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भारत सरकार

जल संसाधन मंत्रालय

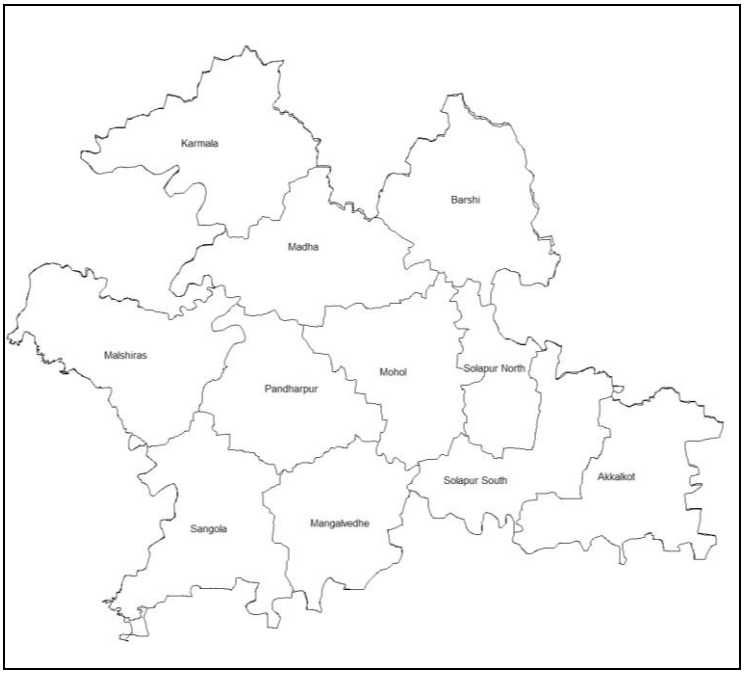
केंद्रीय भुमिजल बोर्ड

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

महाराष्ट्र राज्य के अंतर्गत सोलापुर जिले की

भूजल विज्ञान जानकारी

GROUND WATER INFORMATION
SOLAPUR DISTRICT
MAHARASHTRA



By

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मध्य क्षेत्र, नागपुर

CENTRAL REGION, NAGPUR

2013

SOLAPUR DISTRICT AT A GLANCE

1. GENERAL INFORMATION

Geographical Area	:	14895 sq. km.
Administrative Divisions	:	Taluka-11; N. Solapur, S. Solapur, Barshi, Akkalkot, Pandharpur, Malshiras, Sangola, Mangal Wedha, Madha, Moho, Karmala.
Villages	:	1158
Population (2001 Census)	:	43,15,527
Normal Annual Rainfall		524 mm to 707 mm

2. GEOMORPHOLOGY

Major Physiographic unit	:	Four; Valleys, Denudational Hills (Sahaydri), Highly Dissected Basaltic Plateau, Moderately Dissected Basaltic Plateau, and Moderately Dissected Basaltic Plateau
Major Drainage	:	Tributaries of Bhima River

3. LAND USE (2010-11)

Forest Area	:	342 sq. km.
Non Cutivation Area	:	788.97 sq. km.
Cultivation Area	:	11315.22 sq. km.
GW Irrigated Area	:	1788.09 sq km

4. SOIL TYPE

Very Shallow, Shallow, Medium and Deep Soils

5. IRRIGATION BY DIFFERENT SOURCES (2006-07 MI CENSUS) **- Nos./Potential Created /Potential Utilised(ha)**

Dugwells	:	132842/327709
Borewells	:	28786/65308
Total GW Potential Created		393017
Surface Flow Schemes	:	174/265
Surface Lift Schemes	:	37874/98404
Net Potential Created	:	494686 ha

6. GROUND WATER MONITORING WELLS (As on Nov 2012)

Dugwells	:	53
Piezometers	:	6

7. GEOLOGY

Quarterny to Recent	:	Alluvium
Upper Cretaceous-Lower Eocene:		Basalt (Deccan Trap)

8. HYDROGEOLOGY

Water Bearing Formation	:	**Deccan Trap**: Weathered, vesicular, fractured and jointed basalt form aquifer. The depth of weathered mantle ranges from 1 to 6m and potential fractures normally are limited to 20 to 50m depth range **Alluvium**: Fluvial alluvial sediment with calcareous

		materials occurs in the western part of the district along the coast. The fluvial alluvium occurs along the river drainage. The thickness of alluvium varies from 2m to 12m.
Premonsoon Depth to Water Level (May-2011)	:	GL to 12.80 m bgl
Postmonsoon Depth to Water Level (Nov.-2011)	:	1.00 to 19.60 m bgl
Premonsoon Water Level Trend (2001-10)	:	Rise: 0.0041 to 4.050 m/year Fall: 0.0037 to 0.78 m/year
Postmonsoon water level trend (2001-10)	:	Rise: 0.0157 to 3.53 m/year Fall: 0.0013 to 1.499 m/year

9. GROUND WATER EXPLORATION (As on 31/03/12)

Wells Drilled	:	EW-69, OW-5, Pz- 17
Depth Range	:	115 to 200.00 m bgl (To be checked)
Discharge	:	Traces- 14.88 lps
Transmissivity	:	0.08 to 130.37.36 m^2/day

10. GROUND WATER QUALITY

The groundwater present in Solapur district is mainly affected by Nitrate concentration above MPL. High concentration of TH values are also recorded in some areas.

