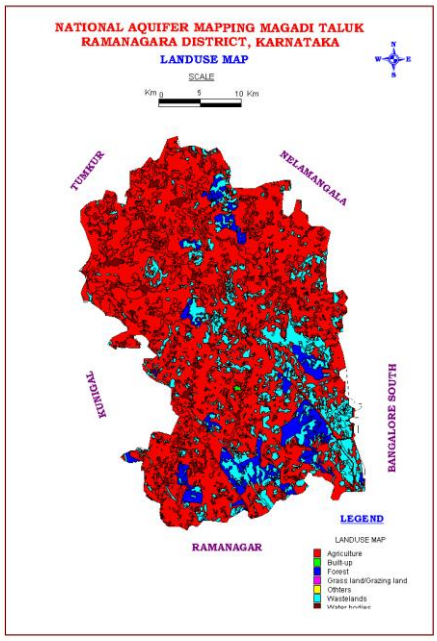

Fig. 2: Landuse Map

Table 5: Details of landuse in Magadi taluk 2016-2017(Ha)

Taluk	Total Geographical Area (sq.km)	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Magadi	799.69	65.98	105.81	87.80	423.81	27.65

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

Table 6: Irrigation details in Magadi taluk (Ha)

Sl. No.	Source of Irrigation	Net area irrigated (Ha)
1	Canals	805
2	Tanks	501
3	Wells	0
4	Tube wells	3473
5	Lift Irrigation	63
6	Other Sources	0
Total		4842

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

1.5 Geomorphology, Physiography and Drainage

The entire taluk is categorised as Pediment- pediplain complex of denundational orgin **(Fig. 3).** Low to medium dissected hillocks and valleys also occur as patches in the taluk. Physiographically, it can be divided into four physiographic units' viz Plains, piedmont zone, hills and plateaus and river. The ground altitude varies from 720 to 1080 m above MSL. The taluk is drained by Cauvery river basin. The drainage pattern in the area can be described as semi dendritic to dendritic. The rivers and streams originate from small watersheds and empty into number of tanks in the taluk and the district **(Fig. 4).**

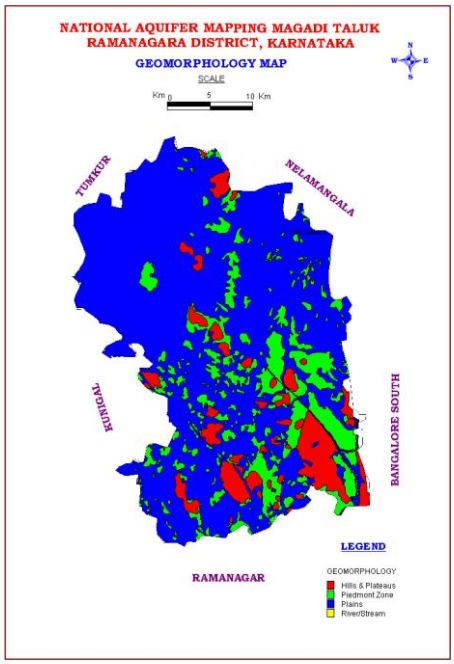

Fig. 3: Geomorphology Map

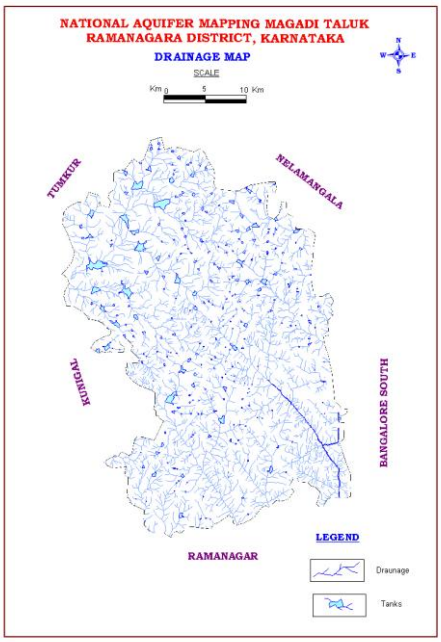

Fig. 4: Drainage Map

1.6 Soil

The taluk is occupied by two types of soils viz. Clayey and Red loamy soils (rocky) generally occur on hilly to undulating land slope on granite and granite gneisses 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 insitu in nature **(Fig. 5)**

