



## केंद्रीय भूमि जल बोर्ड

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**

**RAMANAGARA TALUK,  
RAMANAGARA DISTRICT, KARNATAKA**

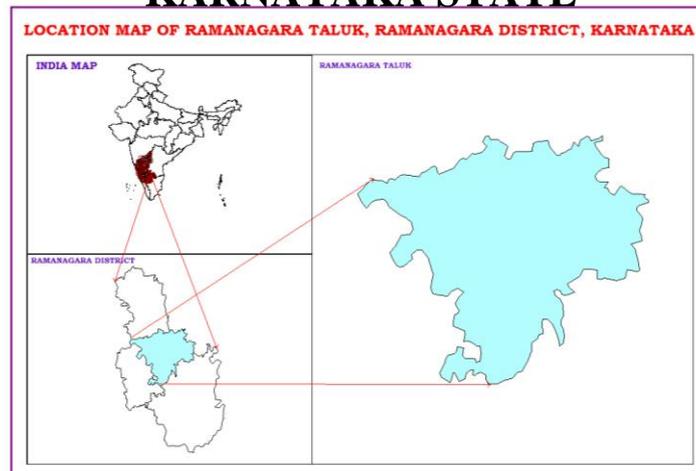
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**GOVERNMENT OF INDIA  
MINISTRY OF JAL SHAKTI  
DEPT. OF WATER RESOURCES, RD & GR  
CENTRAL GROUND WATER BOARD**

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



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## **AQUIFER MANAGEMENT PLAN OF RAMANAGARA TALUK, RAMANAGARA DISTRICT, KARNATAKA STATE**

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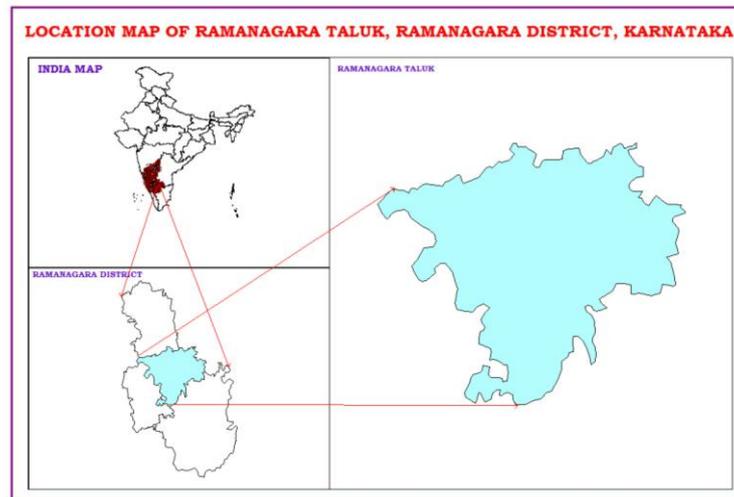
# AQUIFER MANAGEMENT PLAN OF RAMANAGARA TALUK, RAMANAGARA DISTRICT, KARNATAKA STATE

## 1. SALIENT INFORMATION

<b>Name of the taluk:</b>	RAMANAGARA
<b>District:</b>	Ramanagara
<b>State:</b>	Karnataka
<b>Area:</b>	629.30 sq.km.
<b>Population:</b>	2,66,614 (as per 2011 census)
<b>Annual Normal Rainfall:</b>	895 mm

### 1.1 Aquifer management study area

Aquifer mapping studies were carried out in Ramanagara taluk, Ramanagara district of Karnataka, covering an area of 629.30 sqkm under National Aquifer Mapping Project. Ramanagara taluk of Ramanagara district is located between north latitude  $12^{\circ}35'13''$  and  $12^{\circ}52'37''$  & east longitude  $77^{\circ}08'28''$  and  $77^{\circ}29'08''$ , and is covered in parts of Survey of India Toposheet Nos. 57H/1, 57H/5 and 57H/6. Ramanagara taluk is bounded by Magadi taluk on North, Bangalore South taluk on east, Kanakpura on South, Channapatana on South West and Kunigal on North West. Location map of Ramanagara taluk of Ramanagara district is presented in **Fig.1.1**.



**Fig.1.1: Location Map of Ramanagara taluk, Ramanagara district**

Ramanagara taluk is located in Ramanagara District of Karnataka State. Taluk administration of Ramanagara taluk is divided into 4 Hoblies and 20 Gram Panchayaths. There are 123 inhabited and 10 uninhabited villages in the taluk.

