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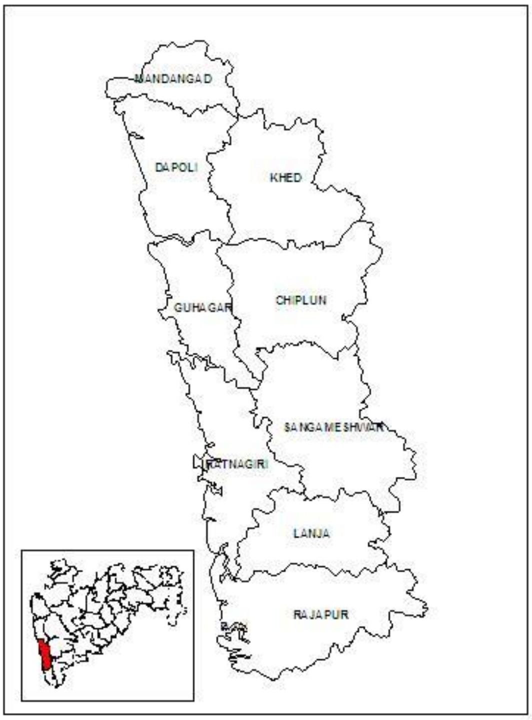
भारत सरकार
जल संसाधन मंत्रालय
केन्द्रीय भूमिजल बोर्ड

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

महाराष्ट्र राज्य के अंतर्गत रत्नागिरी जिले की भूजल विज्ञान जानकारी

GROUND WATER INFORMATION RATNAGIRI DISTRICT MAHARASHTRA



By
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मध्य क्षेत्र, नागपुर
CENTRAL REGION
NAGPUR
2014

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** (2010-11)		
	Forest Area	:	60.0 sq. km.
	Net Area Sown	:	2630 sq. km.
	Cultivable Area	:	4010 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)		
	Paddy	:	772 sq. km.
	Cereals	:	1020 sq. km.
	Oil Seeds	:	30 sq. km.
	Nachani	:	173 sq. km.
	Cashewnut/Coconut/Supari	:	928 Sq km
6.	**IRRIGATION BY DIFFERENT SOURCES** (2010-11) **-**		
	Dugwells/Tube wells	:	2263 ha
	Canal Irrigation		6273 Ha
	Tanks/Ponds	:	244/586
	Net Irrigated Area	:	14603 ha
7.	**GROUND WATER MONITORING WELLS** (As on 31/03/2007)		
	Dugwells	:	48
	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 Laterite: GW occurs under phreatic

		conditions Alluvium- Sand/gravel under phreatic conditions
Premonsoon Depth to Water Level (May-2011)	:	01.60 to 36.40 m bgl
Postmonsoon Depth to Water Level (Nov.-2011)	:	01.42 to 16.3 m bgl
Premonsoon Water Level Trend (2002-11)	:	Rise: 0.003 to 1.65 m/year Fall: 0.008 to 0.53 m/year
Postmonsoon Water Level Trend (2002-2011)	:	Rise: 0.01 to 1.08 m/year Fall: .05 to 0.37 m/year

10. GROUND WATER EXPLORATION (As on 31/03/11)

Wells Drilled	:	EW- Nil; OW- Nil; Peizometer- 4
Depth Range	:	30.00 to 90.00 m bgl

10. GROUND WATER QUALITY

Good and suitable for drinking and irrigation purpose.

11. DYNAMIC GROUND WATER RESOURCES- (As on 31/03/2009)

Net Annual Ground Water Availability	:	466.05 MCM
Annual Ground Water Draft (Irrigation + Domestic)	:	52.49 MCM
Allocation for Domestic and Industrial requirement up to next 25 years	:	24.37 MCM
Stage of Ground Water Development	:	11.26 %

12. AWARENESS AND TRAINING ACTIVITY

Mass Awareness Programme	:	1
a. Date	:	18/03/04
b. Place	:	Ratnagiri
c. Participants	:	100
Water Management Training Programme:	:	Nil

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 district receives rainfall in excess of 3500 mm/year, but water scarcity in non-monsoon season is reported in many villages. The falling trend of water level in the range of 0 to 0.20 m/year is observed in northern eastern parts of the district (in parts of Khed and Chiplun talukas) and in southern part of the district (in Rajapur taluka). Rain water Harvesting and Water Management techniques are solution for combating water scarcity problem. Due to discharge of industrial effluent in some industrial area ground water quality is affected.

