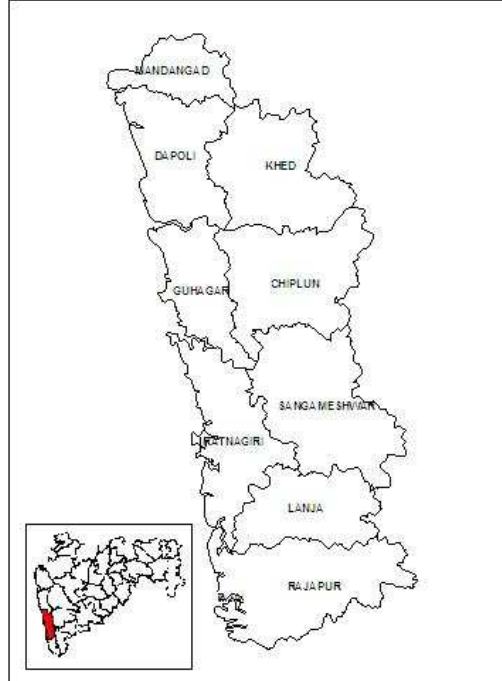




**भारत सरकार
जल संसाधन मंत्रालय
केंद्रीय भूजल बोर्ड**

**GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD**

**महाराष्ट्र राज्य के अंतर्गत रतनागिरि जिले की
भूजल विज्ञान जानकारी
GROUND WATER INFORMATION
RATNAGIRI DISTRICT
MAHARASHTRA**



**By
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**मध्यवर्ती क्षेत्र
नागपुर
CENTRAL REGION
NAGPUR
2009**

RATNAGIRI DISTRICT AT A GLANCE

1. GENERAL INFORMATION

Geographical Area	: 8326 sq. km.
Administrative Divisions (As on 31/03/2007)	: Taluka-9; Ratnagiri, Sangameshwar, Chiplun, Guhagar, Khed, Dapoli, Mandangad, Lanja and Rajapur.
Villages	: 1543
Population	: 16,97,000
Normal Annual Rainfall	: 2658 mm to 3973 mm

2. GEOMORPHOLOGY

Major Physiographic unit	: 5; Coastline, Estuarine plains, Lateritic plateaus, Residual hills, Scrap faces of Sahayadri.
Major Drainage	: 6; Savitri, Vasisthi, Shastri, Ratnagiri, Jaitapur, Wagothan.

3. LAND USE (2000-01)

Forest Area	: 58.60 sq. km.
Net Area Sown	: 2501 sq. km.
Cultivable Area	: 5224 sq. km.

4. SOIL TYPE

Coarse shallow soil, medium deep soil, deep soil along river banks, coastal alluvium and coastal saline.

5. PRINCIPAL CROPS (2000-01)

Rice	: 788 sq. km.
Nachani	: 190 sq. km.
Cashewnut	: 243 sq. km.
Mango	: 206 sq. km.

6. IRRIGATION BY DIFFERENT SOURCES (2000-01) - Nos./Potential Created (ha)

Dugwells	: 2731/3100
Borewells	: 6/3
Tanks/Ponds	: 244/586
Other Minor Surface Sources	: 1151/2487
Net Irrigated Area	: 11026 ha

7. GROUND WATER MONITORING WELLS (As on 31/03/2007)

Dugwells	: 47
Piezometers	: 4

8. GEOLOGY

Recent to sub-Recent	: Alluvium, beach sand
Pleistocene	: Laterite and lateritic spread
Miocene	Shale with peat and pyrite nodules
Cretaceous to Eocene	Deccan Trap Basalt lava flows
Upper Pre-Cambrian	Kaladgi Series: quartzite, sandstone, shale and associated limestone
Dharwar Super Group	Phyllite, conglomerate, quartzite

9. HYDROGEOLOGY

Water Bearing Formation	: Basalt- weathered/fractured/ jointed vesicular/massive, under phreatic and semi-confined to confined conditions
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Laterite: GW occurs under phreatic conditions

Alluvium- Sand/gravel under phreatic conditions

Premonsoon Depth to Water Level (May-2007) : 2.25 to 19.05 m bgl

Postmonsoon Depth to Water Level (Nov.-2007) : 0.49 to 17.90 m bgl

Premonsoon Water Level Trend (1998-2007) : Rise: 0.01 to 0.39 m/year
Fall: 0.01 to 0.30 m/year

Postmonsoon Water Level Trend (1998-2007) : Rise: Negligible to 0.30 m/year
Fall: Negligible to 0.14 m/year

10. GROUND WATER EXPLORATION (As on 31/03/07)

Wells Drilled : Peizometers- 4

Depth Range : 30.00 to 90.00 m bgl

Discharge : to Ips

10. GROUND WATER QUALITY

Good and suitable for drinking and irrigation purpose.

Type of Water : Ca-HCO₃ type in majority of samples

11. DYNAMIC GROUND WATER RESOURCES- (As on 31/03/2004)

Net Annual Ground Water : 236.04 MCM

Availability

Annual Ground Water Draft : 47.02 MCM

(Irrigation + Domestic)

Allocation for Domestic and : 22.47 MCM

Industrial requirement up to next 25 years

Stage of Ground Water : 24.70 %

Development

12. AWARENESS AND TRAINING ACTIVITY

Mass Awareness Programme : 1

a. Date : 18/03/04

b. Place : Ratnagiri

c. Participants : 100

Water Management Training : Nil

Programme:

13. GROUND WATER CONTROL AND REGULATION

Over-Exploited Taluka : None

Critical Taluka : None

Notified Taluka : None

16. MAJOR GROUND WATER PROBLEMS AND ISSUES

Even though the district receives rainfall in excess of 3500 mm/year, water scarcity in the non-monsoon seasons is the major issue of concern and many villages face water scarcity in the summer. There is a lack of efforts to harness and harvest the rain water in the region. Ground water quality in some of the industrial areas of Ratnagiri district is adversely affected by the industrial effluents.

Ground Water Information Ratnagiri District

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Ground Water Information Ratnagiri District

1.0 Introduction

Ratnagiri is one of the coastal districts of Maharashtra and forms part of the Konkan region. It is situated in between the Western Ghats and the Arabian sea and lies between north latitudes 16°30' and 18°04' and east longitude 73°20' and 73°52' and falls in parts of Survey of India degree sheets 47 F, 47 G and 47 H. The district has a geographical area of 8326 sq. km. out of which about 59 sq.km. is covered by forest, whereas cultivable area is 5224 sq. km. and net sown area is 2501 sq. km. The district forms part of coastal basin. Savitri, Vasisthi, Shastri, Ratnagiri, Jaitapur and Wagothan are the main rivers flowing through the district.

The district headquarters is located at Ratnagiri town. For administrative convenience, the district is divided in 9 talukas viz., Mandangad, Khed, Dapoli, Guhagar, Chiplun, Sangameshwar, Ratnagiri, Lanja and Rajapur. It has a population of 16,96,777 as per 2001 census. The district has 4 Nagar Parishads, 1 Nagar Panchayat, 9 Panchayat Samitis and 848 Gram Panchayats.

Central Ground Water Board has taken up several studies in the district. A list of studies conducted in the district is presented in Table-1.