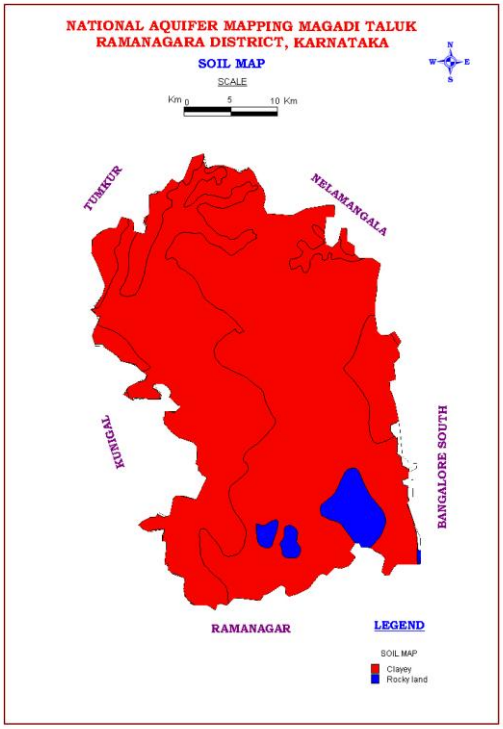

Fig. 5: Soil Map

1.7 Ground water resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth are given in **Table 7** below.

Table 7: Total GW Resources (as on March 2017) (Ham)

Taluk	Annual Replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (down to 200 m)	Dynamic + Phreatic in-storage + fractured
Magadi	6130	12868	1864	20862

1.8 Existing and future water demands (as per GEC-2017)

Net ground water availability for future irrigation development: 7993ham

Domestic and Industrial sector demand for next 25 years: 720 ham

1.9 Water level behaviour

(a) Depth to water level

Aquifer-I

Pre-monsoon: 1.65 – 9.68 mbgl **(Fig. 6)**

Post-monsoon: 2.70 – 8.95 mbgl **(Fig.7)**

Aquifer-II

Pre-monsoon: 18.8–36.67 mbgl

Post-monsoon: 17.78–27.38 mbgl

(b) Water level fluctuation

Aquifer-I

Seasonal Fluctuation: Rise in the range of 0.05 m to 2 m and fall of 0.88 m to 3.5 m **(Fig. 8).**

Aquifer-II

Seasonal Fluctuation: Rise in the range of 2.2–9.29 m and fall in the range 0-5.65m