Type of Water	:	Ca-Cl and Ca-HCO_3

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

Net Annual GW availability	:	1507.84 MCM
Total Draft (Irrigation + Domestic)	:	49.36 MCM
Projected Demand (Domestic + Industrial)	:	89.30 MCM
Stage of Ground Water Development	:	78.23%
Categorisatiom		Malshiras Taluk - OE Other Talukas - SAFE

13. AWARENESS AND TRAINING ACTIVITY

Mass Awareness Programme	:	One
a. Date	:	29/03/05
b. Place	:	Pandharpur
c. Participants	:	300
Water Management Training Programme	:	NIL

14. ARTIFICIAL RECHARGE & RAINWATER HARVESTING

Projects Completed	:	Nil
Projects under Technical Guidance:	:	NIL

15. GROUND WATER CONTROL & REGULATION

Over Exploited Taluka	:	Malshiras
Critical Taluka	:	None
Notified Taluka	:	None

16. MAJOR GROUND WATER PROBLEMS AND ISSUES

The Basaltic rocks due to poor storage and transmission capability get fully saturated during monsoon but a situation of rejected recharge results in post-monsoon and early summer months. These aquifers also drain naturally due to high water table gradient formed by sloping and undulating topography. The available groundwater resources can better augmented by adopting scientific and multi-sectoral approach for making the future plan. The aspect related to conjunctive use, ground water legislation, involvement of NGO'S, woman and community participation, mass awareness, adoption of advanced Irrigation system etc will play an important role in conserving and developing the precious water resources

Ground Water Information
Solapur District

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GROUND WATER INFORMATION
SOLAPUR DISTRICT

1. Introduction

Solapur district is one of the four districts that form the region of Western Maharashtra. It is the fourth largest district in Maharashtra in terms of land area and seventh largest in terms of population. It is an important junction on the Central railway line. Solapur is a city with an array of small and medium scale industries. The district is well known for its textile industries and Solapur chadars and towels are famous around the globe. The district has the largest industry in Maharashtra for Beedi production. Solapur is also known for its oilseed-market. Solapur is situated on Deccan plateau. It has an average elevation of 458 metres. The district is spread over an area of around 14,895 square kilometers. It is located on the south east edge of the state and lies entirely in the Bhima and Seena basins. The entire district is drained by the Bhima River. Revenue Sub-divisions are Solapur, Madha (Kurduwadi), Pandharpur. The district is divided into 11 talukas viz Akkalkot, Barshi, Karmala, Madha, Malshiras, Mangalwedhe, Mohol, Pandharpur, Solapur North and Solapu South. A location map taluka boundaries, taluka head quarters, ground water monitoring stations and physical features is shown in fig 1.

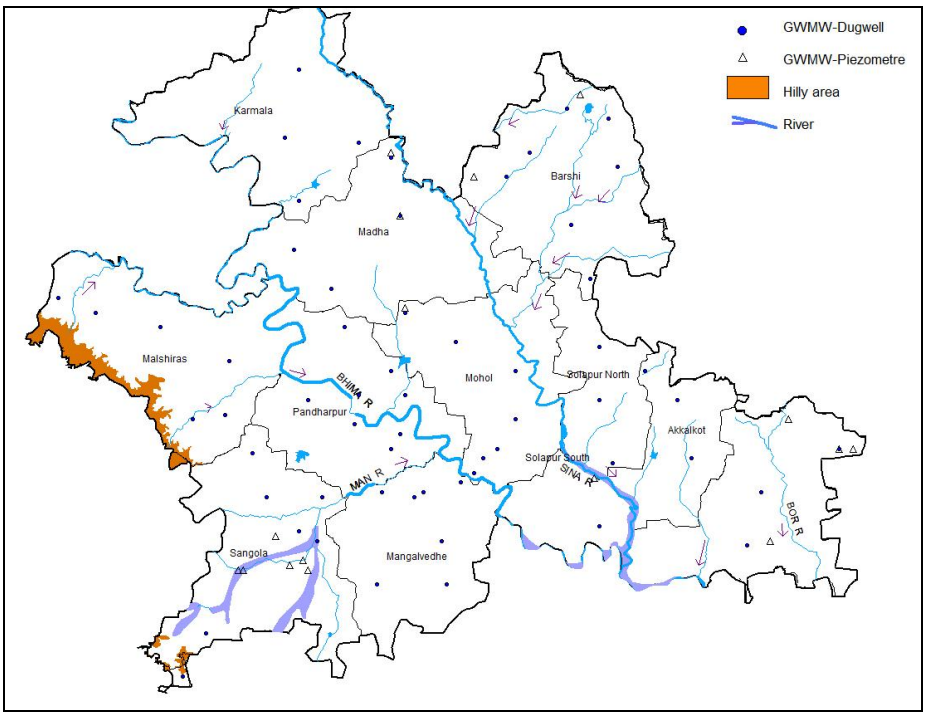

Figure 1: Administrative Divisions

1.1. Location and Communication

The district lies between 17°21′N 75°10′E / 17.35°N 75.16°E - 18°19′N 76°09′E / 18.32°N 76.15°E . The city of Solapur is the district headquarters. It falls under Survey of India topo sheets 47N, 47 J, 47D, 47K And 56K. About 32% of the population lives in urban areas. The economy of the district is dependent on agriculture, especially in rural areas. Means of transport is both railways and ST Buses by road, important railway stations are- Solapur, Mohol, Kurduwadi, Madha, Akkalkot Road; Local movement is facilitated by SMT (Solapur Municipal Transportation). Solapur is well connected by road with major cities of Maharashtra as well as the adjoining State Capital of Hyderabad and important cities of Karnataka State. There are also numerous state and country routes passing through Solapur

In 2011, Solapur district had population of 4,315,527 of which male and female were 2,233,778 and 2,081,749 respectively. Solapur District population constituted 3.84 percent of total Maharashtra population. In 2001 census, this figure for Solapur District was at 3.97 percent of Maharashtra population. The initial provisional data released by census India 2011, shows that density of Solapur district for 2011 is 290 people per sq. km. Average literacy of Solapur in 2011 were 77.72% compared to 71.25% in 2001. The male and female literacy were 86.35% and 68.55% respectively. With regards to Sex Ratio, it stood at 932 per 1000 male compared to 2001 census figure of 935. The average national sex ratio in India is 940 as per Census 2011. In 2011 census, child sex ratio is 872 girls per 1000 boys compared to figure of 895 girls per 1000 boys of 2001 census data.