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Ratnagiri District

1.0 Introduction

Ratnagiri is one of the coastal district of Maharastra and forms part of Konkan region. It is situated in between the Western Ghats and the Arabian sea and lies between north latitudes $16^0$30' and $18^0$04' and east longitudes $73^0$20' and $73^0$52' and falls in parts of Survey of India degree sheets 47F,47P,and 47H. The District has geographical area of 8208 sq km, out of which about 60 sq km is covered by forest, where as cultivable area is 4010 sq km and net sown area is 2630 sq km. The district forms part of coastal basin and it is drained by Savitri, Vasisthi, Shastri, Ratnagiri, jaitapur and Wagothan rivers.

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 population of 16,96,777 as per census-2001. The district has 4 Nagar Parishads, 1Nagar Panchyat, 9 Panchyat Samitis and 851 Gram Panchyats.

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	2007-09	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**.

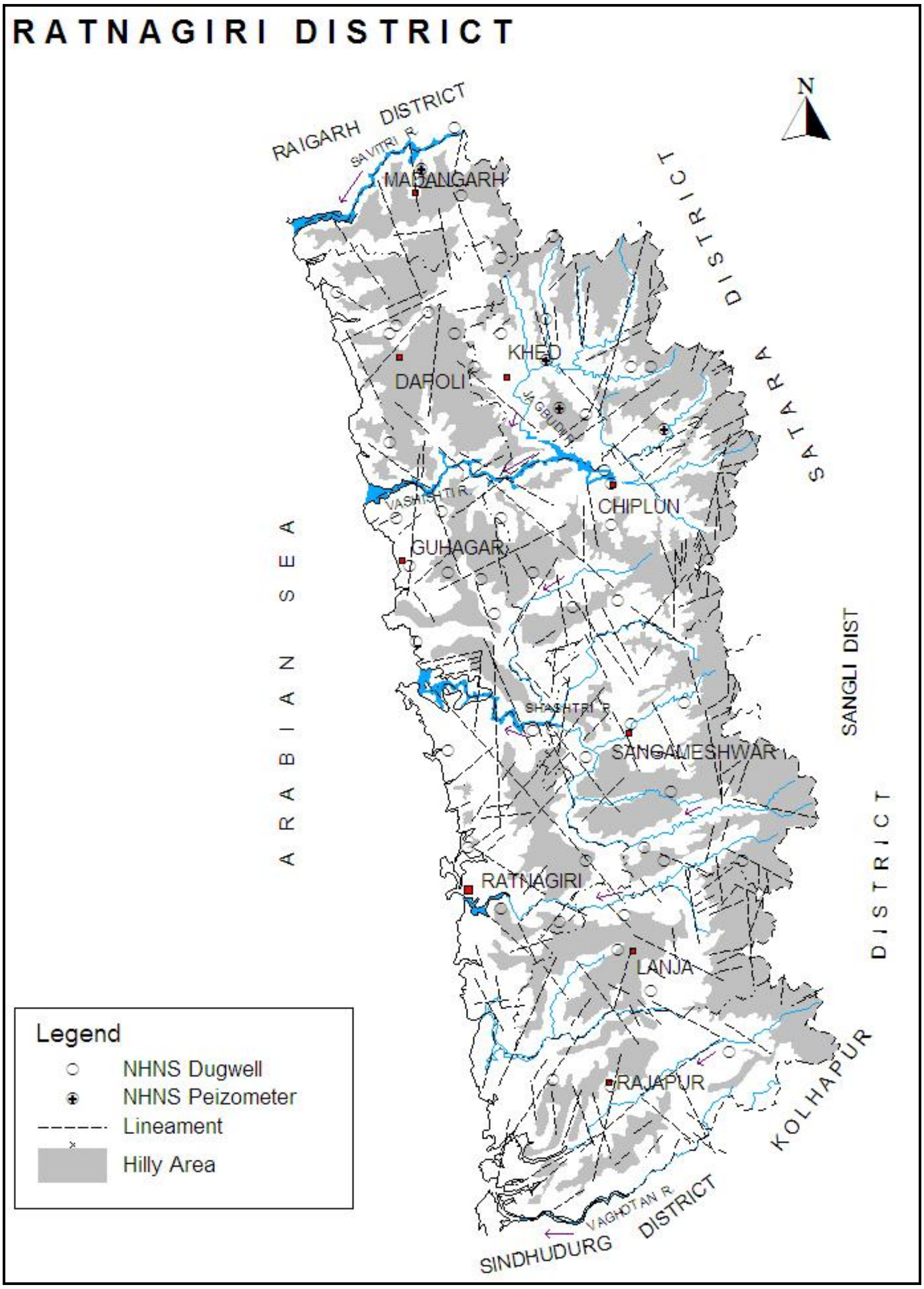

Figure-1: Location

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 38^0C and in the interior, it seldom crosses 40^0C 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. Taluka wise decadal average rainfall for the period 2002-2011 ranges from 2963.26mm (Guhagar) to 5116.8mm (Sangameshwar) and same is presented in Table-2

Table 2: Salient Features of Rainfall Analysis.