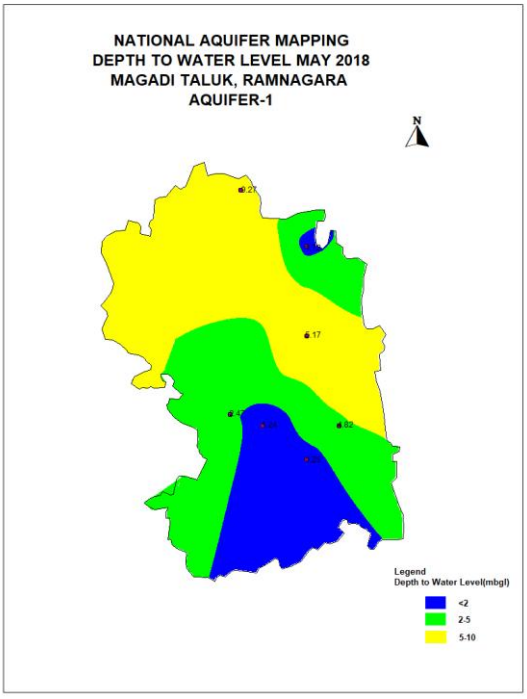

Fig. 6: Depth to Water Level, Pre-Monsoon

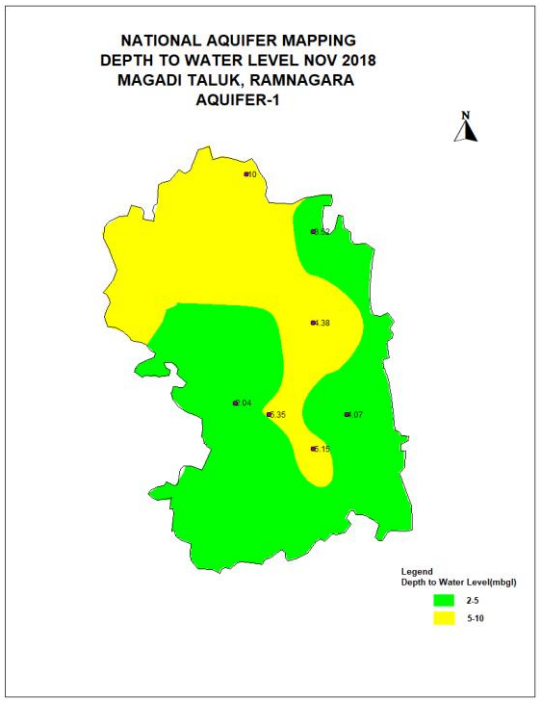

Fig. 7: Depth to Water Level, Post-Monsoon

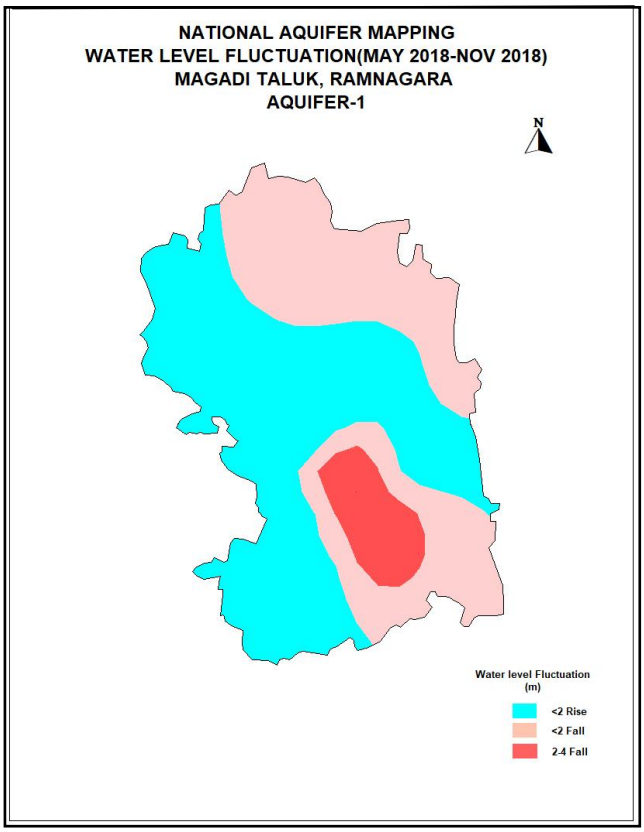

Fig. 8: Water Level Fluctuation, Pre-Post 2018(DW)

2. AQUIFER DISPOSITION

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

i. **Aquifer-I (Phreatic aquifer)** comprising Weathered Banded gneissic complex
ii **Aquifer-II (Fractured aquifer)** comprising Fractured Granite and Gneisses

In Magadi taluk, fractured granite and gneisses are the major water bearing formations **(Fig. 9)**. Groundwater occurs within fractured granite under semi-confined to confined conditions. In Magadi taluk bore wells were drilled from a minimum depth of 47.3 mbgl to a maximum of 200.1mbgl **(Table 8)**. Depth of weathered zone (Aquifer-I) ranges from 8 to 35 mbgl. However, isolated patches in topographical lows are seen yielding seasonally, that too for very short durations. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depth of 19.3 to 126.06 m bgl. Yield ranges from 0.31 to 5.5 lps.