## 1.2 Population

According to 2011 census, the population in Ramanagara taluk is 2,66,614, of which rural population is 1,61,530 constituting about 61%, and the urban population is 1,05,084 constituting only about 39% of the total population. The taluk has an overall population density of 424 persons per sq.km.

### Rainfall

Ramanagara 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 Ramanagara taluk (Table 1.1). The data in respect of this station from the year 1981 to 2010 is analysed and presented in Table 1.2. 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 Ramanagara taluk for the period 1981 to 2010 is 895 mm.

**Table 1.1: Rain gauge and its location in Ramanagara taluk**

Station	Latitude	Longitude	Altitude
Ramanagara taluk	12.72	77.28	974.4

### 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 1.2**.

The mean monthly rainfall at Ramanagara taluk is ranging between 1 mm during February to 187 mm during September. The CV percent for premonsoon, monsoon and post monsoon season is 45, 44 & 61 percent respectively. Annual CV at this station works out to be 28 percent.

### Assessment of Drought

Rainfall data of Ramanagara taluk has been analysed for 45 years using IMD method to assess the drought condition in Ramanagara taluk. The results of the classification are listed in

the **Table 1.3**. It is observed that the Ramanagara taluk has experienced alternating no drought to acute drought conditions over the years.

**Table 1.2: Statistical Analysis of Rainfall Data of Ramanagara Taluk, Ramanagara District for the Period 1981 to 2010**

STATION		JAN	FEB	MAR	APR	MAY	PRE MONSOON	JUN	JUL	AUG	SEP	SW MONSOON	OCT	NOV	DEC	NE MONSOON	ANNUAL RAINFALL
Ramanagara	Normal Rainfall (mm)	2	1	21	46	101	171	79	99	121	187	486	171	55	12	238	895
	STDEV	7	3	42	41	64	77	62	108	88	100	213	110	49	21	145	251
	CV%	2	243	194	90	64	45	78	109	73	53	44	64	89	174	61	28

**Table 1.3: 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	Ramanagara	10	24	11	0	0	Once in 4 years

The details of the drought assessment are discussed as herein under. Out of 45 years of analysis in Ramanagara taluk, “No Drought” condition is experienced in 10 years, “Mild Drought” condition is experienced in 24 years and “Moderate Drought” condition experienced in 11 years in Ramanagara 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 Ramanagara taluk.

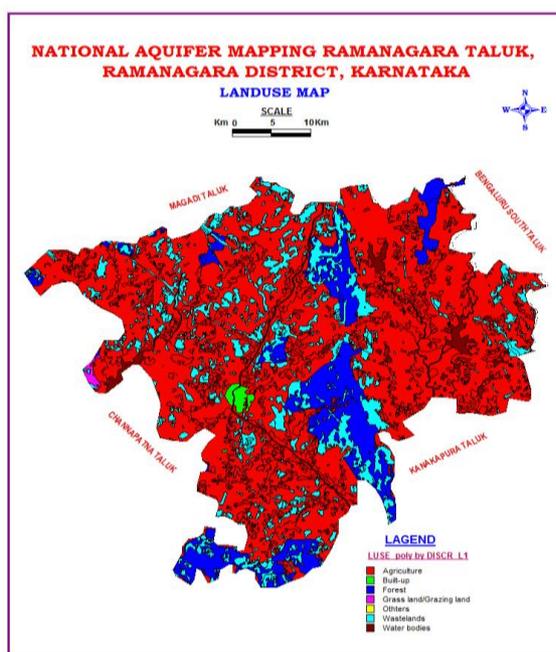
#### 1.4 Agriculture and Irrigation

Agriculture is the main occupation in Ramanagara taluk. Food grains are the major crop grown in the taluk accounting for almost 36.19% of the total crop area, followed by Fruits (25.04%), Ragi (22.33%), Pulses (9.81), Maize (2.67%), Oil Seeds (2%), Paddy (1.38%), Vegetables (0.56%) and Sugar Cane (0.02%) of the total crop area respectively (**Table 1.4**).

**Table 1.4: Cropping pattern in Ramanagara taluk 2015-2016(Ha)**

Year	Paddy	Maize	Ragi	Pulses	Food Grains	Fruits	Vegetables	Oil Seeds	Sugar Cane
	Area under cultivation (in ha)								
2015-16	536	1035	8665	3806	14042	9717	218	778	7

It is observed that net sown area accounts for about 45% of total geographical area, while area sown more than once is 4% of total geographical area in the taluk (Table 1.5). As per the data available, the taluk uses 8048 tubewells for irrigation purpose. Ground Water is the major source for irrigation in the taluk (Table 1.6). Land use pattern of the taluk is represented as Fig.1.2.