The entire district has been covered under Systematic Hydrogeological Survey by the officers of Central Ground Water Board and Geological Survey of India, since1963-64 and the work was completed in year 1992. In year 1983-84 an area of around 6000 sqkm was covered under Reappraisal Hydrogeological Studies by Shri. S. Sudarshna of Central Region Nagpur. The entire district was again covered under Reappraisal Hydrogeological Studies by deputing 4 officers from Central Region Nagpur in 2004-05. The ground water exploration was also carried out in an area of 6826 sqkm under Sina-Man project of C.G.W.B. during 1975-80. Apart from this subsequent ground water exploration in detail covering the entire district was also taken up by C.G.W.B CR Nagpur in 2003-04 and continued in 2004-05 & 2005-06.

The District hydrgeological Report “Ground water resources and development potential of Shlapur District” was prepared by Dr P K Jain in the year 2004-05 which encompass all the

data information regarding water resources, irrigation, agriculture along with guidelines for better management of available water resources in the district.

The detailed ground water exploration was undertaken in the district between the period of 2003 to 2005 to ascertain the presence/ absence of productive aquifer zones, quality of ground water of different depth, yield of aquifer zones and to determine aquifer parameter. During present exploratory drilling programme 69 exploratory wells were drilled in the district up to targeted depth of 200 mbgl. In additions to this, 5 Observation wells and 17 piezometers were also drilled. The depth of the wells ranges from 115 to 200 mbgl and discharge was ranging between <0.14 lps (Vairag) and 14.88lps. Out of these 69 EW, 11 EW's have the yield of >3 lps. At 10 sites, the discharge was recorded between 1 and 3 lps and the discharge of 21 exploratory wells was less than 1 lps, and one EW (Singadgaon) was found dry. The discharge recorded in the observation wells ranges between 0.14 and 4.47 lps. The transmissivity value is ranging between 0.08 and 130.37m^2/day.

2.0 Climate and Rainfall

Solapur falls under the category of dry (arid and semiarid) climate according to the Köppen climate classification. Climate of the district is characterized by high humidity throughout the year, an oppressive summer followed by well distributed and heavy rainfall during the southwest monsoon season. The cold season starts from December to February followed by summer from March to May. The mean daily maximum temperature is 40°C and mean daily minimum temperature is 13°C. The highest temperature ever recorded is 48°C in April 1988. The southwest monsoon season is from June to September while October and November constitute the post monsoon season. Broadly speaking, the district can be divided into three natural zones. The eastern zone, comprising Barshi, North Sholapur, South Sholapur and Akkalkot talukas, has assured rainfall; the central or the traditional zone, comprising Mohol, Mangalwedha, eastern part of Pandharpur and Madha talukas has uncertain rainfall and the western zone which comprises the scarcity areas of Karmala, Sangola and Malshiras talukas and the western parts of the Madha and Pandharpur talukas has also uncertain rainfall.

Rainfall all over the district is uncertain and scanty with an annual average of 625 mm. Only in Barshi taluka which is nearer to Balaghat range it averages to 725 mm. The district gets rain from south-west as well as from north-east monsoon. The main precipitation during June to August is rather precarious. The normal rainfall for the monsoon

period, *i.e.*. June-September is 425.9 mm. which is 73.6 per cent of the total annual rainfall. The farming practices are adjusted according to the normal character of the rainy season. It is the minimum in the North – Western part of the district around Malsiras (524mm). It increases towards southeast and attains a maximum around Akkalkot (707 mm). The co-efficient of variation of the annual rainfall from the normal ranges from 30% at Barshi to 42% at Malsiras. This suggests a high fluctuation in annual rainfall over the district.

The percentage probability of receiving excess rainfall (that is 25% or more in excess of the normal) varies from 19% to 23% . It is the minimum around Malsiras, Pandharpur and Solapur (19%) and maximum around Akkalkot (23%). the probabilities of occurrence of moderate drought ranges from 15% at Karmala to 22% at Madha and Akkalkot (Table 1). Severe drought conditions were experienced at all station for 1% to 11% of the years. Acute drought condition was experienced for 1% of the years only at Pardharpur, Malsiras and Madha. As every station of the district experienced moderate, severe and acute drought condition for more than 20% of the years, the entire district can be classified as "Drought Area".

3.0 Geomorphology and Soil Type

The district is comprised of Bhima sub-basin and has undulating topogragraphy. The elevation in the district is ranges from 400 to 600m amsl. The district is typically characterized by the morphology of Deccan basaltic flows. The major Rivers flowing in the district are the Bhima, The Sina, The Man, and The Bhargavati Rivers. The Sina and the Man River's are the tributaries of the Bhima and the Bhogawati River is tributary of Sina. Dendritic drainage has been observed only in the vicinity of major Rivers where alluvial deposits or thick soil cover is present. However all the streams and Rivers which flow in the district are effluent in nature.

The soil prevailing in Solapur district is mainly derived forms Deccan basalts. The soil of the district is underlain by partially decomposed basaltic rock locally known as "Murum" which overlies parent rock. Due to more of less complete absence of leaching, the soils are base-saturated. The lime reserve in the soil is fairly high (3.5 to10%). The soils exhibit varying degrees of erosion and truncated profile is a common occurrence. The soils can be broadly classified in the four main categories on the basis of depth and structure.

- Vary shallow with depth less than 7.5cm.
- Shallow soils between 7.5-to22.5cm depths.

- Medium deep soils between 22.5 and 90cm depths.
- Deep soils with depth more than 90cm.