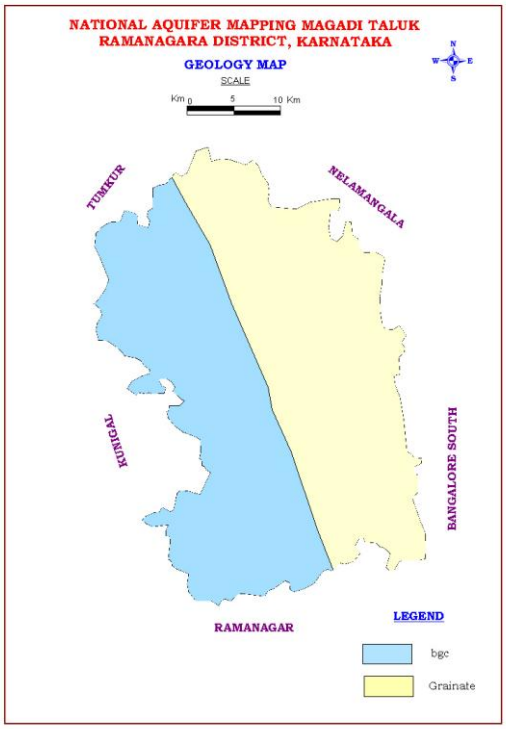

Fig. 9 : Geology Map

Table 8: Details of Ground water Exploration

Sl. No.	Location	Latitude	Longitude	Depth Drilled (mbgl)	Casing Depth (mbgl)	Fracture Zones (mbgl)	SWL (mbgl)	Q (lps)	DD (m)
1	Tippasandra EW	13.0426	77.1255	141.7	19.8	77.65, 95.95	30.68	2.02	4.35
2	Tippasandra OW	13.0418	77.1258	200	18	19.3, 126.06	29.52	0.37	5.15
3	Guddemaranahalli EW	13.0482	77.2629	200	8.5	58.95, 86.40	13.47	0.31	
4	Jalamangala EW	12.7989	77.2242	200	14.7	28.45	14.31	0.83	
5	Veeragoudanadoddi EW	12.8983	77.2725	200	13.9	40.65			
6	Kuduru EW	13.1056	77.1665	181.6	37.6	86.4,126.05		5.5	
7	Bachanahatti	12.95	77.30	60	12.3		8		
9	Magadi	12.95	77.22	46.50	13.12	20-21, 23-24		.75	
10	Solur	13.07	77.25	60	25.9	37-38, 43-44, 47-48, 51-51.5	19.45	.133	
11	Kuduru OW	13.1086	77.1555	200	34.5	116.9		4.36	

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

3.1 Aquifer wise resource availability and extraction Tables 9a,b,c

(a) Present Dynamic Ground Water Resource (2017)

Taluk	Command/Noncommand	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
		HAM						%	
Magadi	Non Command	7993	6644	657	7301	720	796	91	Critical

(b)Present total Ground Water Resource (as on March 2009)

Taluk	Annual Replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (down to 200 m)	Dynamic + Phreatic in-storage + fractured
Magadi	6130	12868	1864	20862

(c) Comparison of Ground Water Availability and Draft Scenario in Magadi 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
	2011			**2013**			**2017**		
Magadi	6439	6362	98.81	6829	6519	95	7993	7301	91

3.1 Chemical Quality of Ground Water and Contamination

Ground Water Quality (May 2014)

The water samples collected from shallow aquifers of GWMS were collected during pre-monsoon and analysed in the Regional Chemical Laboratory for pH, Electrical Conductivity (EC), Chloride, Nitrate and Fluoride by employing Standard methods. 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 electrical conductivity in water samples is an indication of total dissolved ions. Thus the higher the EC, the higher the levels of dissolved ions in the sample. The perusal of the data indicates that the distribution of electrical conductivity in the taluk shows wide variations (772-2390 μS/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 purpose. In general, EC values range from 470 to 1200 μ/mhos/cm at 25^oC **(Fig.10).**

One of the essential elements for maintaining normal development of healthy teeth and bones is Fluoride. Lower concentrations of fluoride usually below 0.6mg/l may contribute to dental caries. However, continuing consumption of higher concentrations, above 1.2mg/l however cause dental fluorosis and in extreme cases even skeletal fluorosis. Most of the fluoride found in groundwater is of geogenic origin. Distribution of fluoride in the taluk ranges from 0.6 mg/l to 2.6 mg/l. Thus majority of samples in the taluk shows fluoride concentration beyond 1.5 mg/l rendering them unsuitable for drinking purpose. F value ranges between 0.3 to 1.1mg/l. **(Fig.11).**

Nitrate is a problem as a contaminant in drinking water (primarily from groundwater and wells) due to its harmful biological effects. High concentrations can cause methemoglobinemia, and have been cited as a risk factor in developing gastric, an intestinal cancer. Nitrate in drinking water should not exceed 45 mg/l as per BIS (ISO: 10500: 2012) standard. In the taluk Nitrate value ranges between 0.001 to 6 mg/l **(Fig.12).**

Thus majority of the samples collected from the taluk indicates that the ground water is not suitable for drinking purpose.