Taluka	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Average**
Chiplun	2691.0	3268.0	3158.0	4635.0	4408.0	4482.4	3730.0	3465.0	4178.2	5052.0	**3906.76**
Dapoli	2757.2	3007.7	3131.6	3749.4	3577.3	4254.9	3044.2	2693.5	4679.9	4937.2	**3583.29**
Khed	4446.0	4753.0	3387.6	4082.0	4090.0	3649.7	3569.0	3029.0	4104.0	4194.0	**3930.43**
Guhagr	1921.0	2311.6	2342.9	2787.0	3724.0	3878.5	2116.6	2596.0	4122.0	3833.0	**2963.26**
Madangad	3220.9	3808.2	3934.0	4779.0	4371.8	4352.1	3768.3	2686.9	3839.0	5006.0	**3976.62**
Ratnagiri	2802.2	2513.8	2849.2	3125.0	4242.7	3797.7	2598.8	3211.4	4015.7	4470.9	**3362.74**
Sangmeswr	2989.0	3066.2	4885.8	5515.0	6615.0	4240.0	5101.0	5116.0	6698.0	6942.9	**5116.89**
Rajapur	2773.0	2515.3	3542.6	4015.0	5358.9	5167.0	**3626.0**	3262.0	4229.6	4885.0	**3937.44**
Lanja	2809.0	2476.0	2644.4	3284.0	3214.0	3664.6	3679.7	3407.1	4304.0	4560.0	**3404.28**
District Average	**2934.3**	**3079.9**	**3319.6**	**3996.8**	**4400.1**	**4165.2**	**3370.3**	**3274.1**	**4463.3**	**4875.6**	

Perusal of rainfall data from above table reveals that during last decade (year 2002-2011) reveals that lowest rainfall amounting 2934.3 mm was observed during year-2002 in Ratanagiri district, whereas maximum rainfall 4875.6 mm was recorded in year-2011 in 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 been 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 form 15 to 145 m^3/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 m^3/ hr.