**Fig.1.2: Landuse Map of Ramanagara Taluk, Ramangara District**

**Table 1.5: Details of land use in Ramanagara taluk 2015-2016(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
Ramanagara	629.30	11954	10628	11051	28378	2512

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

**Table 1.6: Irrigation details in Ramanagara taluk (Ha)**

Source of Irrigation	Net area irrigated (Ha)	% of area
Canals	735	8
Tanks	202	2
Wells	0	0
Tubewells	8048	90
Lift Irrigation	0	0
Other Sources	0	0
<b>Total</b>	<b>8985</b>	

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

### **1.5 Geomorphology, Physiography and Drainage**

Geomorphologically, the entire taluk is divided into residual hills, pediment zone and plains about 900 m amsl (**Fig 1.3**). Geomorphologically the Ramanagara district can be divided into rocky upland, plateau and flat topped hills at an elevation of about 900 m amsl. The pediplain forms major part of the taluk underlain by gneisses and granites with the highest pediplain in the range of 850 m to 950 m amsl. Rocky upland pediplain and plateau constitute erosional topography. Major part of pediplain constitutes low relief area having matured dissected rolling topography with erosional landscape covered by layers of red soil of varied thickness. Major parts of the pediplain are dissected by streamlets flowing in southerly direction. An alluvial valley with low relief of 600 – 650 m is located in Kanva plain. The entire taluk is drained by Cauvery river basin (**Fig. 1.4**).

### **1.6 Soil**

The taluk is occupied clayey soil, clayey mixed and clayey skeletal and rocky land. 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.1.5**).