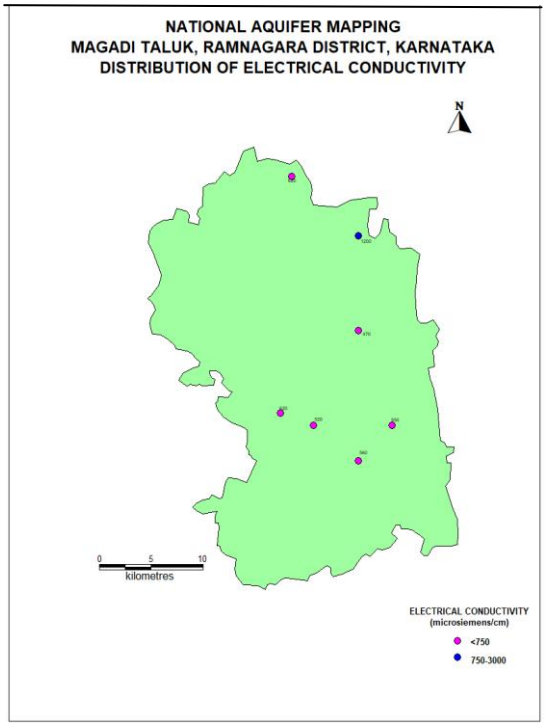

Fig.3.1: Distribution of EC

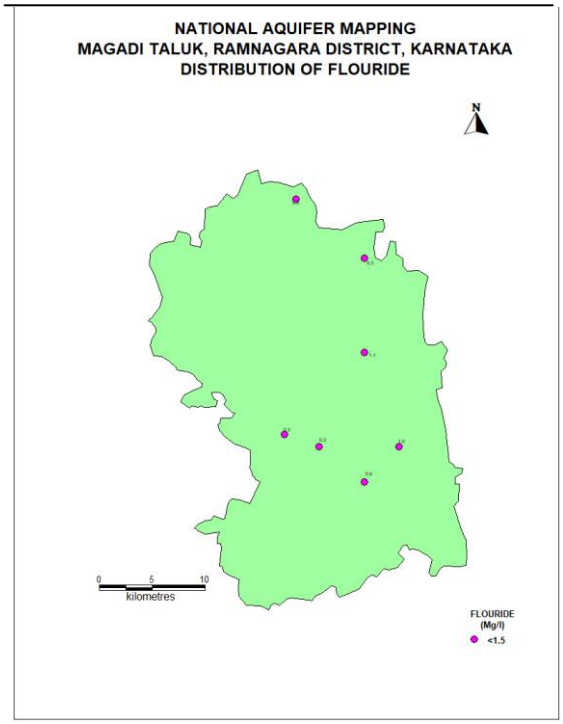

Fig.3.2: Distribution of Fluoride

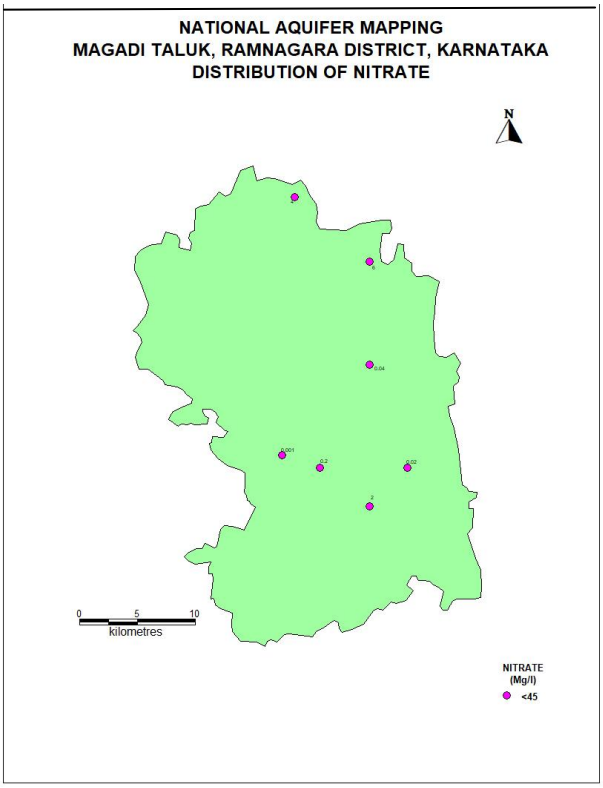

Fig.3.3: Distribution of Nitrate

4. GROUND WATER RESOURCE ENHANCEMENT

4.1 Aquifer wise space available for recharge and proposed interventions

Recharge phreatic aquifer (Aquifer-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.

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

Artificial Recharge Structures Proposed	Magadi Taluk
Non committed monsoon runoff available (Ham)	2049
Number of Check Dams	126
Number of Percolation Tanks	9
Number of Point Recharge structures	14
Tentative total cost of the project (Rs.in lakhs)	470
Excepted recharge (MCM)	9
Expected rise in water level (m)	0.844
Cost Benefit Ratio (Rupees /cu.m. of water harvested)	4.26

4.2 Improvement in GW availability due to Recharge, Magadi taluk

Table 11: Improvement in GW availability due to Recharge, Magadi 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 inter-basin 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	%	%
Magadi	7993	7301	91	900	-	8893	9	82

After implementation of Artificial Recharge structures for GW recharge, the annual ground water availability will increase from 7993 to 8893 ham and the expected improvement in stage of development is 9% from 91% to 82%.

5. DEMAND SIDE INTERVENTIONS

5.1 Advanced irrigation practices

It is observed that presently, in the command areas canals are the source of irrigation and in non-command areas water from tanks and ground from borewells are 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 5207 ha of gross irrigated area. After adopting WUE methods and Grey water the stage of extraction can be improved from 82% to 66%. **(Table 12).**

5.2 Change in cropping pattern

In Magadi taluk the water intensive crops grown are paddy, sugarcane, vegetables and ragi. Paddy is grown 766 hectares, Sugarcane is grown in 17 hectares and Ragi in 23464 hectare and vegetables in 291 hectare of the taluk, which can be reduced by using less water require crops.