Table-1. Salient Features of Rainfall Analysis in Solapur District

S.N	Station	No. of years data	Normal Annual Rainfall (mm)	Co-efficient of variation (%)	Less than normal RF (Y/%)	Moderate drought (Y/%)	Severe Drought (Y/%)	Acute Drought (Y/%)	More than normal RF (Y/%)	Excess RF (Y/%)	RF trend (mm/Yr.)
1	Solapur	103	704.0	31	53/51	21/20	3/3	0/0	50/49	20/19	0.6
2	Pandharpur	101	619.9	34	52/51	21/21	3/3	1/1	49/49	19/19	0.4
3	Akkalkot	93	706.6	33	47/51	20/22	3/3	0/0	46/49	21/23	-0.5
4	Malsiras	99	524.4	42	52/53	19/19	7/7	1/1	47/47	19/19	0.9
5	Madha	90	592.3	32	47/52	20/22	1/1	1/1	43/48	18/20	0.3
6	Barshi	101	653.7	30	49/49	19/19	5/5	0/0	52/51	21/21	-0.5
7	Karmala	102	574.0	37	48/47	15/15	11/11	0/0	54/53	21/21	0.7

4.0 Ground Water Scenario

4.1 Hydrogeology

The entire Solapur district is occupied by lava flows of the Deccan Basalt formation, which constitute the main rock formation of the district. The important water bearing formations of the district are discussed below. A map depicting hydrogeological feature is shown in figure 2.

4.1.1 Deccan Trap Basalt

Ground water in Deccan Traps mostly occurs in the weathered and fractured parts down to 10-15m depth. At places potential zones are encountered at deeper levels in the form of fractures and inter-flow zones which are generally confined down to 60-80m in the district. The weathered portions of both vesicular and massive units have better porosity and permeability. Intensity of weathering is less in hilly region of the district while it is higher in plain area. The yield of dug wells tapping phreatic aquifer ranges between 18 to 152cum/day, which have 5-12m depth range. The bore wells are generally drilled down to 40 to 60m tapping weathered and fracture/vesicular zones, these wells have a discharge of 2 to 4lps. It is noticed and reported that the yields of the wells drastically get reduced in summer months beginning form March up June end.

4.1.2 Alluvium

Ground water in this formation occurs under water table condition in the district as it is very shallow in depth and spreads over a very limited area. It is observed that the saturated thickness of alluvial material comprises of silt, clay, sand and gravel. The detrital material consisting of sand and gravel occurring as lenses in the alluvial piles sometimes form good aquifer but on other hand these deposit do not constitute potential aquifer in the district as compared to hard rock due to its limited area extent.

The yield of dug wells developed closer to river course ranges between 122 to 172cum/day, which have 8-16m depth range. The bore wells are generally drilled down to 20 tapping alluvium and part of weathered and fracture/vesicular zones, these wells have a discharge of 4 to 6lps.

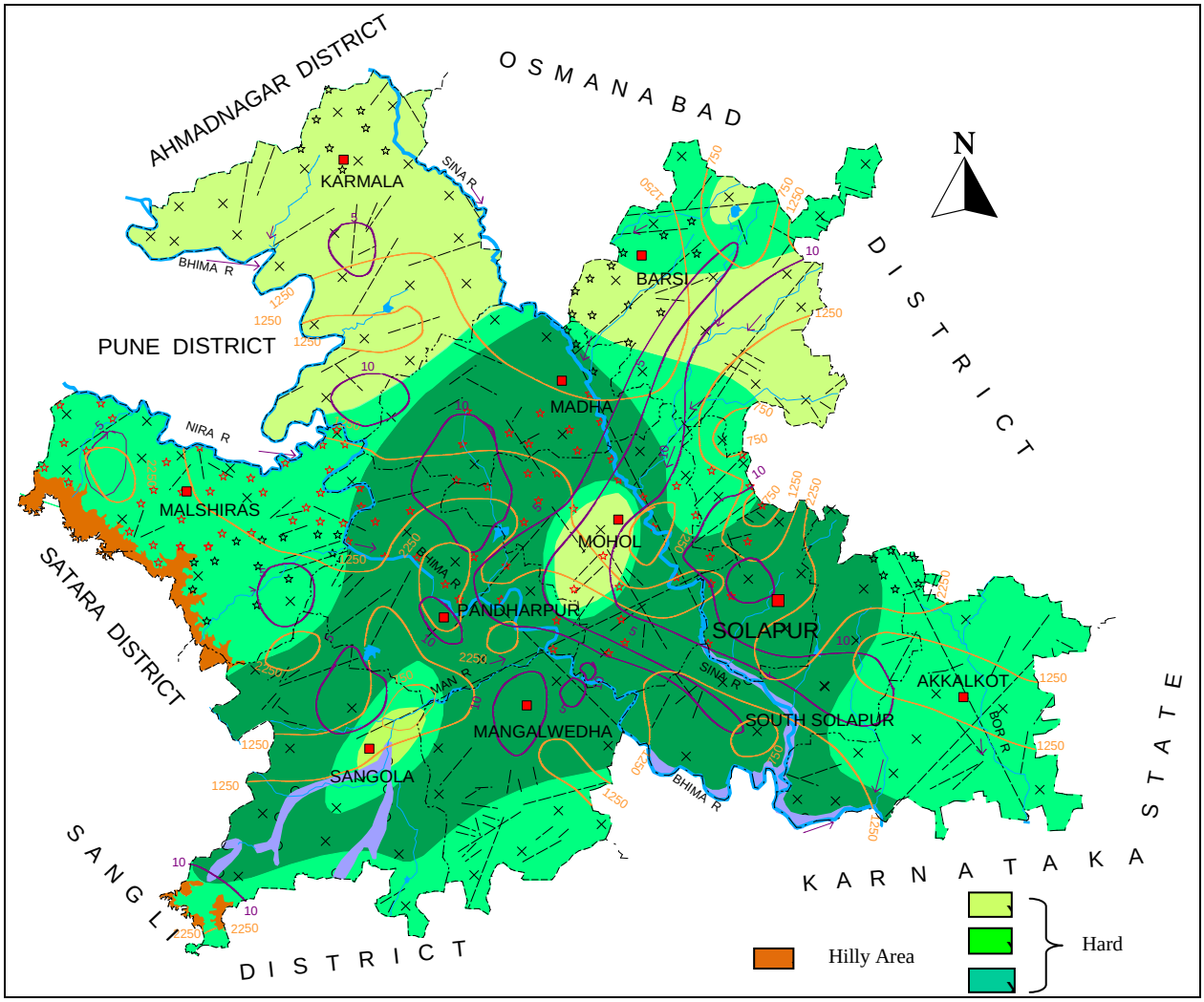

Figure 2: Hydrogeology

4.2 Water Level Scenario

Central Ground Water Board monitors ground water level 53 National Hydrograph Network monitoring Stations (NHNS) established in the district four times a year ie during January, May (Pre-monsoon), August and November (Post-monsoon).

