GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

GROUNDWATER INFORMATION
NAGAUR DISTRICT
RAJASTHAN

Western Region

Jaipur

2013

DISTRICT AT A GLANCE – NAGAUR DISTRICT, RAJASTHAN

S No	ITEM	INFORMATION	
1	**GENERAL INFORMATION**		
	(i) Geographical area (sq km)	17718	
	(ii) Administrative Division (As on 2011)		
	Number of Tehsils	13	
	Number of Blocks	11	
	Number of Villages	1620	
	(iii) Population (As per 2011 Census)	3307743	
	(iv) Average Annual Rainfall (1971-2005)	410 mm	
2	**GEOMORPHOLOGY**		
	Major Physiographic Units	Sand Dunes, Alluvial plains, Ridges and Hillocks.	
	Major Drainage	Luni River	
3	**LAND USE (Hectare) (2010-11)**		
	(a) Forest Area	18563	
	(b) Net Sown Area	1329398	
	(c) Cultivable Area	85616	
4	**MAJOR SOIL TYPE**	Red desertic soils, Desert soils, Sand dunes, Lithosol and regosols of hills, Saline soils	
5	**AREA UNDER PRINCIPAL CROPS (2010-11)**	**Crops**	**Area in ha**
		Bajra	517838
		Jowar	44560
		Wheat	77362
		Barley	16898
		Pulses (Kharif)	528700
		Condiments & spices	64615
		Gram (Rabi)	56970
		G. Nut	13290
		Mustard	52924
		Sesamum	23223
		Tarameera	309889
		Guar	73708
		Cotton	20479

S No	ITEM	INFORMATION	
6	**IRRIGATION BY DIFFERENT SOURCES** (2010-11)		
	Source	No. of structures	Gross Irrigated Area in hectare
	Tube wells/Bore wells	16742	234189
	Open wells	47187	93886
	Tanks/Ponds	7	0
	Canals	-	0
	Other Sources	-	13
	Net Irrigated Area (ha)	246033	
	Gross Irrigated Area (ha)	328088	
7	**NUMBER OF GROUND WATER MONITORING WELLS OF CGWB**(As on May 2011)		
	Number of Dug wells	61	
	Number of Piezometers	28	
8	**PREDOMINANT GEOLOGICAL FORMATIONS**	Aeolian sand, Alluvium, Nagaur Sandstone, Bilara Limestone and Jodhpur Sandstone of Marwar Super Group, Erinpura granite & rocks of Delhi Super group.	
9	**HYDROGEOLOGY**		
	Major Water bearing formation	Quaternary Alluvium, Nagaur Sandstone, Bilara Limestone and Jodhpur Sandstone, Granite, Schist and Phyllites.	
	Depth to water level (Pre-monsoon, 2011) (mbgl)	5.00 – 68.46	
	Depth to water level (Post-monsoon, 2011) (mbgl)	4.97 – 68.06	
10	**GROUNDWATER EXPLORATION BY CGWB** (As on 31.3.2012)		
	Number of wells drilled (EW, OW, PZ, SH)	EW – 53, OW - 19, SH – 23 & PZ- 10	
	Depth Range (m)	40 – 300	
	Discharge (liter per second)	1 – 15	
	Storativity	-	
	Transmissivity (m^2/day)	50-565	
11	**GROUND WATER QUALITY**		

S No	ITEM	INFORMATION
	Presence of chemical constituents more than permissible limit (EC>1500 m mhos/ cm at 25^0 C, F>1.5 mg/l, NO_3> 45mg/l)	EC – 4500 sq km F – 6500 sq km NO_3 – 3000 sq km
12	**DYNAMIC GROUND WATER RESOURCES (March, 2009) in mcm**	
	Annual Ground Water Availability	544.7959
	Annual Ground Water Draft (Irrigation + Domestic)	969.3294
	Stage of Ground Water Development	177.93%
13	**AWARENESS AND TRAINING ACTIVITY** A. Mass Awareness Program B. Water Management Training Program:	A. Mundwa B. Nagaur
14	**GROUND WATER CONTROL AND REGULATION**	
	Number of Over-exploited blocks(31.03.2009)	09
	Number of Critical Blocks (31.03.2009)	01
	No of Blocks Notified (March,2013)	03
15	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	1. Water level decline. 2. Quality Problem. 3. Less recharge due to less & uneven rainfall.

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NAGAUR DISTRICT

1.0 Introduction

Nagaur district is located almost in the middle of the state of Rajasthan and extends between North latitudes 26°25' and 27°40" and East longitudes 73°10" and 75°15". It covers an area of 17778 sq. km. out of which 17448.5 sq. km is rural area and 269.5 sq. km is urban. The Nagaur district is bounded on the north by Bikaner and Churu districts, on the east by Sikar and Jaipur districts, on the south by Ajmer, and Pali districts and on the west by Jodhpur districts. Nagaur district covers only 5.18 percents of the total area of the state. There are 13 tehsil headquarters in the district viz. Nagaur, Khinwsar, Jayal, Degana, Didwana, Ladnun, Parbatsar, Makarana, Nawa, Kuchaman, Riyanbadi and Mundwa. The district is divided into 11 blocks (Panchayat Samitis) viz. Nagaur, Mundwa, Jayal, Merta, Riyan, Degana, Didwana, Ladnun, Parbatsar, Makarana and Kuchaman. A map showing the blocks of the district is presented in Figure – 1.