Table 12: 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	Stage of ground water development after implementing AR structures & Surface water schemes	Saving due to adopting WUE measures	Saving due to adopting Grey Water	Cumulative annual ground water availability	Final overall stage of ground water extraction after implementing all interventions	Total water likely to be saved after all interventions	Additional area can be brought into irrigation keeping the stage of extraction at the existing level
	Ham	Ham	%	Ham	Ha	Ham	%	Ham	Ha
Magadi	8893	7301	82	1993	205	11091	66	3098	7745

5.3Additional area of irrigation

After adopting various water use efficiency techniques, changing cropping pattern and recharge measures and its resultant savings, the stage of development is expected to be 60% in the taluk, the taluk which is in critical category can bring to safe category. Hence bringing additional area under irrigation may not be practical with a long-term resource management point of view.

5.4 Regulation and Control

The overall stage of development in the taluk is 91% and is falls under critical category. Karnataka Ground Water Authority has to take necessary action for controlling the over exploitation of ground water in the taluk as well as for improving the quality of ground water.

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

5.5 Other interventions proposed:

Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.

5.6 Summary

The summary of Management plan of Magadi taluk is given in **Table 13.**

Table 13: Summary of Management plan of Magadi taluk

Magadi taluk is 'critical' and present stage of GW Development (2013)	91%
Net Annual Ground Water Availability (MCM)	79.93
Existing Gross Ground Water Draft for all uses (MCM)	73.01
Total GW Resources (Dynamic & Static up to the depth of 200 m bgl (MCM)	227.25
Expected additional recharge from monsoon surplus runoff (MCM)	9
Change in Stage of GW development, %	82
Expected Saving due to adopting WUE measures (MCM)	19.93
Expected Saving due to adopting Grey Water (MCM)	2.05
Final overall stage of ground water extraction after implementing all interventions (%)	66
Total water likely to be saved after all interventions (MCM)	30.98
Additional area can be brought into irrigation keeping the stage of extraction at the existing level (ha)	7745