Table 1: Studies undertaken by CGWB.

S. No.	Year	Officer(s)	Toposheets	Area covered (sq. km)	Type of Survey/Study
1	1981-82	D. B. Shetye	47 H/5, H/6, H/9	2000	SHS
2	1982-83	D. B. Shetye	47 G/7, G/8, G/12, G/16	2160	SHS
3	1988-89	P. K. Naik	47 G/11, G/15, G/16	2150	SHS
4	1989-90	R. P. Singh	47 G/1, G/5, G/9	2000	SHS
5	1989-90	D. K. Rai	47 G/2, G/3, G/6, G/10	2000	SHS
6	2000-01	P. K. Jain and V.P. Nawale	47 G/6, H/5		Impact of Industrialisation on ground water
7	2006-07	D.N. Mandal	47- F/4, F/8, 47 G/1, G/2, G/3, G/4+8, G/5, G/6, G/7 and G/11	3129	GWMS
8	2007-08	D.N. Mandal	47 G/4+8, G/5, G/6, G/7, G/9, G/10, G/11, G/12, G/16 and 47 H/5, H/9 and H/13	3050	GWMS

(Here, SHS- Systematic Hydrogeological Survey, GWMS- Ground Water Management Studies)

Shri D. B. Shetye, Scientist-B in 1995 has compiled the report entitled "Ground Water Resources and Development Potential of Ratnagiri District, M.S." Central Ground Water Board has so far not carried out ground water exploration work in the district. However, 4 Peizometers (Pz) to monitor ground water levels have been drilled in the district and their depth ranges from 30 to 90 m bgl. A map of the district showing the taluka boundaries, taluka headquarters, physical features and location of Peizometers and monitoring wells is presented as **Figure-1**.

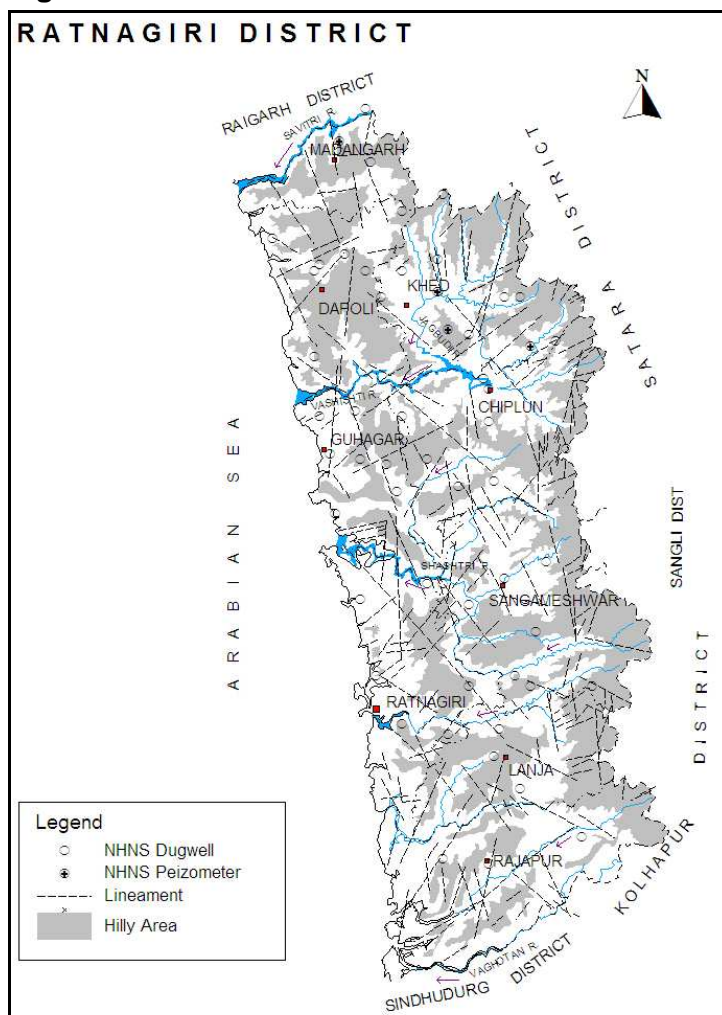


Figure-1: Location

2.0 Climate and Rainfall

Climatic conditions in the district are strongly influenced by its geographical conditions. Being a coastal district, variation in the temperature during the day and throughout the season is not large. Maximum temperature at the coast rarely goes beyond 38°C and in the interior, it seldom crosses 40°C owing to proximity to the sea. Climate of the district is very humid and relative humidity seldom goes below 50%. The normal annual rainfall over the district varies from 2657.8 mm (Guhagar) to about 3973.4 mm (Mandangad). It is minimum in the western part of the district along the coast and gradually increases towards east and northern

parts of the district. The decadal average rainfall for the period 1997-2006 ranges from 2573.19 mm (Guhagar) to 4119.89 mm (Sangameshwar). The salient features of rainfall analysis is presented in Table-2.

Table 2: Salient Features of Rainfall Analysis.

S. No.	Station	No. of Years	Normal Rainfall (mm)	Coefficient of Variation (%)	Rainfall Received (No of yrs / % of Total Years)		Rainfall Trend (1901-2006) (mm/yr.)	Decadal Average (1997-2006) (mm)	Decadal Trend (1997-2006) (mm/yr.)
					Normal	Excess			
1	Mandangad	105	3973.4	21	81/77	14/13	1.66	3753.48	102.60
2	Dapoli	106	3509.9	20	83/79	12/11	5.89	3499.88	-59.93
3	Khed	106	3563.5	19	91/85	6/6	5.60	3837.25	64.68
4	Chiplun	104	3603.0	19	85/81	9/9	1.77	3437.64	39.36
5	Guhagar	106	2657.8	27	73/69	17/16	2.90	2573.19	-70.34
6	Ratnagiri	106	2811.6	22	75/71	16/15	7.47	3038.85	31.67
7	Sangameshwar	98	3868.2	20	77/79	12/12	5.97	4119.89	260.46
8	Lanja (1947-2006)	58	3536.5	17	51/88	3/5	-14.52	3081.38	-79.39
9	Rajapur	105	3427.9	24	71/68	18/17	7.06	3374.41	119.81

The perusal of Table-3 indicates also shows that long term rainfall trend (1901-2006) is rising at all stations except Lanja and it ranges from 1.66 mm/year (Mandangadh) to 7.47 mm/year (Ratnagiri). However the decadal trend (1997-2006) indicates falling rainfall trend at 3 stations located along the western coast i.e., Dapoli, Guhagar and Ratnagiri in the range of 59.93 mm/year to 79.39 mm/year, whereas rising trend is observed at remaining stations ranging from 31.67 mm/year (Ratnagiri) to 260.46 mm/year (Sangameshwar). Thus it is quite evident that the rainfall has decreased during the last decade or so particularly in the western coastal areas of the district.