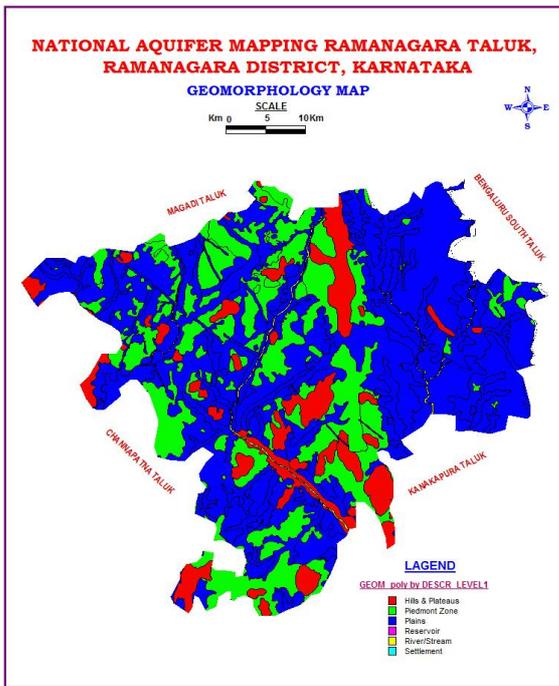


Fig.1.3: Geomorphology Map

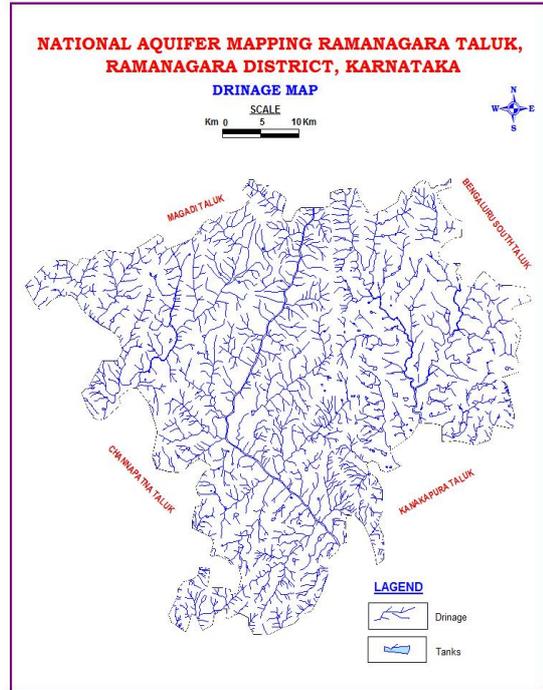


Fig.1.4: Drainage Map

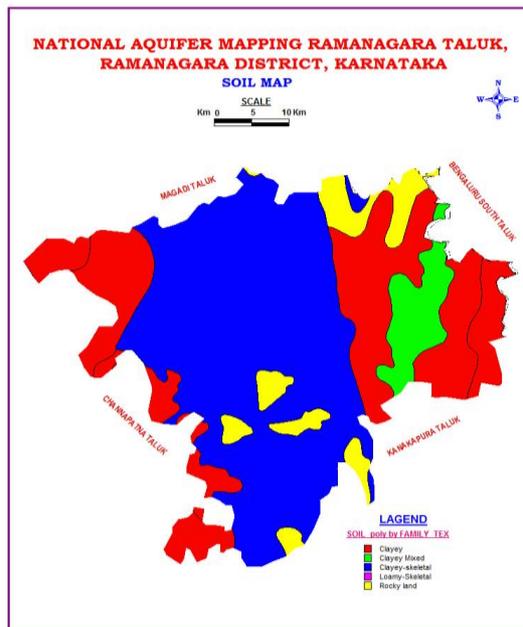


Fig.1.5: Soil Map

## 1.7 Ground water resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth are given in **Table 1.7** below.

**Table1.7: Total GW Resources (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
Ramanagara	3762	7615	1173	12550

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

Net ground water availability for future irrigation development: 347.34ham

Domestic and Industrial sector demand for next 25 years: 301.92 ham

## 1.9 Water level behaviour

### *(a) Depth to water level*

#### **Aquifer-I**

Pre-monsoon: 3.26 – 11.24 mbgl (**Fig.1.6**)

Post-monsoon: 1.47 – 12.05 mbgl (**Fig.1.7**)

#### **Aquifer-II**

Pre-monsoon: 12.6–12.8 mbgl

Post-monsoon: 9.47–12.62 mbgl

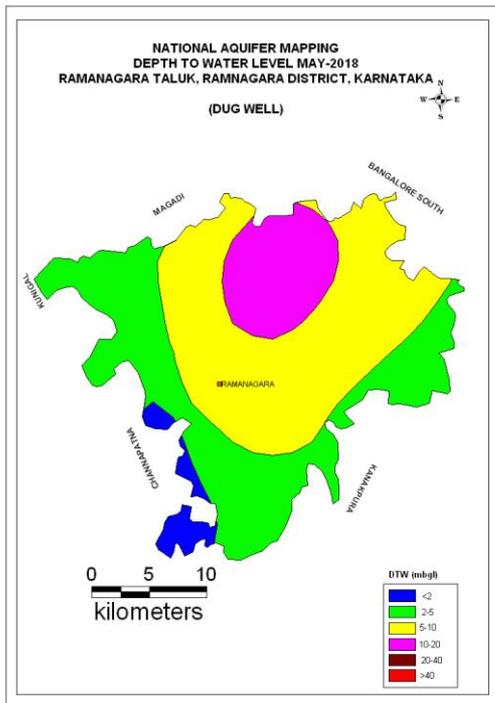
### *(b) Water level fluctuation*

#### **Aquifer-I**

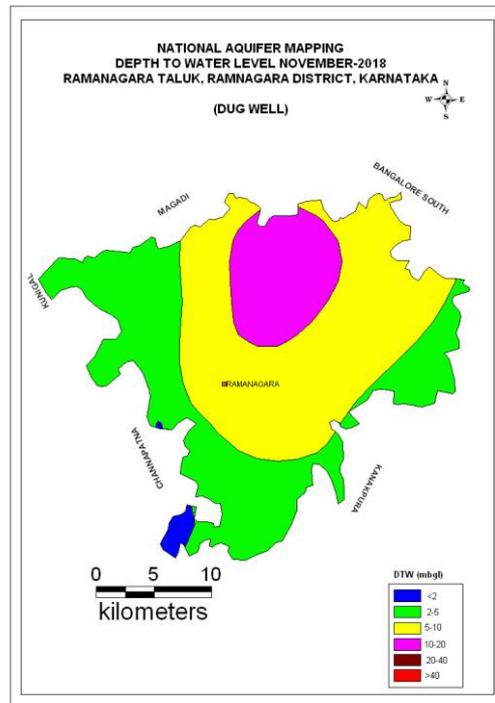
Seasonal Fluctuation: Rise in the range of 0.01 m to 1.79 m and fall of 0.01 m to 1.47 m (**Fig. 1.8**).