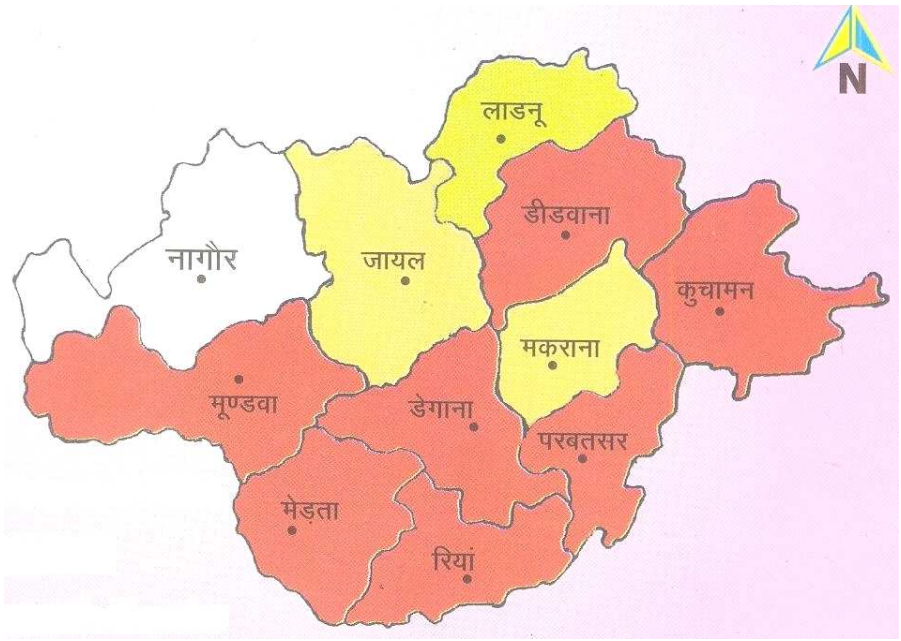

Figure 1: Administrative Divisions

Total Population (Census 2011) of the district is 3307743 including urban population of 637204 and rural population of 2670539.

Systematic Hydrogeological survey in the district was initially carried out by GSI during 1964-65. Various studies including Systematic and Reappraisal Hydrogeological Surveys have been carried out in the district from time to time by Central Ground Water Board. List of studies carried out by CGWB is given in Table 1.

Table 1: Scientific studies undertaken by Central Ground Water Board

S. No.	Officer/ Project	AAP	Type of Study
1.	UNDP Project Phase II	1971-74	Ground Water Surveys in Rajasthan and Gujarat
2.	Virendra Sharma	1975-76	Systematic Hydrogeological Survey
3.	Suresh Kumar	1983-84	Reappraisal Hydrogeological Survey in Ladnun, Didwana and Parbatsar blocks of Nagaur district.
4.	G.S. Mittal	1983-84	Reappraisal Hydrogeological Survey in parts of Bikaner basin (Part of Nagaur district.
5.	S.K. Gupta	1985-86	Reappraisal Hydrogeological Survey in part of Nagaur district (Merta and Degana Tehsil) Rajasthan (1985-86)
6.	S.K. Gupta	1988-89	Reappraisal hydrogeological survey in Parbatsar, Makrana and Kuchaman blocks of Nagaur district.
7.	Dr. Ratesh Kumar	1997-98	Reappraisal Hydrogeological Survey in parts of Sikar basin, Nagaur district.

Apart from these, Ground Water Management Study was carried out during 2002-03. District report was compiled by V.V. Rane and M.K.M. Rao in the year 1981.Revised District report was compiled by Bharat Bhushan in 1988. Ground Water Exploration was first carried out by Geological Survey of India in 1961. Central Ground Water Board, since it's inception has drilled 53 exploratory wells, 04 observation holes, 23 slim holes and 10 piezometers under Ground Water Exploration Programme. Since 1973, monitoring of water level is being carried out four times a year.