3.0 Geomorphology and Soil Types

The outstanding feature in the relief of the district is its highly uneven nature and very narrow riverine plains that fringe the coastline. About 45% of the area in Ratnagiri district is hilly. On the east this consists of the steep and forbidding scarp of the main Sahyadris. In the center are traverses chains of small hills, which project from the main ranges, develop higher elevation in the middle portion. These are separated from each other by undulating plateaus having area gradually increasing westward towards the coast. The physiography of the area has given rise to five characteristic landforms, namely 1) coastline 2) estuarine plains and river basins 3) lateritic plateaus 4) residual hills and 5) scarp faces of the Sahayadri proper. The lateritic plateau that occupies most of the district are either formed in-situ from the lateritisation of Deccan Trap Basalt or are of secondary nature, formed due to the lateritic material brought down from the Sahyadrian hill ranges. They are broad, compact and undulating.

Based on the physical characteristics of the soils, they can be classified into five major groups as follows.

1) Coarse Shallow Soil: They are reddish brown in colour and occur on the slopes of the hills and are partly eroded, poor in fertility, shallow in depth and coarse in texture. These soils are ideal for Cashew and Mango plantations.

2) Medium Deep Soil: These are reddish yellow in colour and have various names depending upon the place of occurrence. Those situated at higher elevations are known as *Mal*, while at slightly lower levels are known as *Kuyat*. Near water courses, which have a fair supply of water during Rabi season are known as *Panthal* or *Vaigan*. Paddy is grown on these soils during Kharif. On *Panthal* soils pulses and summer paddy can also be grown.

3) Deep Soil: They occur along river banks or valleys and are usually of mixed origin and are yellowish red to brown in colour. They are light, easily workable, well drained and fairly fertile. Areca nut and coconut gardens are grown well on these soils.

4) Coastal Alluvial Soil: They are found along the coastal strip and consist of deep sandy loams suitable for Coconut and Areca nut.

5) Coastal Saline Soil: They are formed due to the inundation of the sea, where by part of coastal soils become salty. They are locally known as *Khar*, *Khajan*, *Kharvat* etc. They are found along coastal strip of Dapoli, Guhagar and Ratnagiri tehsils.

4.0 Ground Water Scenario

4.1 Hydrogeology

Deccan Trap lava flows (Upper Cretaceous to Lower Eocene age), Kaladgi Sandstones (Precambrian), Laterite (Pleistocene) and Alluvial deposits (Recent to Sub-Recent) are the water bearing formations observed in Ratnagiri district. However Kaladgi formation occurs in very limited patches and does not form potential aquifer in the district. The Alluviums also has limited areal extent found mainly along the coast. A map depicting the hydrogeological features is shown in **Figure-2**.

4.1.1 Hard Rock Areas

4.1.1.1 Deccan Trap Basalt

Major part of the district is covered by basaltic lava flows of Upper Cretaceous to Lower Eocene age. The lava flows are predominantly of 'aa' type with 'pahoehoe' type flows occurring at few places.

Deccan Trap Basalt forms an important water bearing formation in the district. The primary porosity in the vesicular units is negligible due to lack of interconnection and secondary filling. The secondary porosity due to cooling joints, partition planes, cracks and fissures play an important role in ground water circulation especially in the highly porous 'pahoehoe' flows. Degree of weathering and topographic setting also plays a major role in respect of productivity. In Basalt, ground water occurs in Vesicular and Massive Basalt as well as inter-flow zones in weathered mantle and fractured zones. In general, ground water occurs under water table conditions in shallow aquifer and semi-confined to confined conditions in deeper aquifer. The unconfined aquifer is developed due to the weathering and jointing of upper flow in Basalt down to depth of 15-20 m bgl and the yield of the wells tapping such aquifer varies from 15 to 145 m³/day. Borewells are not common in the district due to poor ground water potential of deeper aquifers of Deccan Traps and their yield varies between 2 and 20 m³/hr.

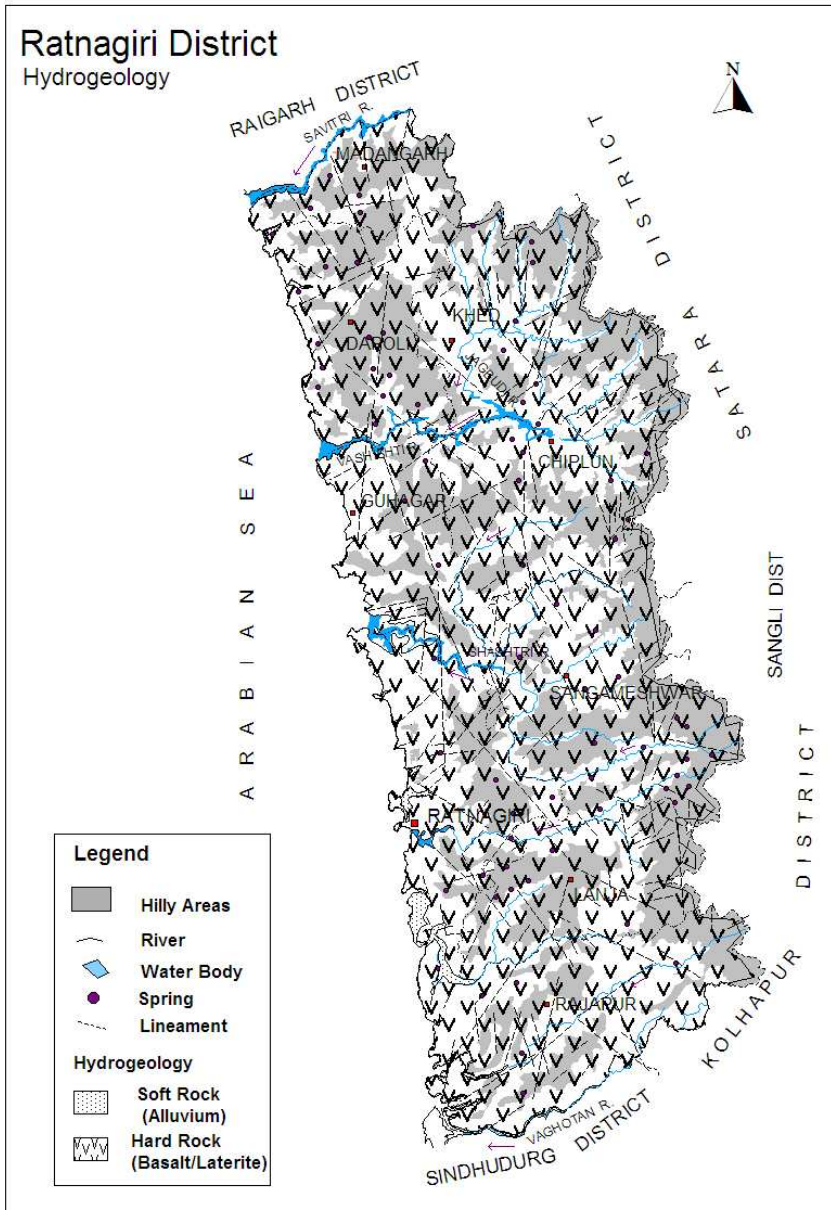


Figure-2: Hydrogeology

4.1.1.2 Laterite

Laterite has better porosity due to intricate network of sinuous conduits making it porous formation. The ground water circulates through a network of voids and conduits, joints and fractures. The lithomargic clay occurring at base act as aquiclude preventing further percolation of ground water and springs emerge at this contact due to lateral movement of ground water. Only dugwells are found in this formation tapping aquifer down to about 15 m and their yield varies from about 4 to 22 m³/day

4.1.2 Soft Rock Areas

4.1.2.1 Beach Sand/Alluvium

The Alluvial deposits are found along the coastal areas in few isolated patches having limited areal extent as Beach Sand. In the alluvial deposits,

primary porosity is due to the inter-granular pore spaces making sands and gravels good water bearing formations. The ground water occurs under phreatic/unconfined aquifer at relatively shallow depths of 3-5 m and their yield ranges from about 12 to 30 m³/day.