#### **Aquifer-II**

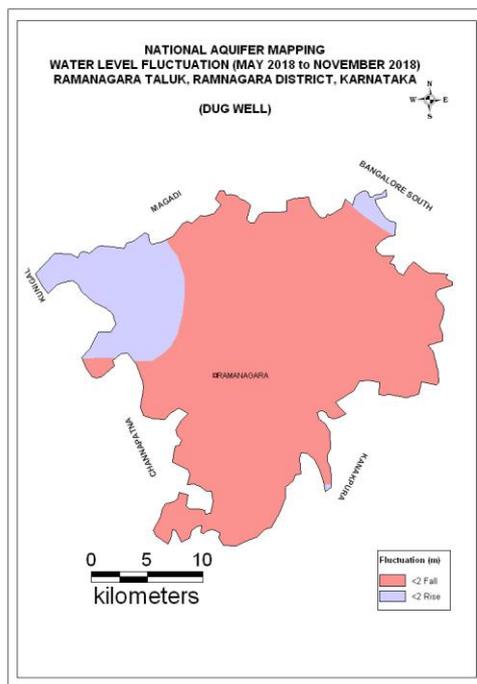
Seasonal Fluctuation: Rise in the range of 2.53 m and fall of 1m



**Fig.1.6: Depth to Water Level, Pre-Monsoon (DW)**



**Fig.1.7: Depth to Water Level, Post-Monsoon (DW)**



**Fig.1. 8: Water Level Fluctuation, Pre-Post 2018 (DW)**

## 2. AQUIFER DISPOSITION

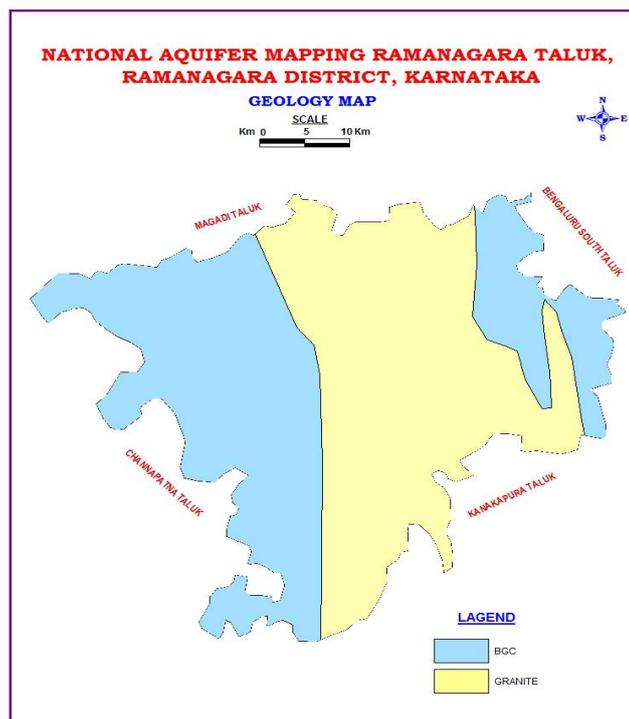
### 2.1 Number of aquifers:

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

**i. Aquifer-I (Phreatic aquifer)** comprising Weathered Granite and Banded Gnessic Complex (BGC)

**ii. Aquifer-II(Fractured aquifer)** comprising Fractured Granite and BGC

In Ramanagara taluk, fractured granite and BGC are the major water bearing formations (**Fig.2.1**). Groundwater occurs within the jointed and fractured granite under semi-confined to confined conditions. In Ramanagara taluk bore wells were drilled from a minimum depth of 65.49 mbgl to a maximum of 200mbgl (**Table 2.1**). Depth of weathered zone (Aquifer-I) ranges from 6.8 mbgl to 12.33mbgl. 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 51 to 133m bgl. Yield ranges from 0.96 to 11.09 lps.