4.2.1 Pre monsoon Depth to Water Level (May-2011)

The pre-monsoon depth to water level ranges from ground level to 12.80. It is observed that most of the stations were dry during pre-monsoon season indicating roughly the water level has gone below 9 mbgl as majority of the wells are having a depth range between 8 and 16 mbgl except at few observation wells where it is more than 16 mbgl. Depth to water level range of 5-10 mbgl are observed in major part of the district. Water level in the range of 2-5 mbgl are observed in northern part of the district and also in isolated pached spread over the district. Water Level >10 mbgl is observed in very small ara in two isolated patches as shown in figure 3.

4.2.2 Post-monsoon Depth to Water Level (Nov- 2011)

The post monsoon water level ranges from 1.00 to 19.60 m bgl. Major part of the district shows water level in the range of 5-10 mbgl. The water level within 3 mbgl have been recorded only in few patches in western part of Solapur district particularly in the area ground Jeur and Kanhar in Karmala Taluka, area around Mahlshiras town and Salmukh in Malshiras Taluka and area around Sangola in Sangola Taluka. The area around Pandharpur and Mangalvedha in west central part of the district has recorded water level below 9 mbgl. Similarly the area around Nagaj village in Sangola Taluka in the extreme south west part and village Chincholi in eastern part in South Solapur Taluka and village Shole in Mohol Taluka have also shown water level below 9 mbgl in post monsoon season. Spatial variation in post monsoon depth to water level has been shown in Figure 4.

4.2.3 Seasonal Water Level Fluctuation (May-Nov 2011)

The seasonal water level fluctuation (May-Nov 2011) ranges from -7.95 to 7.20 m and the mean fluctuation is1.67m. The highest negative fluctuation is at Chale NHS and positive fluctuation is observed at Shelgoan. The fluctuation range of 0-2 m and 2-4 m have been observed in major part of the area. The higher fluctuation ranges of 4-6 m and 6-8 m are observed in the recharge area. Negative fluctuation is observed in six few wells in isolated patches.

4.2.4 Long Term Water Level Trend (2001-2010)

The long term water level trend for pre and post monsoon period for the last 10 years have been computed. The decadal water level trend is showing raise in majority of wells (47) and fall in few wells (12) varying from +4.05 to -0.780m/yr. In general pre-monsoon water levels are stable with mean rising trend of 0.4m/yr. Decadal mean post-monsoon depth to water level varies between 0.32 and 5.25 m bgl. In major part of the district mean water level is in the range of less than 2 m bgl. The decadal water level trend varies from +3.53 to -1.50m/yr. In post-monsoon 12 wells out of 53 monitored show fall in water levels indicating draining of aquifer due to steep gradient and natural base flow. In general the water levels are showing rising trend over long period. the maximum area of central part and eastern and south eastern part of Solapur district is showing declining trend of ground water level which is more prominent at the maximum rate in the area around Pandharpur. Also decline of 0.1 to 0.2 m/year is observed in the small patches in northern part of the district around Varkute and Karmala. Similarly in southern portion around Shivani, Pout and Nagaj in also showing decline in water level.