4.2 Water Level Scenario

Central Ground Water Board periodically monitors 48 National Hydrograph Network Stations (NHNS) stations in Ratnagiri district, four times a year i.e., in January, May (Premonsoon), August and November (Postmonsoon).

4.2.1 Depth to Water Level – Premonsoon (May-2007)

The depth to water levels in the district during May 2007 ranges between 2.25 (Shringartale) and 19.05 (Jaigad) m bgl. Depth to water levels during premonsoon (May 2007) has been depicted in **Figure-3**.

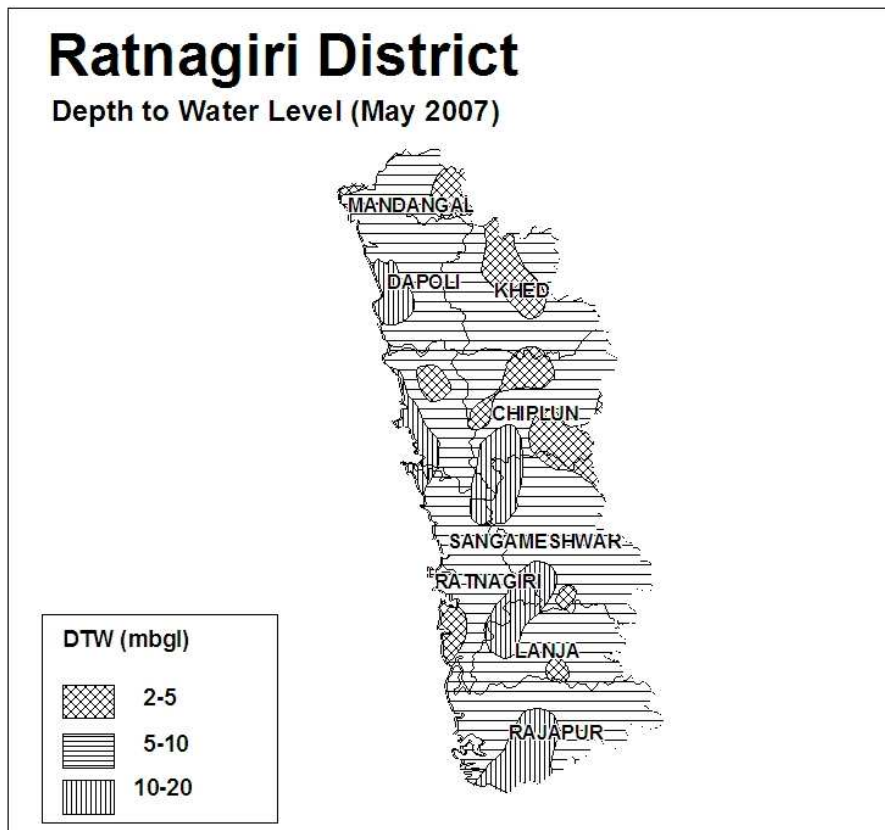


Figure-3: Depth to Water Level (Premonsoon- May 2007)

The shallow water levels within 10 m bgl are seen in almost entire district. The deeper water levels in the range of 10-20 m bgl are observed in isolated patches in parts of Rajapur, Lanja, Guhagar and Dapoli taluka.

4.2.2 Depth to Water Level – Postmonsoon (Nov.-2007)

The depth to water levels during Nov. 2007 ranges between 0.49 m bgl (Pimper) and 17.9 m bgl (Jaigad). Spatial variation in postmonsoon depth to water levels is shown in **Figure-4**. In the entire district the water levels are shallow within 5 m bgl. The water levels of 2-5 m bgl are the most dominant range. The water levels in the range of 5-10 m bgl are observed in isolated patches i.e., in parts of Rajapur, Dapoli and Khed talukas, southern part of

Sangameshwar taluka and boundary portions of Chiplun-Sangameshwar and Sangameshwar-Ratnagiri talukas. The deeper water levels in the range of 10-20 m bgl are observed in 2 to 3 isolated patches in parts of Rajapur, Chiplun, Sangameshwar and coastal areas of Guhagar taluka.

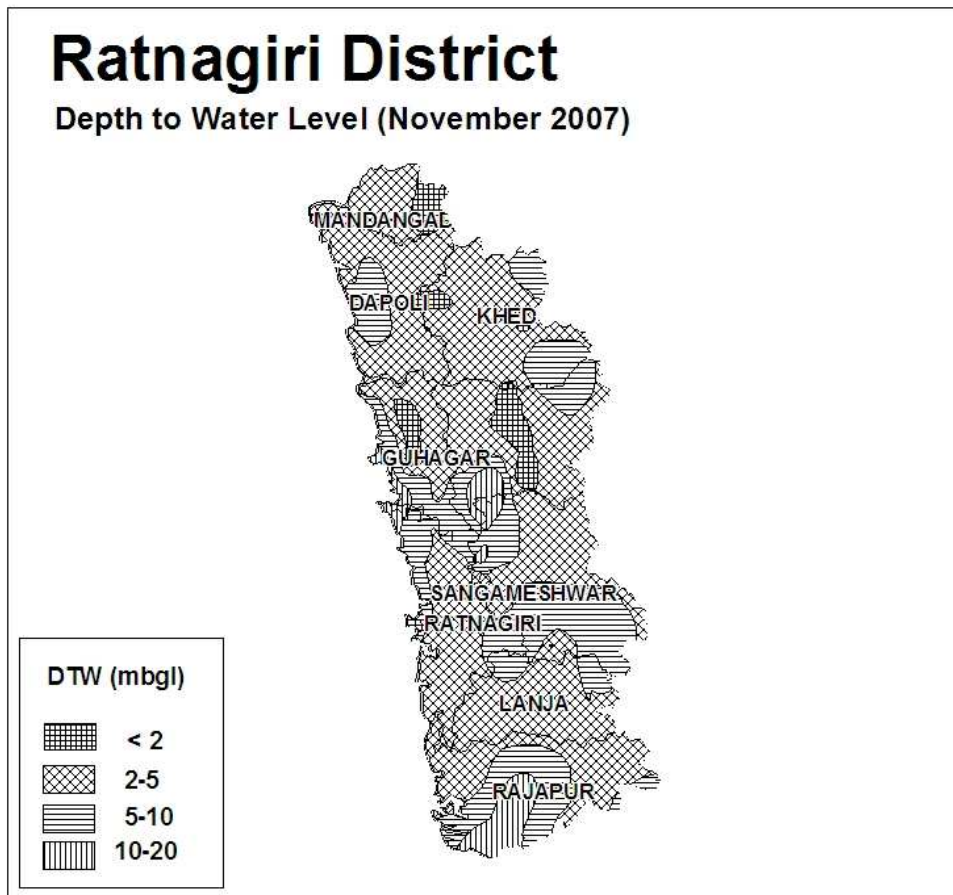


Figure-4: Depth to Water Level (Postmonsoon- Nov.2007)

4.2.3 Seasonal Water Level Fluctuation– (May to Nov. 2007)

The rise in water levels in the range of 0.62 (Vankhed) to 8.51 m (Pimper) has been observed. Major part of the district show rise of water level up to 4 m. Rise above 4 m was observed at a few patches covering major part of Dapoli taluka, parts of Guhagar taluka and the boundary portion of Ratnagiri and Sangameshwar taluka.