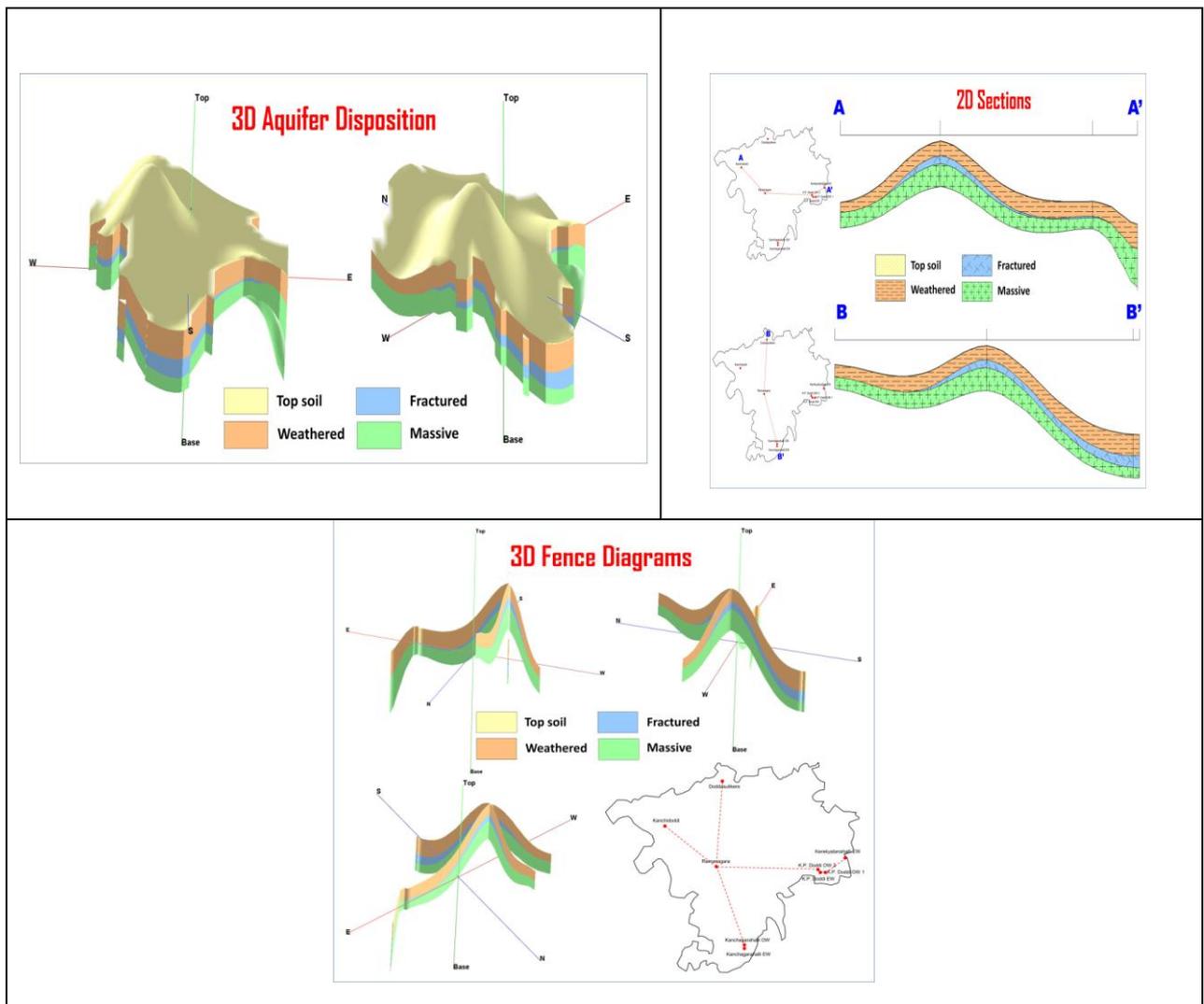


**Fig. 2.1: Geology Map**

**Table 2.1: Details of Ground water Exploration**

Sl. No.	Location	Latitude	Longitude	Depth Drilled (m bgl)	Casing Depth (m bgl)	Fracture Zones (mbgl)	SWL (mbgl)	Q (lps)	DD (m)
1.	K.P.Doddi EW	12°43'30"	77°25'59"	90.97	11.65	5.6, 35, 39.2, 45.25, 51, 53, 60, 65, 74, 83, 90, 90.97	5.62	11.09	8.44
2.	K.P.Doddi OW	12°43'30"	77°26'00"	90	10	8.7,10,31	0.44	0.96	-
3.	K.P.Doddi OW	12°43'45"	77°26'00"	65.49	6.8	4.7,23.25,27, 35.63,47.25,52	6.125	5	2.39
4.	Kanchagarah alli EW	12°34'00"	77°25'59"	159.93	11.5	32, 98, 133	14.075	4.36	14.47
5.	Kanchagarah alli OW	12°34'30"	77°25'58"	130.67	12.33	58, 129.07	18.85	5.4	8.115