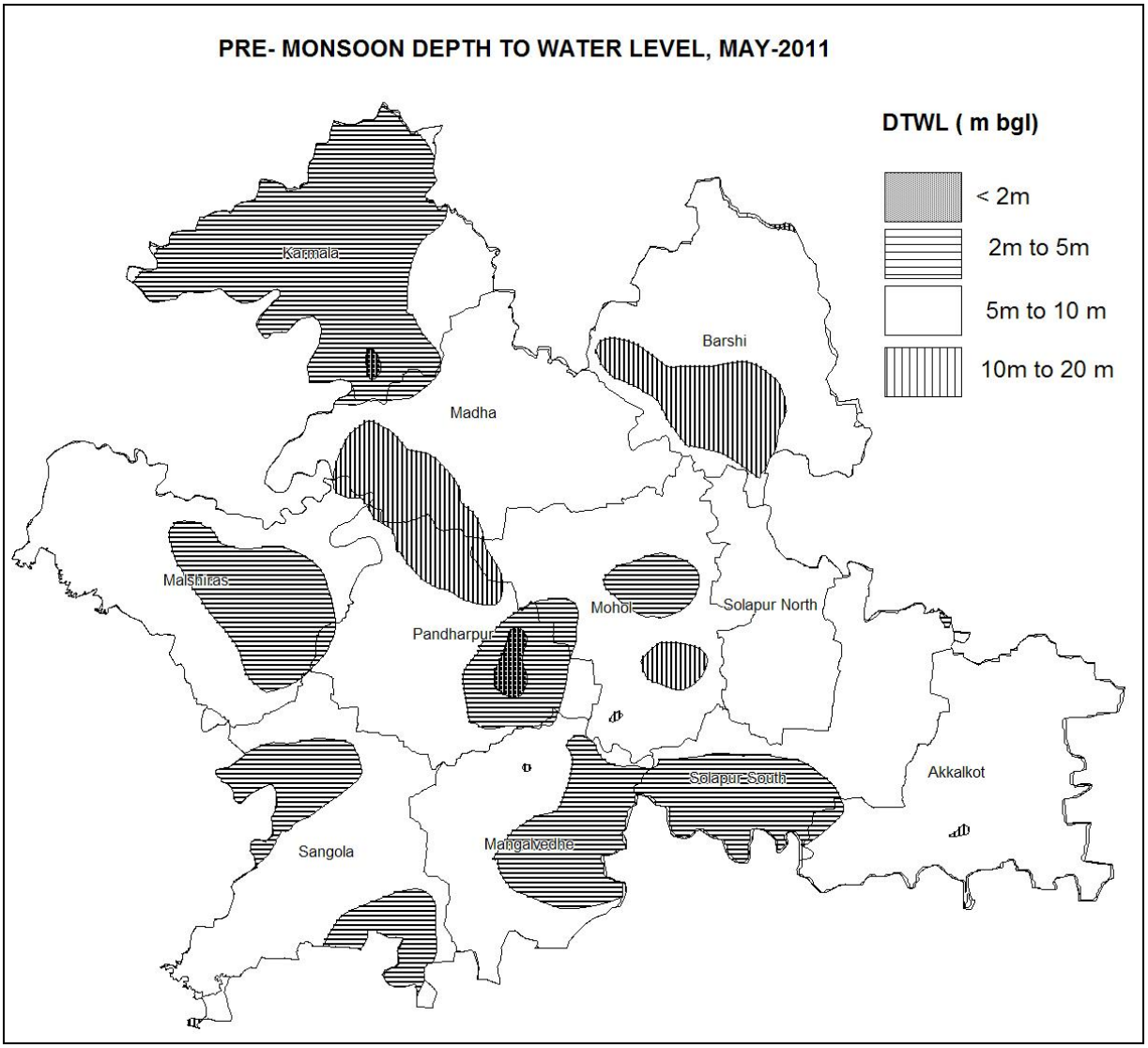

Figure 3: Premonsoon Depth to Water Level (May 2011)

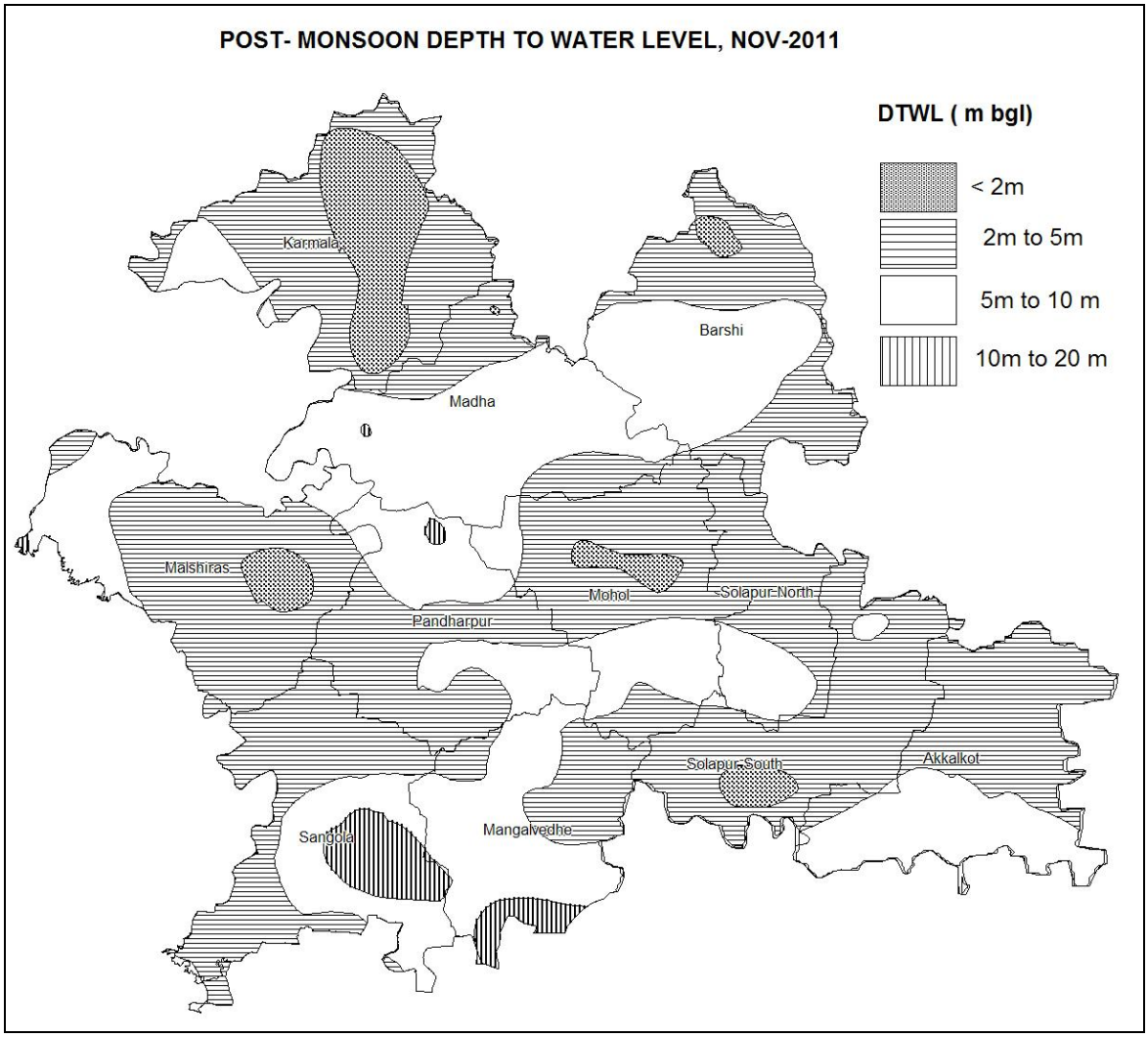

Figure 4: Postmonsoon Depth to Water Level (May 2011)

4.3. Yield of Bore Wells

A wide variation in yield of bore wells has been recorded in the district. The Ground Water Surveys and Development Agency (GSDA) and Zilla Parishad had drilled 19,936 borewells in the district for rural water supply till the ends of March 2004 out of which17439 borewells are successful. Out of these 17439 successful wells, 15914 have been fitted with hand pumps and 938 borewells, where the discharge was recorded more than 5000 liters/hour, have been fitted with power pumps.