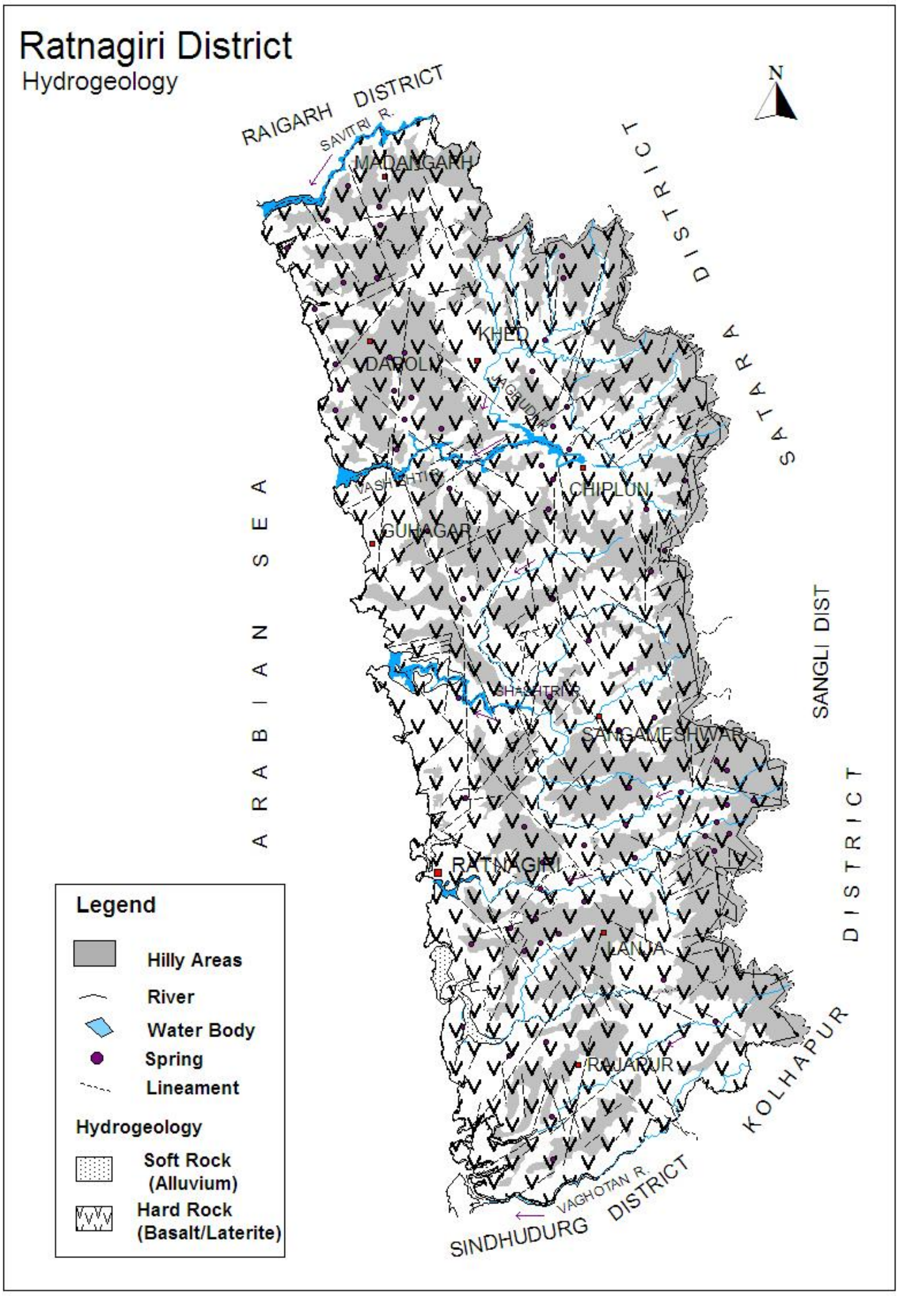

Figure-2: Hydrogeology

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 m^3/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 m^3/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). Based on data collected from these stations Pre-Monsoon Depth to Water Level Map, Post-Monsoon depth to Water Level Map are complied for Year-2011

4.2.1 Depth to Water Level – Premonsoon (May-2011)

Pre-monsoon depth to water levels in the district during May-2011 vary from 1.6 m (Khopi) to 36.40 m bgl (Dhmanand). Depth to Water Level Map of Ratnagiri district is depicted in Figure-3. From depth to water level map it is seen that shallow water levels in the range of 2-5. is occurring eastern and north-eastern parts of the district. In major part of the district depth to water level is ranging between 5 to 10m,b.g.l. extending area from north to south. In south-central part of the district water level is recorded between 10 - 20 m bgl. Deeper water level of more than 20 m bgl is observed in only one patch in north-eastern part around Dhamnand.

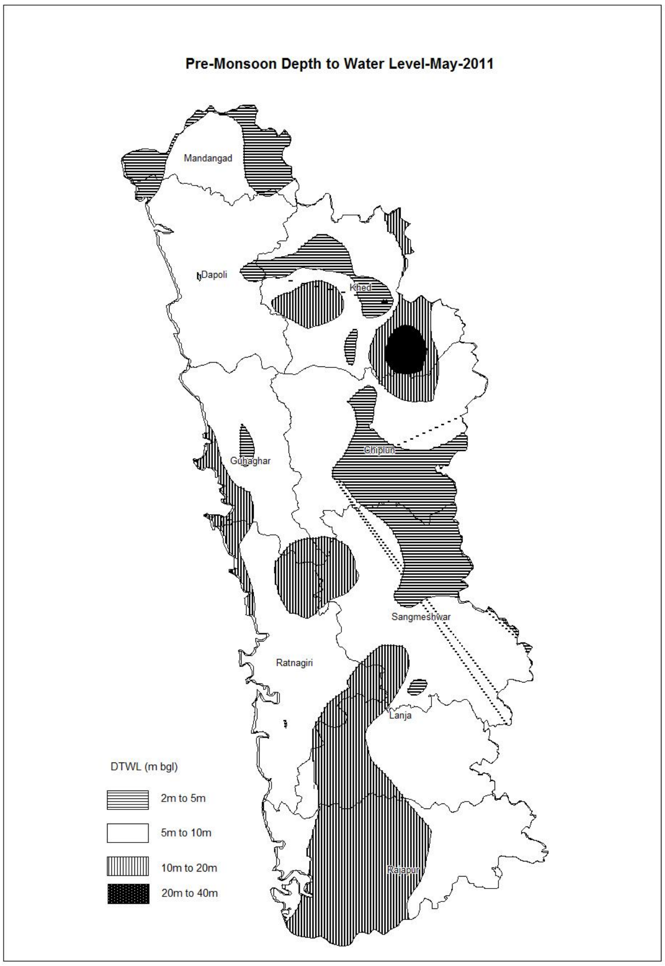

Figure-3: Depth to Water Level (Premonsoon- May 2011)