**2.2. 3 D Aquifer Disposition and Cross-sections**



**Fig. 2.2: 3 D Aquifer Disposition and Cross-sections**

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

#### 3.1 Aquifer wise resource availability and extraction

##### (a) Present Dynamic Ground Water Resource (2017)

Taluk	Command/Non Command	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							
Ramanagara	Non Command	4393	2847	4319	4611	302	347	105	Over exploited

##### (b) Present total Ground Water Resource (in 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
Ramanagara	3762	7615	1173	12550

##### (c) Comparison of Ground Water Availability and Draft Scenario in Ramnagara 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		
Ramanagara	4066	5233	129%	4596	6559	143%	4393	4610	105%

### 3.2 Chemical Quality of Ground Water and Contamination

#### Ground Water Quality (May 2018)

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 (674-1630  $\mu\text{S}/\text{cm}$  at 25° C). The BIS has recommended a drinking water standard for total dissolved solids a limit of 500 mg/l (corresponding to about EC of 750  $\mu\text{S}/\text{cm}$  at 25° C) can be extended to a TDS of 2000 mg/l (corresponding to about 3000  $\mu\text{S}/\text{cm}$  at 25° C) in case of an alternate source. Water samples having TDS more than 2000mg/l are not suitable for drinking purpose (**Fig 3.1**).

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 0.62 mg/l to 1.26 mg/l. Thus all the samples in the taluk show fluoride concentration below 1.5 mg/l rendering them suitable for drinking purpose (**Fig.3.2**).

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. The distribution of nitrate in the taluk indicated that the values are in the range of 7.1 mg/l to 64.5 mg/l. Nitrate in drinking water should not exceed 45 mg/l as per BIS (ISO: 10500: 2012) standard (**Fig.3.3**).

Thus majority of the samples collected from the taluk indicates that the ground water is contaminated by nitrate.