4.2.4 Water Level Trend (1998-2007)

Trend of water levels for premonsoon and postmonsoon period for last ten years (1998-2007) have been computed for 44 NHNS. Analysis of long term water level trend indicates that during premonsoon period, rise in water levels has been recorded at 27 stations and it ranges between 0.01 m/year (Kotluk) and 0.39 m/year (Jaigarh). Fall in water levels has been observed at 17 stations in the range of 0.01 m/year (Dapoli) to 0.30 m/year (Oni). During postmonsoon period, rise in water levels has been recorded at 23 stations and it ranges from negligible at few NHNS to 0.30 m/year (Jakadevi), whereas at 21 stations, fall in water levels ranging between negligible at few NHNS and 0.14 m/year (Abitgaon) is observed. However in majority of NHNS the rise/fall during both the periods is up

to 0.20 m/year and in major part of the district, both during pre and postmonsoon periods rising trend of water levels has been observed.

The premonsoon trend map was also prepared and the same is presented in **Figure-5**. It shows that the rise in water level trend of up to 20 cm/year is observed in major parts of the district, whereas the fall in water level trend of up to 20 cm/year is observed in 3 to 4 isolated patches occupying parts of Khed, Chiplun, Sangameshwar talukas and western coastal parts of Guhagar and Dapoli talukas. Thus the situation is favourable for further ground water development in almost entire district.

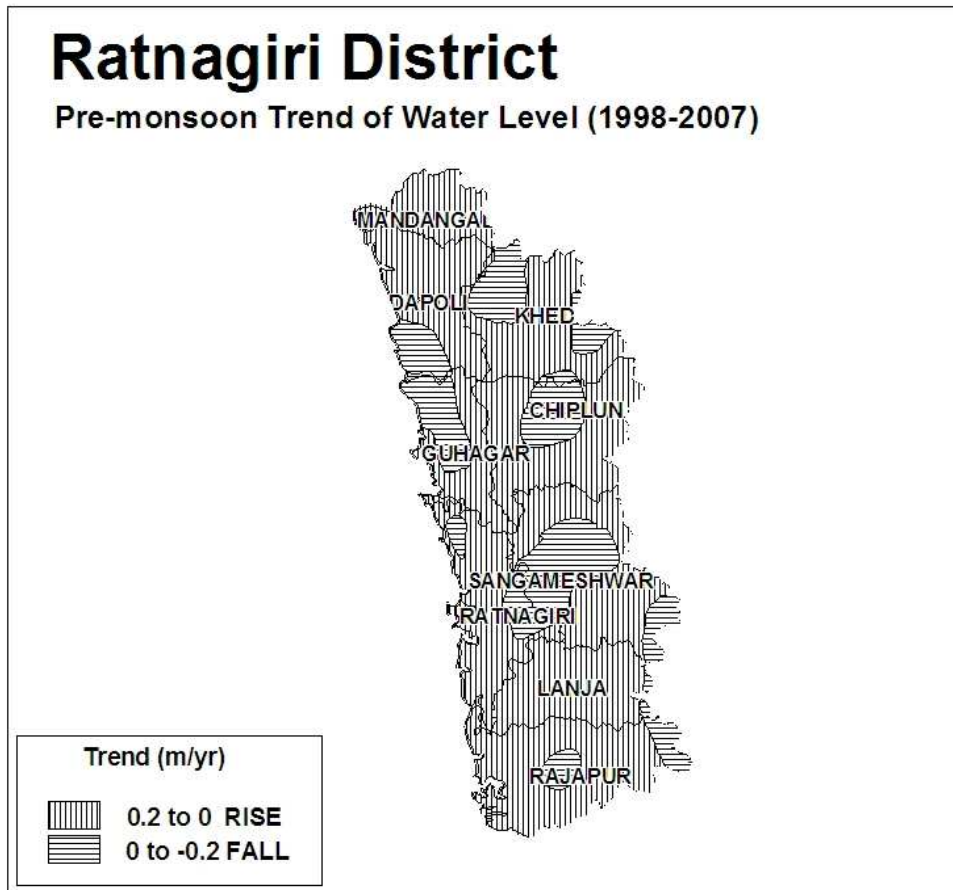


Figure-5: Water Level Trend (Premonsoon- 1998-2007)

4.3 Aquifer Parameters

As mentioned earlier, CGWB has not carried out any deep exploratory drilling in Ratnagiri district and as such no data is available on aquifer parameters of deeper aquifer. The aquifer parameters are available from dugwell pumping tests conducted during previous studies by CGWB. The summarised results of pumping tests to determine aquifer parameters such as Specific capacity, transmissivity and permeability are given in Table-3.

Table 3: Aquifer Parameters.

S. No.	Aquifer	Specific Capacity (lpm/m of dd)	Transmissivity (m ² /day)	Permeability (m/day)
1	Beach Sand/ Alluvium	41.49 to 230.00	40 to 161	26 to 81
2	Shell Sandstone	26.86 to 211.00	19 to 126	7 to 210
3	Laterite	116.50 to 982.60	24 to 648	15 to 261
4	Jointed/Weathered Massive Basalt	19.93 to 471.40	13 to 36	7 to 58
5	Weathered Vesicular Basalt	37.00 to 67.53	29 to 50	8 to 12

4.4 Yield of Wells

The yield of wells is functions of the permeability and transmissivity of aquifer encountered and varies with thickness of the aquifer zone encountered, location, diameter and depth etc. Ground water in the area is being developed by two type of abstraction structures i.e., borewells and dugwells. However dugwells are the main ground water abstraction structures in the district. The yield of dugwells in laterite varies from 5 to 22.50 m³/day, in massive/jointed Basalt it varies from 4.5 to 22.5 m³/day, whereas in fractured and weathered Basalt it varies form 20 to 145 m³/day. High yielding dugwells are generally located in weathered and fractured Basalt occurring in physiographic depressions. The wells located in topographic lows have better yield than located elsewhere. However, the summer yield of dugwells is less than half the yield during post monsoon periods. The formation-wise yield of dugwells is given in Table-4.

Table 4: Yield of Dugwells.

S. No.	Formation	Depth (m bgl)	Yield (m ³ /day)
1	Alluvium/Beach Sand	3 to 8	20 to 30
2	Laterite	8 to 14	4.5 to 22.5
3	Basalt massive/ jointed	12 to 20	15 to 30
4	Fractured and weathered basalt	9 to 17	20 to 145

Borewells for irrigation are not common in the district due to poor ground water potential of deeper aquifers of Deccan Traps. Borewells also have very limited storage capacity as compared to the large diameter open wells. However, borewells have been found to be one of the very important, safe and pollution free source of drinking water. The yield of the borewells drilled by Groundwater Survey and Development Agency (GSDA) varies from about 2 to 20 m³/hr and majority of borewells have yield between 2 and 5 m³/hr. A good number of high yielding borewells with yield of more than 10 m³/hr are found to be located on or near the vicinity of the lineaments.