4.2.2 Depth to Water Level – Postmonsoon (Nov.-2011)

Post-monsoon depth to water levels in the district observed during month of November-2011 vary from 1.42 m bgl (Vakarli) to 16.32 m bgl (Abitgaon). Post-monsoon depth to water level map is presented in Figure-4. Perusal of Post-monsoon depth to water level map of Ratnagiri district reveals that in major portion of eastern, central and north-eastern part of the district water level is occurring between 2 to 5 mbgl. In southern and north-western part of district depth to water level is observed between 5 to 10 mbgl. In isolated pockets depth to water level more than 10 m bgl is observed in Ratnagiri, Sangmeshwar and Rajapur taluka area.

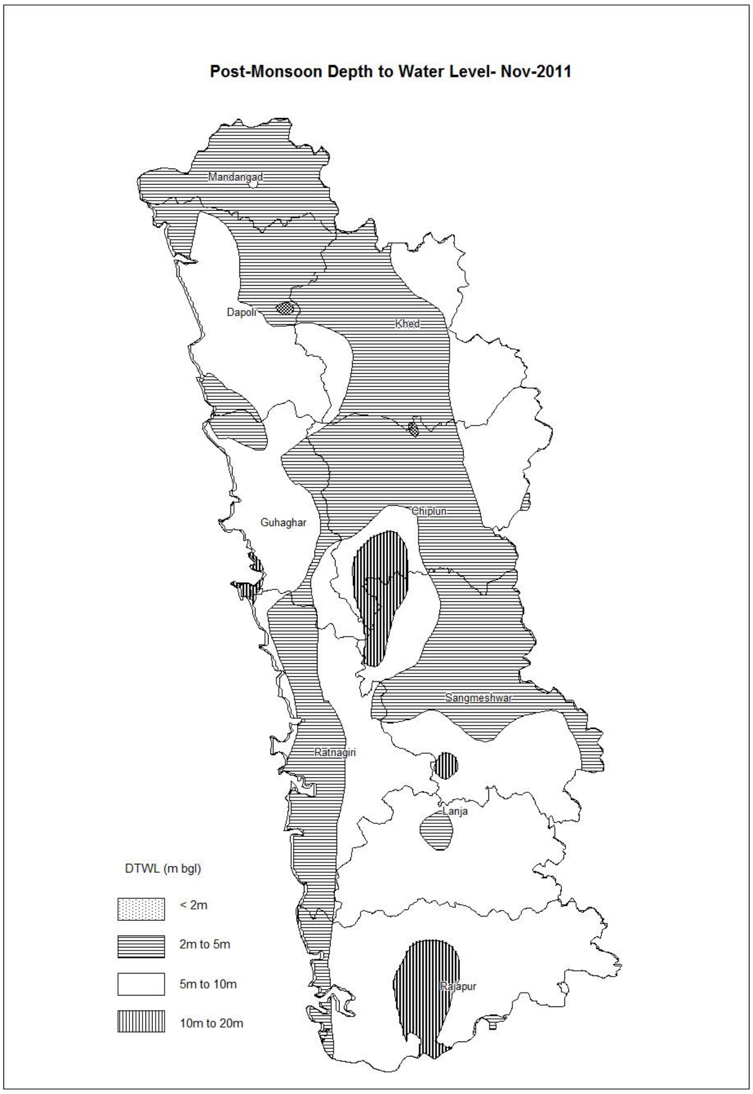

Figure-4: Depth to Water Level (Postmonsoon- Nov.2011)

4.2.3 Seasonal Water Level Fluctuation– (May to Nov. 2011)

In general in major part of the Ratnagiri district, rise in water level in the range of 0.05m (at Sakarpa, Taluka- Sangmeshwar) to 7.22m (at Jaigarh, Taluka-Ratnagiri) is recorded between pre-monsoon and post-monsoon season of the year-2011. In major portion of district excepting north-west and central-west part, rise in water level is varying between 2 to 4m. In north-west and central west portion rise in water level is recorded between 2 to 4m and in isolated pocket. Rise from 4 to 7.22m is too observed in this area.