4.4 Findings of Sina-Man Project

Hydrogeological studies under Sina-Man project of the CGWB covering 6826 sq km of the district revealed variation in the well performance and aquifer characteristics. Area was explored up to depth of 205 mbgl and three distinct aquifer systems were observed as shown in Table 2.

Table 2. Aquifer characteristics in the Area Covering parts of Sina and Man River basin.

S N	Aquifer Type	Thickness (m)	Depth Range (mbgl)	DTW Range (mbgl)	Fluctuation (m)	Trans-missivity (m^2/ day)	Specific Yield (%)	Yield (lps)
1	Water table	5 to 20	Up to 20	2 to 8	0.5 to 12	30 to 207	1.6 to 5	13 to 36
2.	Semi Confined	2.5 to 30	21 to 40	NR	NR	1.25 to 210	-	1 to 5 (DCB) 4 to 16 (B/W)
3	Confined	Variable	Below 40	Few to 24	NR	6 to 90	-	0.25 to 2

4.5. Ground Water Resource Estimation (2009)

Ground water resource estimation has been done jointly be CGWB and GSDA, Government of Maharashtra based on GEC-1997 methodology. The total number of watersheds in the Solapur district is 64, which has been again sub-divided into 86 sub units (23 command and 63 non command), which form the assessment unit for the estimation of ground water resources.

Resources were estimated as on 2009. The estimated Net annual ground water availability of the district is 150784.49 ham. Existing ground water draft for domestic and industrial purpose is 4936.63 ham. The stage of ground water development is 78.23 % and out of 64 watersheds, 51 watersheds fall in Safe category, 6 in Semi-Critical and remaining 7 in Over-exploited category. Malshiras taluka has been categorized as OE and rest of the talukas are in Safe category. The same are presented in table 4.

Table 3: DYNAMIC GROUND WATER RESOURCES OF THE SOLAPUR DISTRICT, MAHARASHTRA - 2008-2009

(in ham)

Sl No.	Administrative Unit	Command / Non-Command / Total	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 water Supply to 2025	Net Ground Water Availability for Future Irrigation Development	Stage of Ground Water Development (%)	Category
1	Akkalkot	Total	14783.17	7496.74	499.89	7996.63	999.78	6286.65	54.09	SAFE
2	Barshi	Total	11600.15	8684.92	497.83	9182.74	919.31	1995.93	79.16	SAFE
3	Karmala	Total	12653.18	9421.39	397.70	9819.09	705.08	2703.97	77.60	SAFE
4	Madha	Total	17294.39	13056.60	524.17	13580.76	887.71	4166.65	78.53	SAFE
5	Malshiras	Total	21141.50	20851.03	613.74	21464.77	890.63	2452.44	101.53	OE
6	Mangalwedha	Total	9449.14	7628.17	344.12	7972.29	654.35	1166.63	84.37	SAFE
7	Mohol	Total	13362.63	11243.48	474.11	11717.58	763.93	2227.92	87.69	SAFE
8	N.Solapur	Total	7067.28	4324.25	210.91	4535.16	418.39	2338.10	64.17	SAFE
9	Pandharpur	Total	14899.90	11075.76	382.99	11458.76	707.31	3441.74	76.90	SAFE
10	S.Solapur	Total	12481.59	7351.55	365.73	7717.27	718.33	4480.43	61.83	SAFE
11	Sangola	Total	16051.53	11891.79	625.44	12517.23	1266.13	2897.93	77.98	SAFE
	Total		150784.49	113025.66	4936.63	117962.29	8930.95	34158.39	78.23	SAFE

4.6 Ground Water Quality

CGWB monitors the ground water quality of the Solapur 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 44 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 suggested in the manual of American Public Health Association for the Examination of Water and Waste water (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-4**.

Table-4: 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	2	21	13
NO_3 (mg/L)	45	No relaxation	17	-	27
F (mg/L)	1.0	1.5	42	2	0

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

The perusal of Table-4 shows that the concentrations of all the parameters except nitrate in most of the samples are within the maximum permissible limit of the BIS standards. It is also seen from the Table-4 that the potability of ground water in the wells is mainly affected due to the Nitrate (NO_3) as its concentration exceeds more than MPL in 60% of samples. Overall, it can be concluded that the ground water quality in the wells monitored in the district is affected because of high NO_3 concentrations.

Suitability of Ground Water for Irrigation Purpose

The water used for irrigation is an important factor in productivity of crops, their 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-5.

It is observed from the Table-5 that maximum number of samples (66%) falls under the category of high salinity water while nearly 9% 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 should be used for irrigation with proper soil and crop management practices.

Table-5: Classification of Ground Water for Irrigation based on EC.

Type	**EC (µS/cm)**	**No. of Samples**	**% of Samples**
Low Salinity Water	<250	Nil	Nil
Medium Salinity Water	250-750	4	9
High Salinity Water	750-2250	29	66
Very High Salinity Water	>2250	11	25
Total		**44**	**100**

5.0 Status of Ground Water Development

The prominent hill ranges, isolated hillocks, undulation etc. in the district give rise to higher run off conditions. The predominance of hard rock formation in the form of basaltic lava flows facilitates the run off rather than natural recharge due to the poor ground water storage and transmission capabilities. The rainfall in the district is 524 to 707 mm with average

rainy days of 40 which flows out as surface runoff and the heavy rainfall leads to flash flood. As such ground water development in the region is low to moderate. Most of the dug wells become dry during peak summer. The bore wells range in depth from 45 to 90 m bgl and have been drilled in most of the difficult village.