4.5 Ground Water Resources

Central Ground Water Board and Groundwater Survey and Development Agency (GSDA) have jointly estimated the ground water resources of Ratnagiri district based on GEC-97 methodology. The same is presented in Table-5. Out of total area of 8326 sq. km., ground water resources estimation was carried out for 5045.26 sq. km. area out of which 62.47 sq. km. area is under command and 4982.79 sq. km. is under non-command. Taluka wise ground water resources are shown in **Figure-5**.

As per the estimation the total annual ground water recharge is 248.51 MCM with the natural discharge of 12.46 MCM, thus the net annual ground water availability comes to be 236.04 MCM. The total annual draft for all uses is estimated at 58.29 MCM with irrigation sector being the major consumer having a draft of 47.02 MCM. The net annual ground water availability for future irrigation is 166.84 MCM, whereas the allocation for domestic and industrial requirements is 22.47 MCM. The stage of ground water development varies from 12.45% (Sangameshwar) to 70.15% (Dapoli). The overall stage of ground water development for the district is 24.70%. Thus there is plenty of scope for further development of ground water resources. All the talukas and watersheds have been categorised as “Safe”. It is observed that in the command area of Sangameshwar takuka, ground water development has reached 122%, however the overall stage of ground water development for the taluka is very low i.e., 12.45% and area coming under command is very small i.e., about 4 sq.km.

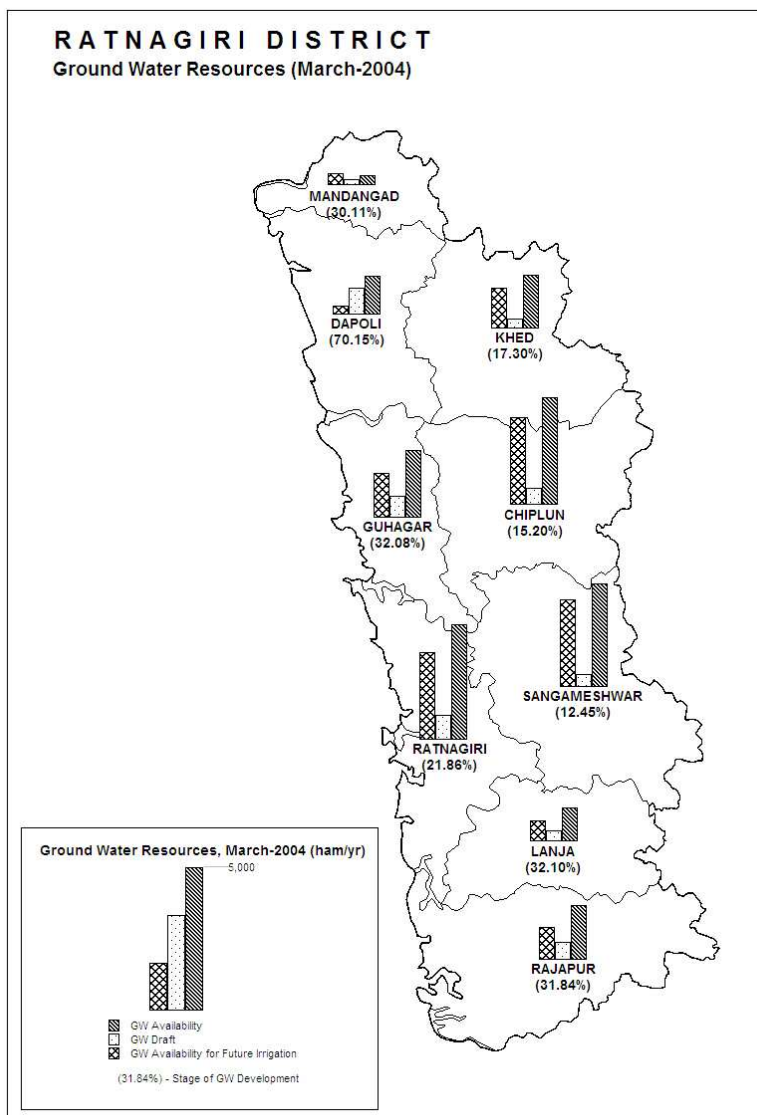


Figure-5: Ground Water Resources

Table 5: Taluka wise Ground Water Resources (March 2004).

Taluka	Area type	Net annual ground water availability (ham/yr.)	Annual ground water draft (ham/yr.)			Allocation for domestic & industrial requirement supply up to next 25 years (ham/yr.)	Ground water availability for future irrigation (ham/yr.)	Stage of ground water development (%)	Category
			Irrigation	Domestic & industrial uses	Total				
Ratnagiri	Non command	4600.73	850.96	154.87	1005.83	309.74	3440.03	21.86	Safe
Lanja	Command	115.72	0.00	4.10	4.10	8.20	107.52	3.54	Safe
	Non command	1240.86	340.36	91.07	431.42	182.13	718.37	34.77	
	Total	1356.58	340.36	95.17	435.52	190.33	825.89	32.10	
Rajapur	Command	90.51	0.00	12.40	12.40	24.80	65.71	13.70	Safe
	Non command	2084.07	519.17	160.80	679.97	321.60	1243.30	32.63	
	Total	2174.58	519.17	173.20	692.37	346.40	1309.01	31.84	
Dapoli	Command	36.21	0.00	1.80	1.80	3.60	32.61	4.97	Safe
	Non command	1492.27	961.85	108.55	1070.40	211.02	319.39	71.73	
	Total	1528.48	961.85	110.35	1072.20	214.62	352.00	70.15	
Mandangad	Non command	795.78	182.45	57.18	239.64	114.36	498.96	30.11	Safe
Chiplun	Command	218.86	50.62	17.20	67.82	34.40	133.84	30.99	Safe
	Non command	4024.69	442.83	134.32	577.15	268.65	3313.22	14.34	
	Total	4243.55	493.44	151.53	644.97	303.05	3447.06	15.20	
Khed	Command	114.22	0.00	8.30	8.30	16.60	97.62	7.27	Safe
	Non command	2016.19	217.96	142.21	360.16	284.41	1513.82	17.86	
	Total	2130.41	217.96	150.51	368.46	301.01	1611.44	17.30	
Sangameshwar	Command	79.45	90.43	6.70	97.13	11.00	6.78	122.25	Safe
	Non command	4009.20	264.90	146.98	411.88	293.96	3450.34	10.27	
	Total	4088.65	355.33	153.68	509.01	304.96	3457.12	12.45	
Guhagar	Non command	2686.01	780.50	81.23	861.73	162.48	1743.05	32.08	Safe
District Total	Command	654.97	141.04	50.51	191.55	98.60	444.08	29.25	
	Non command	22949.80	4560.98	1077.21	5638.18	2148.35	16240.48	24.57	
	Total	23604.76	4702.02	1127.71	5829.73	2246.95	16684.56	24.70	

4.6 Ground Water Quality

Central Ground Water Board monitors the ground water quality of the district through analysis of water samples collected from its National Hydrograph Network Stations (NHNS) which represent the shallow aquifer of the district only. The objective behind quality monitoring is to understand an overall picture of ground water quality of the district. During year 2007, CGWB has carried out the ground water quality monitoring at 37 NHNS. The geochemical classification of ground water samples is given in Table-6.