Fall in water levels between 0.21m (at Rajapur,Taluka-Rajapur) to -3.90 (at Dabhola, Taluka-Sangmeshwar) is also observed in localized pockets in north-east part (parts of Khed and ChiplunTaluka area) and in other parts as isolated pockets between pre-monsoon and post-monsoon seasons.

4.2.4 Water Level Trend (2002-2011)

Long term trend of water levels for pre-monsoon and post-monsoon period for last decade (2002-2011) have been computed for Ground Water Monitoring Wells (GWMW). Analysis of long term water level trend indicated that 29 GWMW are showing rising water level trend in pre-monsoon season and rise in water level is recorded between 0.002 m/year (Vakrali) and 1.65 m/year (Dabhol). However falling water level trend is also observed in 17 GWMW and decline in water levels is varying from 0.008 m/yr (Tetavali) to 0.53 m/year (Abitgaon) during pre-monsoon seasons.

Long term trend analysis for post-monsoon season indicates rising water level trend in 16 GWMW and rate of rise in water levels is recorded between 0.01m/year (Dugway) and 1.08 m/year (Dhabhol). Whereas majority of GWMW (27) are showing falling water level trend and rate of fall in water levels is observed between 0.05 m/year (Rai Patan) and 0.37 m/year (Chiplun).

The premonsoon water level trend map was also prepared for the period May 2002-2011 and the same is presented in **Figure- 5**. A perusal of the map indicates that in major part of the district the rising trend of water level in the range 0 to 0.20 m/year is observed. The falling trend of water level in the range of 0 to 0.20 m/year is observed in northern eastern parts of the district (in parts of Khed and Chiplun talukas) and in southern part of the district (in Rajapur taluka).

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

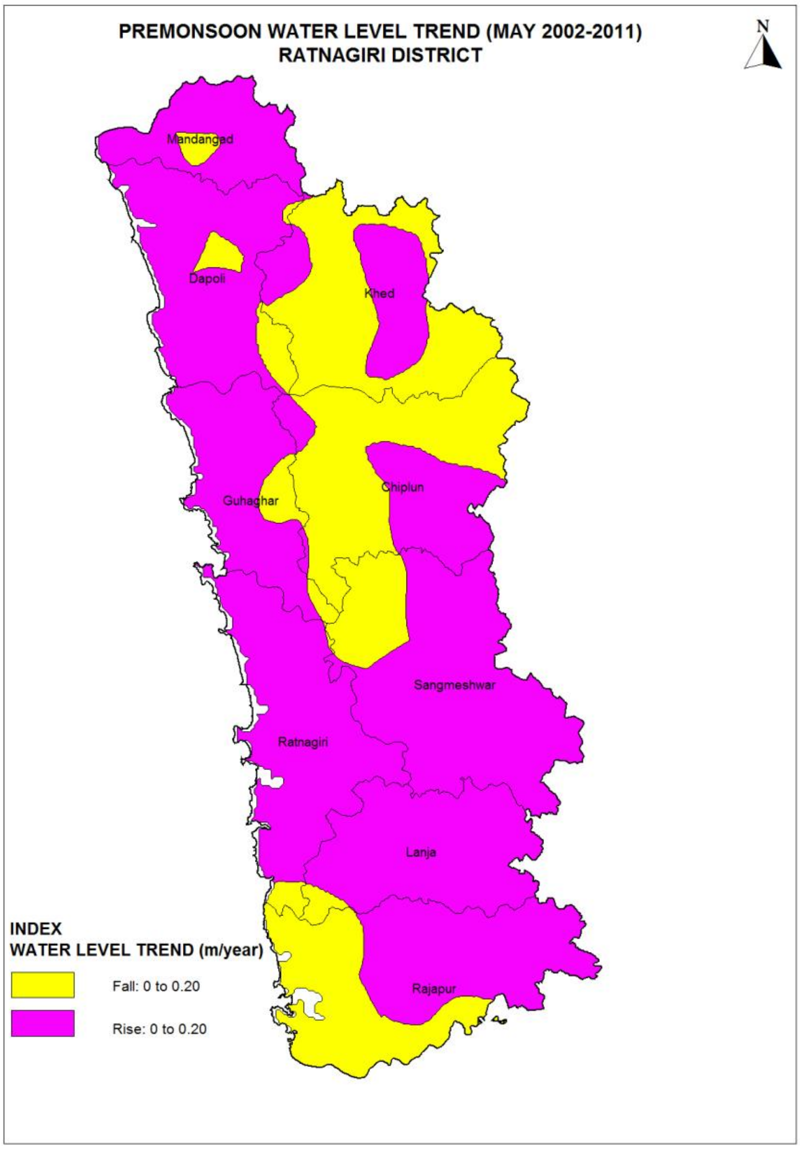

Figure-5: Water Level Trend (Premonsoon- May 2002-2011)

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 m^3/day, in massive/jointed Basalt it varies from 4.5 to 22.5 m^3/day, whereas in fractured and weathered Basalt it varies form 20 to 145 m^3/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 m^3/hr and majority of borewells have yield between 2 and 5 m^3/hr. A good number of high yielding borewells with yield of more than 10 m^3/hr are found to be located on or near the vicinity of the lineaments.