The district has a stage of ground water development of 78.23 %. All talukas are in safe category where as Malshira is Over Exploited. Out of 64 watersheds, 51 watersheds fall in Safe category as per the ground water resource assessment (2009) thus there is scope for further ground water development at feasible locations so as to bring more cultivable land under irrigation. The prime objective should be to achieve the development in scientific manner and multi-sectoral approach by adopting latest ground water management techniques. However even today in many part of the district where the water level is deep during post monsoon season and the long term trend is also showing declining trend, the ground water augmentation measures should be immediately taken up by artificial recharge methods.

The major part of the area constitutes hilly and rugged terrain where ground water conditions are highly localized, any further ground water development to meet drinking water requirement can be implemented on village to village basis. There exists scope for tapping the deep aquifer through bore well in the depth range of 45-100 m bgl for drinking water supply. Dug wells may be constructed down to the depth of 15 m, so as to tap the weathered, vesicular/ fractured and jointed basalt, normally available down the depth of 15 m bgl. The diameter of the well can be 3.5 to 6.5 m, so that the storage in the well can also be made use of in addition to the ground water seeping in. Dry dug wells existing in the trap area are shallow and these can be revitalized by converting them to dug-cum-bore wells.

5.1 Rural Water Supply

Under rural water supply schemes all the 1134 villages and 3263 wadis are covered and all the villages and wadis are having bore wells. Out of 17439 successful bore wells 15914 are fitted with hand pumps and 938 are provided with electric motors.

6.0 Water Conservation Practices

The entire area of Solapur district is occupied by hard rocks of Deccan basaltic group and receives rainfall varying from 524 to 707 mm/year. The availability of surface water is limited to monsoon period. The state government has taken small schemes of water conservation in the district to conserve monsoon water and run off generated thereof.

Total 278 percolation tanks have been constructed in the district with storage capacity of 82.9 MCM with irrigation potential of 4256 ha. Kolhapur types (KT Weirs) are constructed at 93 locations in the district having storage capacity of 246.68 MCM with irrigation potential of 78843.5 ha. Apart from this there are 40 village tanks constructed in the district, which have 59.91 MCM of gross storage.

Ground Water Surveys and Development agency (GSDA) Government of Maharashtra has under taken ground water conservation effort by adopting unconventional techniques in the district. Fracture Seal Cementation (FSC), 23 jacket well, 223 hydro fracturing and 1 bore blasting technique schemes have been completed till the end of 2001 in 154 villages of the district.

The work of soil, land and water conservation in the state is done by the department like Agriculture and Soil etc. The State Agriculture department has constructed 2495-brush wood dams, 26896 loose boulder structures, 38136 Earthen structures, 329 Gabian structures, 7223 Farm ponds, 22884 Earthen nala bandh, 1173 Cement nala bandhs, 462 Under ground bandharas, and 197 Gulley plugging. Apart from this 99.78 km of continuous contour trenching and 50.24 km of line trenching has also been done.

7.0 Mass Awareness and Training Programme

7.1 MAP and WMTP

Till March 2009 one Mas Awareness Programme has been organized at Pandharpur on 29/03/2011 which was attended by 300 participants

7.2 Area Notified by CGWA/SGWA

Though Malshiras Taluka has been categorized as Over Exploited, it has not been notified by either CGWB/SGWA till March 2011.

7.0 Recommendations

To develop the available ground water resources in Solapur district, the necessary care should be taken so that the agriculture, which is the main activity for lively hood in the area, is boosted up. Solapur district, from recommendation point of view for ground water development and augmentation, is divided into three categories. These are hill ranges, Deccan pedeplain and urban area.

- Hilly areas and foot hills are suitable for soil and water conservation activities such as continuous contour trenching (CCT), Nala bunds, Gabion structure, Vegetative bunds, Loose boulder bunds, Terracing etc. The construction of medium and minor irrigation project at foot hills are also feasible with lined or pipe canal system.
- Ground water development in the district is to be done very judiciously in Deccan peneplains. With declining water level trends particularly in post monsoon season, future ground water development should be taken very carefully particularly in scarcity villages/ areas. This area requires ground water augmentation by constructing percolation tanks, cement plugs and K.T.Weirs, at appropriate and need based locations on scientific lines.
- The area showing rising water level trend and having shallow water level ranging <3m and 3 to 6 mbgl during pre monsoon needs ground water development at favorable locations.
- It has been estimated that Net annual ground water availability is 1507.84 MCM. Malshira Taluk has be categorized as Over Exploited and rest of the talukas are in Safe Category. The stage of ground water development is 78.23 % and out of 64 watersheds, 51 watersheds fall in Safe category, 6 in Semi-Critical and remaining 7 in Over-exploited category. Thus 51 watersheds are safe for ground water development. However while developing ground water or making new structure for ground water abstraction, the dual strategy for ground water development and augmentation is required that would be beneficial for future ground water management. Whereas, in Semi critical and Over exploited watersheds intensive site specific artificial recharge measures coupled with public awareness at every level is the need of the hour
- In the City/Urban areas, the roof top rainwater harvesting for artificial recharge should be made mandatory. So that the available resources for drinking water supply should remain sustainable.
- The issue related with ground water development, augmentation and management indicates that there is need of scientific and multi-sectoral approach for making the future plan. However all the aspect related to conjunctive use, ground water legislation, involvement of NGO'S, women and community participation, mass awareness, adoption of advanced irrigation system etc will play an important role in conserving and developing the precious water resources.
- Ground water quality is adversely affected by nitrate contamination in 60% of the samples. Hence all the used for water supply should be checked for nitrate content and if the nitrate content is found beyond permissible limits for drinking water purposes, adequate sanitary protection may be provided to well to control it.