Table 6: Geochemical Classification of Ground Water Samples.

S. No.	Classification	Type	No. of Sample	% of Sample
1	Alkaline earths (Ca+Mg > 50%) exceeds alkali metals and weak acids (CO ₃ +HCO ₃ > 50%) exceeds strong acids	Ca-HCO ₃	35	95
2	Alkali metal (Na+K > 50%) exceeds alkaline earths and weak acids (CO ₃ +HCO ₃ > 50%) exceeds strong acids.	Na-HCO ₃	1	2.5
3	Alkaline earths (Ca+Mg > 50%) exceeds alkali metals and strong acids (Cl+SO ₄ +NO ₃ > 50%) exceeds weak acids	Ca-Cl	1	2.5
	Total		37	100

As majority of the samples are from Basaltic aquifer, the type of water present in these samples should be of Ca-HCO₃ type. The perusal of Table-6 also confirms the same as 95% of the samples are of Ca-HCO₃ type, whereas 1 sample collected from Ahmed (Bk) is of Na-HCO₃ type and 1 sample of Niwali is having Ca-Cl type of water indicating that the type of water in 1 sample has changed from Ca-HCO₃ type to Ca-Cl type. This may be due to percolation of waste and wastewater containing high concentration of strong acid ions (Cl+NO₃+SO₄) to ground water.

4.6.1 Suitability of Ground Water for Drinking Purpose

The suitability of ground water for drinking purpose is determined keeping in view the effects of various chemical constituents in water on the biological system of human being. Though many ions are very essential for the growth of human, but when present in excess, have an adverse effect on human body. The standards proposed by the Bureau of Indian Standards (BIS) for drinking water (IS-10500-91, Revised 2003) were used to decide the suitability of ground water. The classification of ground water samples was carried out based on the desirable and maximum permissible limits for the parameters viz., TDS, TH, Ca, Mg, Cl, SO₄ and NO₃ prescribed in the standards and is given in Table-7. It is observed that out of the 37 ground water samples, TH and Ca are above desired limits but below permissible limits in 1 sample collected from NHNS well located at Dabhol. In all other samples all the parameters are within the desired limits, thus ground water is suitable for drinking purpose.

Table 7: Classification of Ground Water Samples for Drinking based on BIS Drinking Water Standards (IS-10500-91, Revised 2003).

Parameters	DL	MPL	Samples with conc. < DL	Samples with conc. in DL-MPL	Samples with conc. >MPL
TDS (mg/L)	500	2000	37	0	0
TH (mg/L)	300	600	36	1	0
Ca (mg/L)	75	200	37	0	0
Mg (mg/L)	30	100	36	1	0
Cl (mg/L)	250	1000	37	0	0
SO ₄ (mg/L)	200	400	37	0	0
NO ₃ (mg/L)	45	No relaxation	37	0	0
F (mg/L)	1.0	1.5	37	0	0

(Here, DL- Desirable Limit, MPL- Maximum Permissible Limit.)

4.6.2 Suitability of Ground Water for Irrigation Purpose

The water used for irrigation is an important factor in productivity of crop, its yield and quality of irrigated crops. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. Sodium Absorption Ratio (SAR) and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation.

4.6.2.1 Sodium Absorption Ratio (SAR)

Sodium Absorption Ratio (SAR) is an expression pertaining to cation make up of water and soil solution and is used for characterizing the sodium hazard of irrigation water.

SAR value is used to calculate the degree to which irrigation water tends to enter into cation exchange section in the soil. The main problem with high sodium concentration is its effect on soil permeability. Sodium also contributes directly to the total salinity of the water and may be toxic to sensitive crops such as fruit trees. The higher value of SAR indicates soil structure damage.

4.6.2.2 Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate (RSC) is considered to be superior to SAR as a measure of sodicity particularly at low salinity levels. The classification of ground water samples based on SAR and RSC values for its suitability for irrigation purpose is shown below in Table-8.

The perusal of Table-8 shows that the ground water samples from all the wells have SAR values less than 10 and RSC values less than 1.25. Thus the ground water quality in the wells monitored is good for irrigation purpose and there is a less possibility of developing sodium hazard.

Table 8: Classification of Ground Water for Irrigation based on SAR and RSC.

SAR	<10		10-18		18-26		>26	
Category	Good		Good to Permissible		Doubtful		Unsuitable	
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%	No. of Samples	%
37	37	100	Nil	Nil	Nil	Nil	Nil	Nil
RSC	<1.25		1.25-2.50		>2.50			
Category	Good		Doubtful		Unsuitable			
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples		%	
37	37	100	Nil	Nil	Nil		Nil	

4.7 Status of Ground Water Development

Ground water development depends on many factors viz., availability, crop water requirement, socio-economic fabric and on the yield of the aquifers existing in that area. Ground water is predominantly used for irrigation, as it is the major ground water utilising sector. As per the Minor Irrigation Census data available for year 2000-01, area irrigated by ground water is about 90 sq.km., whereas surface water accounts for only 20 sq.km. and the net irrigated area is 110 sq.km. Thus it is clear that ground water is the major source of irrigation as it accounts for about 82% of net irrigated area. However, the net irrigated area is negligible i.e., 4.40% when compared with the net area sown. The district had 2731 irrigation dugwells, which create an irrigation potential of 31.00 sq.km., out of which 18.10 sq.km., of irrigation potential is utilised. There are very few irrigation borewells in the district and the area irrigated by them is negligible.

State Government agencies have drilled number of borewells fitted with hand pumps and electric motors for rural drinking water purposes in the district. In all till March 2007, GSDA, Government of Maharashtra was successfully operating 2206 borewells for rural water supply under various schemes in the district, out of which 158 are fitted with electric pumps and 2048 are fitted with hand pumps.

5.0 Ground Water Management Strategy

Agricultural development in the district mainly depends on rainfall. The ground water development in almost entire district is on the lower side mainly due to the presence of hilly areas in major part of the district occupying about 3697 sq.km. i.e., about 45% of the total area. The district also faces water scarcity during summer months in spite of heavy rainfall. There is thus a need to adopt an integrated approach of development of ground water resources dovetailed with ground water augmentation and rainwater conservation to provide sustainability to ground water development.

5.1 Ground Water Development

Almost entire district is covered by Basalt and Laterite. The Alluvium mainly occurs along the coast as beach sand at shallow depths. In all these formations dugwells are the most feasible structures for ground water development and they may be expected to yield between 25 and 150 m³/day depending on the local hydrogeological conditions. Borewells for irrigation are not common in the district

due to poor ground water potential of deeper aquifers of Deccan Traps. However, if the borewells are required then their sites need to be selected only after proper scientific investigation. The borewells generally tap deeper fractures, which may not be sustainable. Besides, the borewells should only be used for drinking water supply and not for irrigation.