4.5 Ground Water Resources

Central Ground Water Board and Ground Water Survey and Development Agency (GSDA) of Maharastra State have jointly carried out Taluka and Watershed wise estimation of ground water resources of Pune district for base year 2008-09 according to GEC methodology 1997.Ground Water Resource Estimation figures as a whole for Ratnagiri district indicates that Net Ground Water Availability is 466.05 MCM and Existing Ground Water Draft for all uses is 52.49 MCM. After making provision for Domestic and Industrial Supply for next 25 Years as 24.37 MCM, Ground Water Availability for future Irrigation is 401.36 MCM. Over all Stage of Ground Water development of the district is 11.26%. indicating there is ample scope for ground water development in the district. All Talukas of Ratnagiri district are categorized under **"Safe Category".** Taluka wise ground water resources figures of Ratnagiri district are given below in Table-5.

As per the estimation the net annual ground water availability comes to be 466.05 MCM. The total annual draft for all uses is estimated at 52.49 MCM with irrigation sector being the major consumer. The net annual ground water availability for future irrigation is 401.36 MCM, whereas the allocation for domestic and industrial requirements is 24.37 MCM. The stage of ground water development varies from 7.14% (Sangameshwar) to 19.65% (Guhari). The overall stage of ground water development for the district is 11.26%. Thus there is plenty of scope for further development of ground water resources. All the talukas and watersheds have been categorised as "Safe".

Taluka wise figures of ground water resources are revealing that stage of ground water development is computed as less than 10% in 6 Talukas. Stage of ground water development computed for Dapoli,Guhagar and Ratnagiri Talukas are 18.52%,19.65% and 19.07% respectively but there is also plenty of scope for future development of ground water resources of the area.

Table 5: Assessment of Dynamic Ground Water Resources of Ratnagiri District - 2009

(in ham)

Sr No.	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	Provision for domestic and Industrial Requirement Supply to 2025	Net Ground Water Availability for Future Irrigation Development	Stage of Ground Water Development (%)
1	Chiplun	7274.99	405.69	152.44	558.14	298.04	6572.20	7.67
2	Dapoli	3769.62	587.46	110.75	698.21	221.24	2958.84	18.52
3	Guhagar	4748.41	801.74	131.51	933.25	263.02	3683.65	19.65
4	Khed	6595.01	330.61	133.67	464.28	275.02	5999.33	7.04
5	Lanja	3772.91	261.25	128.30	389.55	249.27	3212.12	10.32
6	Mandangad	2690.63	160.54	69.99	230.53	139.98	2390.10	8.57
7	Rajapur	6662.78	419.19	193.38	612.57	389.68	5854.83	9.19
8	Ratnagiri	4790.47	761.96	151.45	913.41	307.27	3756.37	19.07
9	Sangameshwar	6300.25	302.25	147.28	449.52	294.03	5709.39	7.14

4.6 Ground Water

CGWB is monitoring the ground water quality of the Ratnagiri district since the last four decades through its established monitoring wells. The objectives behind the monitoring are to develop an overall picture of the ground water quality of the district. During the year 2011, the Board has carried out the ground water quality monitoring of 39 monitoring wells. These wells mainly consist of the dug wells representing the shallow aquifer. The sampling of ground water from these wells was carried out in the month of May 2011 (pre-monsoon period). The water samples after collection were immediately subjected to the analysis of various parameters in the Regional Chemical Laboratory of the Board at Nagpur. The parameters analyzed, include pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Nitrate (NO_3) and Fluoride (F). The sample collection, preservation, storage, transportation and analysis were carried out as per the standard methods given in the manual of American Public Health Association for the Examination of Water and Wastewater (APHA, 1998). The ground water quality data thus generated was first checked for completeness and then the validation of data was carried out using standard checks. Subsequently, the interpretation of data was carried out to develop the overall picture of ground water quality in the district in the year 2011.