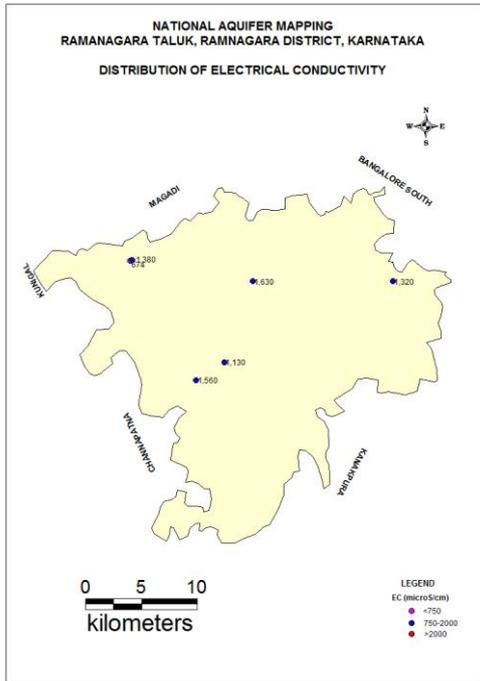


Fig.3.1: Distribution of EC

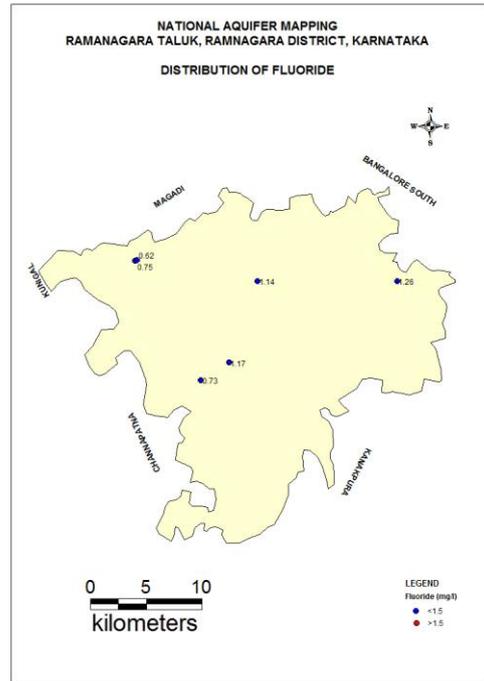


Fig.3.2: Distribution of Fluoride

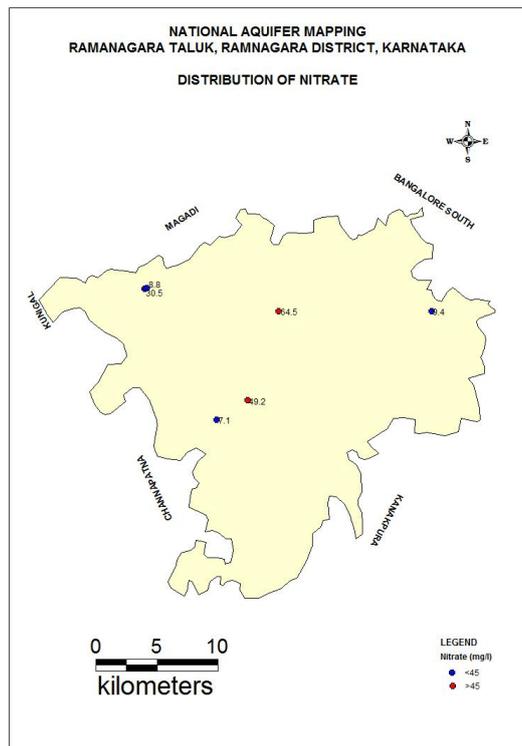


Fig.3.3: Distribution of Nitrate

## 4. GROUND WATER RESOURCE ENHANCEMENT

### 4.1 Aquifer wise space available for recharge and proposed interventions

Recharge phreatic aquifer (Aq-I) in the taluk, through construction of artificial recharge structures, viz. Check dams, percolation tanks & point recharge structures (Table 4.1). 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 4.1: Quantity of non-committed surface runoff and expected recharge through AR structures**

Artificial Recharge Structures Proposed	Ramangara Taluk
Non committed monsoon runoff available (Ham)	1424
Number of Check Dams	88
Number of Percolation Tanks	6
Number of Point Recharge structures	9
Tentative total cost of the project (Rs.in lakhs)	327.00
Excepted recharge (MCM)	8
Expected rise in water level (m)	0.895
Cost Benefit Ratio (Rupees /cu.m. of water harvested)	4.26

### 4.2 Improvement in GW availability due to Recharge, Ramanagara taluk

**Table 4.2: Improvement in GW availability due to Recharge, Ramanagara 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	%	%
Ramanagara	4393	4611	105	800	-	5193	16	89

After implementation of Artificial Recharge structures for ground water recharge, the annual ground water availability will increase from 4393 to 5193 ham and the expected improvement in stage of development is 16% from 105% to 89%.

## 5. DEMAND SIDE INTERVENTIONS

### 5.1 Advanced irrigation practices

It is observed that presently, the major source of irrigation in the taluk is ground water through tube wells. 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 9205 ha of gross irrigated area. Presently, draft through irrigation is 2847 ham. Implementation of efficient irrigation techniques will contribute in saving ground water by 1777 ham and thus, will improve stage of development by 23% from 89% to 66% (Table 5.1).

### 5.2 Change in cropping pattern

In Ramanagara taluk the water intensive crops grown are paddy and sugarcane. Paddy is grown in small area of 536 hectares which is 1% of the total area and basically for self-consumption, and hence, it may not be possible to change it. Sugarcane is grown in 7 hectares which is also in very small area.

**Table 5.1: Improvement in Groundwater availability due to saving by adopting water use efficiency**

Taluk	Cumulative annual ground water availability	Existing gross groundwater draft for all uses	Stage of groundwater development after implementing AR structures & Surface water schemes	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 improved in overall stage of groundwater development
	Ham	Ham	%	Ham	Ham	%	%
Ramanagara	5193	4611	89	1777	6970	66	39

### 5.3 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 69% in the taluk, indicates the taluk which is in over exploited 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

Ramanagara taluk has been categorized as **Over-Exploited**, since the Stage of ground water development has reached **105%** (GEC 2017). Hence, stringent action has to be taken up through Karnataka Ground Water Authority to control ground water exploitation in the taluk.

Ground water 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 Ramanagara taluk is given in **Table 5.2**.

**Table 5.2: Summary of Management plan of Ramanagara taluk**

Ramanagara taluk is 'OE' and present stage of GW Development (2017)	105%
Net Annual Ground Water Availability (MCM)	43.93
Existing Gross Ground Water Draft for all uses (MCM)	46.11
Total GW Resources (Dynamic & Static up to the depth of 200 mbgl (MCM)	87.88
Expected additional recharge from monsoon surplus runoff (MCM)	8
Change in Stage of GW development, %	105 to 89
Expected Saving due to adopting WUE measures (MCM)	17.77
Change in Stage of GW development, %	89 to 66