Major parts of Ratnagiri district are covered by hilly areas. In these areas rocks are hard and compact, resistant to weathering with steep gradient causing rapid runoff and low infiltration and such areas are not feasible for ground water development. The overall stage of ground water development is low i.e., about 25%, thus there is plenty of scope of ground water development, however major part of the district is covered by hilly areas and in the remaining areas of the district ground water development potential is medium.

5.2 Water Conservation and Artificial Recharge

A large number of water conservation structures in the form of check dams, percolation tanks and KT weirs have been constructed in the district. As per the data available for year 2005, 11 percolation tanks, 7 village tanks, 12 KT Weirs with total irrigation capacity of 180.98 Ha, 59 storage tanks with total irrigation capacity of 678.75 ha, 348 diversion dams with total irrigation capacity of 4534.88 ha, 1 underground bandhara and 452 lift irrigation schemes with total irrigation capacity of 1171.25 ha had been constructed in the district.

In Basaltic area, the artificial recharge structures feasible are check dams, gully plugs, percolation tanks, nalla bunds, etc. The structures like gully plugs, contour bunds are most favourable in the hilly areas. In the highland area and wide lateritic plateau areas, contour trenching should be carried out to arrest the surface runoff and ensure recharge of rainfall runoff into the ground water reservoir. Existing dugwells can also be used for artificial recharge, however, the source water should be properly filtered before being put in the wells. These sites need to be located where the hydrogeological conditions are favourable, i.e., where sufficient thickness of unsaturated/de-saturated aquifer exists and water levels are deeper than 5 m. Occurrence of such areas are limited in the district as seen from postmonsoon water level map.

It is also observed that sufficient water is available in the rivers and streams in the post-monsoon period for 2-3 months, hence lift irrigation schemes may be encouraged using small check dams.

6.0 Ground Water Related Issues and Problems

Even though the district receives rainfall in excess of 3500 mm/year, water scarcity in the non-monsoon seasons is the major issue of concern and many villages face water scarcity in the summer. In such areas in the basaltic terrain, attempts may be made to increase recharge and create additional storage spaces by employing unconventional methods like hydro-fracturing, bore blast technique, horizontal bores in dugwells along the plane of weakness etc., and artificial recharge structures. Small schemes of water conservations like storage tanks on hill tops/plateau needs to encouraged to mitigate the water scarcity situation.

There is a lack of efforts to harness and harvest the rain water in the region. Mass awareness programmes should be organized in large scale by district administration. Such programmes are necessary so as to educate the user regarding yielding capacity of aquifer, benefits of small water conservation

schemes/efforts, appropriate crop planning and irrigation practices etc.

In the year 2000-01, CGWB has carried out a study on impact of industries on ground water quality in some of the industrial areas of Ratnagiri district. Water sampling was carried out in Lote Parshuram Industrial area in Khed taluka and MIDC, Mirjole and industrial area near Waingani in Ratnagiri taluka. It was found in the study that ground water quality was adversely affected by the industrial effluents. Ground water was found to be changed from its original Ca-HCO₃ type to Na-Cl, Ca-Cl₂ and Ca-SO₄ type and higher values of TDS, TH, Ca, Mg, Na, Cl, SO₄, NO₃ and COD and low pH was found in ground water samples. To stop further deterioration of ground water adequate measures needs to be taken such as proper treatment of effluent, disposal of effluents through pipelines or lined channels only, since disposing the treated effluents in natural streams is causing percolation of effluents to ground water. The wells used for water supply in the vicinity of the industries should be first analysed for pollution and contamination, if any harmful chemical content is found beyond permissible limit the ground water may be used for other purposes than drinking.

7.0 Mass Awareness and Training Activities

7.1 M.A.P. and W.M.T.P.

Till March 2007, one MAP had been organised in the district at Ratnagiri. The details are given in Table-9.

Table 9: Status of MAP and WMTP.

S. No.	Item	AAP	Venue	Date	No of Persons Attended
1	MAP	2003-04	Panchyat Samiti Hall, Ratnagiri	18/03/04	100

7.2 Participation in Exhibition, Mela, Fair etc.

During the MAP at Ratnagiri, an exhibition depicting rainwater harvesting model, various ground water related posters, leaflets, literature and technical reports were displayed along with maps of Ratnagiri district. The models, maps, posters were explained to the visitors in details.

8.0 Areas Notified by CGWA/SGWA

As per ground water resource estimation all the talukas fall under "Safe" category, hence till March 2007 the area has not been notified either by CGWA or SGWA.

9.0 Recommendations

- 1 The entire district is underlain by the Deccan Trap Basalt and Laterite, where only dugwells are most feasible structures for ground water development and they may be expected to yield between 25 and 150 m³/day depending on the local hydrogeological conditions.
- 2 The sites for borewell need to be selected only after proper scientific investigation. The borewells generally tap deeper fractures, which may not be sustainable and are not recommended for irrigation purpose due to poor/low ground water potential of deeper aquifers of Deccan Traps.

However, to cater to the drinking water requirements the borewells can be used by installing the hand pumps.

- 3 The overall stage of ground water development for the district is about 25%, therefore, scope for further development of ground water resources exists. However proper planning for development of resources is must as major part of the district is covered by hilly areas and in the remaining areas of the district ground water development potential is medium.
- 4 In spite of heavy rainfall over the area, many villages face water scarcity in the summer. In such areas in the basaltic terrain, attempts may be made to increase recharge and create additional storage spaces by employing unconventional methods like hydro-fracturing, bore blast technique, horizontal bores in dugwells along the plane of weakness etc., and artificial recharge structures. Small schemes of water conservations like storage tanks on hill tops/plateau needs to encouraged in mitigating the water scarcity situation.
- 5 The scope exists for construction of suitable artificial recharge structures in the district. The structures recommended for the hilly- Deccan Trap Basalt areas are: contour bunds, gully plugs, nala bunds and check dams. For other basaltic areas, the nala bunds, check dams and KT weirs are suggested. The existing dugwells may also be used for artificial recharge of ground water provided source water is free of silt and dissolved impurities.
- 6 In the highland area and wide lateritic plateau areas, contour trenching should be carried out to arrest the surface runoff and ensure recharge of rainfall runoff into the ground water reservoir.
- 7 As sufficient water is available in the rivers and streams in the post-monsoon period for 2-3 months, lift irrigation schemes may be encouraged using small check dams.
- 8 The existing village ponds/tanks need to be rejuvenated to act both as water conservation and artificial recharge structures.
- 9 Ground water quality is adversely affected in the vicinity of major industries. To stop further deterioration of ground water adequate measures needs to be taken such as proper treatment of effluent, disposal of effluents through pipelines or lined channels only. The wells used for water supply in the vicinity of the industries should be first analysed for pollution and contamination, if any harmful chemical content is found beyond permissible limit the ground water may be used for other purposes than drinking.
- 10 Mass awareness programmes as the one organised by CGWB at Panchayat Samit Hall, Ratnagiri should be organized in large scale by district administration. Such programmes are necessary to educate the user regarding yielding capacity of aquifer, benefits of small water conservation schemes/efforts, appropriate crop planning and irrigation practices etc.