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., TH, NO_3 and F prescribed in the standards and is given in **Table-6**.

Table-6: 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
TH (mg/L)	300	600	39	-	-
NO_3 (mg/L)	45	No relaxation	39	-	-
F (mg/L)	1.0	1.5	39	-	-

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

The perusal of **Table-6** shows that the concentrations of all the parameters are within the desirable limit of the BIS standards. It is also seen from the **Table-6** that can be concluded that the ground water quality in the wells monitored in the district is not affected much.

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. Electrical Conductivity (EC) and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation.

Electrical Conductivity (EC)

The amount of dissolved ions in the water is best represented by the parameter electrical conductivity. The classification of water for irrigation based on the EC values is as follows.

Low Salinity Water (EC: 100-250 µS/cm): This water can be used for irrigation with most crops on most soils with little likelihood that salinity will develop.

Medium Salinity Water (EC: 250 – 750 µS/cm): This water can be used if moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.

High Salinity Water (EC: 750 – 2250 µS/cm): This water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

Very High Salinity Water (EC: >2250 µS/cm): This water is not suitable for irrigation under ordinary condition. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching and very salt tolerant crops should be selected.

The classification of ground water samples collected from monitoring wells for was carried out irrigation purpose and given below in **Table-7**.

It is clear from the **Table-7** that maximum number of samples (82%) falls under the category of Low salinity water while nearly 18% of samples fall in medium salinity water category. This shows that the ground water in the pre-monsoon season from shallow aquifer in the district can be used for irrigation with crop management practices.

Table-7: Classification of Ground Water for Irrigation based on EC.

Type	**EC (µS/cm)**	**No. of Samples**	**% of Samples**
Low Salinity Water	<250	32	82
Medium Salinity Water	250-750	7	18
High Salinity Water	750-2250	Nil	Nil
Very High Salinity Water	>2250	Nil	Nil
Total		**39**	**100**

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 the area. As for as availability is concerned ground water resources estimation figures reveals that there is ample scope for future development. For base year 2008-09 in Ratnagiri district Net Ground Water Availability was computed as 46605.08 ha-m, where as Existing Ground Water draft for all uses was only 5249.47 ha-m and Stage of Ground Water Development was calculated as 11.26%. After making Allocation of 2437.54 ha-m for Domestic and Industrial water Supply for next 25 years, still 40136.83 ha-m ground water is available in balance for future irrigation. But considering steep topography of the area of Sahyadri Hills perhaps availability of this much ground water may not exist in true sense, specially in deeper horizons.

Analysis of Statistical Data of Ratnagiri District available for year 2010-11 reveals that area irrigated from ground water sources was 22.63 sq. kms, where as Canal Irrigation accounts for 62.73 sq.kms and Net Irrigated Area was 146.03 sq kms. It indicates that component of ground water irrigation in this district is also having significant contribution and it is worked out to be 15.50% of Gross irrigation. However Net Irrigated Area of the district is negligible when compared with Net Sown area of 2716.85 hectares and it is found as 5.37% only. There were 7534 Irrigation Wells in the district and were 10951 Electric Pumps and 636 Diesel Pumps under use for irrigation. There were very few irrigation bore wells in the district and area irrigated by them was negligible.

Ground water is also playing an important role in Rural water supply of the district for drinking purposes. In Year 2010-11 The Maharashtra Government was using 2560 bore wells for rural water supply in the district under various schemes out of which 184 were reported fitted with electric pumps and 2376 were installed 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 m^3/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.

The falling trend of water level in the range of 0 to 0.20 m/year is observed in northern eastern parts of the district (in parts of Khed and Chiplun talukas) and in southern part of the district (in Rajapur taluka).

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 $Ca\text{-}HCO_3$ type to Na-Cl, $Ca\text{-}Cl_2$ and $Ca\text{-}SO_4$ type and higher values of TDS, TH, Ca, Mg, Na, Cl, SO_4, NO_3 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 2011, one MAP had been organised in the district at Ratnagiri. The details are given in Table-8.

Table 8: 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 2011 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 m^3/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 11.26%, 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 falling trend of water level in the range of 0 to 0.20 m/year is observed in northern eastern parts of the district (in parts of Khed and Chiplun talukas) and in southern part of the district (in Rajapur taluka). In such areas dual approach of development coupled with augmentation needs to be adopted.

6 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.

7 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.

8 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.

9 The existing village ponds/tanks need to be rejuvenated to act both as water conservation and artificial recharge structures.

10 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.

11 Mass awareness programmes as the one organised by CGWB at Panchayat Samiti 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.