2.0 Climate & Rainfall

The district experiences arid to semi-arid type of climate. Mean annual rainfall (1971-2005) of the district is 410 mm whereas normal rainfall (1901-1970) is lower than average rainfall and placed at 363.1 mm. It is obvious that there is significant increase in rainfall during the last 30 years. The rainy days are limited to maximum 15 in a year. Almost 80% of the total annual rainfall is received during the southwest monsoon. The probability of occurrence of mean annual rainfall is 38%. Based on agriculture criteria, the district is prone to mild and normal type of droughts. Occurrence of severe and very severe type of drought is very rare. There is not much variation in aerial distribution of rainfall. However, the southern part of the district gets slightly more rainfall than northern part. The monsoon enters the district in the first week of July and withdraws by the middle of September. As the district lies in the desert area, extremes of heat in summer and cold in winter are the characteristics of the desert. Both day and night temperatures increase gradually and reach their maximum values in May and June respectively. The temperature varies from 46 degree in summer to 7 degree in winter. The winter season starts by middle of November and lasts till February. January is the coldest month with both

mean maximum and minimum temperatures being lowest at 22.5° and 6.7° respectively. The minimum temperature sometimes drops down to below the freezing point of water and frost occurs. The diurnal variation in temperature during winter is as high as 16°C. Both maximum and minimum temperatures begin to rise rapidly from February onwards, reaching their respective maximum in late May or early June. The mean daily maximum temperature in May is 40.4°C and the mean daily minimum temperature is 25.7°C. Night temperatures in June are much higher than in May with mean daily minimum temperature of 27.9°C. Atmosphere is generally dry except during the monsoon period. Humidity is the highest in August with mean daily relative humidity at 80%. The annual maximum potential evapotranspiration in the district is quite high and it is the highest (255.1 mm) in the month of May and the lowest (76.5 mm) in the month of December.

3.0 Geomorphology & Soil Type

The general topography of the area is fairly even. Slope of the area is fairly even. Slope of the land surface is towards west and elevation varies from 250 meter above msl in south to 640 m above msl in north. South-eastern part of the district comprises small scattered hillocks. The northern, north-western and north-eastern parts of the district are covered by sand dunes. The offshoots of Aravalli range are projected along the common boundary of Ajmer district and Merta, Nawa and Parbatsar tehsils of Nagaur district.

There is no river originating in the district. However, the river Luni which rises near Pushkar in Ajmer district, draining western slopes of the Aravalli, crosses the district in the southern part flowing for about 37 km in western direction. It is an ephemeral river and carries runoff that is generated in the upper reaches. Channel deposits of Luni facilitate percolation during rainstorm, thereby feeding the neighboring wells along its bank. Other nalas and streams are also ephemeral in nature which originate and die out in the district itself.

3.1 Soil Characteristics

Four types of soils have been reported in the district viz, clay, clay loam, sandy loam and sandy soil. The general texture of the soil in the area is sandy loam to clayey loam which is further classified into “Barani” or un-irrigated and “Chahi” or irrigated soil. A part of Nagaur tehsil and south-eastern part of Merta tehsil have deep sandy loam, while red loamy soil exists elsewhere in Merta tehsil except on the banks of river Luni. Light loamy soil occurs in Parbatsar tehsil away from hill ranges. A longitudinal belt from Didwana to Nawa extending up to Sambhar Lake has the characteristics of alkaline soil. Distribution of different types of soils is shown in table 2.

Table 2: Soil Types in Nagaur district

S. No.	Soil type	Area (hectare)	Block
1	Clay	22,840	Nagaur, Jayal, Merta, Riyan, Parbatsar
2	Clay loam	1,34,450	Nagaur, Kuchaman, Jayal, Riyan, Merta, Degana, Makarana, Ladnun, Parbatsar, Mundwa, Didwana.
3	Sandy loam	4,72,905	Makarana, Ladnun, Parbatsar, Mundwa, Didwana, Nagaur, Kuchaman, Jayal, Riyan,

			Merta, Degana.
4	Sandy	5,65,705	Nagaur, Khuchaman, Jayal, Riyan, Merta, Degana, Makarana, Ladnun, Parbatsar, Didwana.

4.0 Ground Water Scenario

4.1 Geological Framework

The geological set up of the district is presented by different sedimentary, igneous and metamorphic rocks belonging to Bhilwara Super Group, Delhi Super Group, Marwar Super Group, Palana Formation and Quaternary alluvium. A few outcrops of gneisses belonging to the Mangalwar Complex of the Bhilwara Supergroup are exposed north-east of Nawa. The Delhi Super Group includes Alwar, Ajabgarh/ Kumbhalgarh and Punagarh Group in descending order of antiquity. The rocks of Alwar Group are well exposed in the eastern part of the district and comprise of arkose, grit, conglomerate and schist. The overlying Ajabgarh/ Kumbhalgarh Group of rocks are exposed between Kerkeri and Bijathal. The Ajabgarh Group mainly consists of Quartzite with schist and marble. Kumbhalgarh comprises mica schist and marble. The overlying Punagarh Group of rocks (quartzite, slate phyllite, marble etc.) occur as isolated outcrops. The rocks of Bhilwara Super Group and Delhi Super Group are structurally isoclinal and recline fold which are exposed along south eastern margin (trend NE-SW) of the district adjacent to Ajmer district.

The rocks of Delhi Super Group have been intruded by Erinpura granite and Malani igneous suite. All these rocks are overlain by marine sedimentary sequence of the Marwar Super Group which is subdivided into Jodhpur, Bilara and Nagaur group representing arenaceous, calcareous and areno-argillaceous facies respectively. These rocks are overlain by sandstone and bentonite of the Palana formation. The Marwar Super Group of rocks have horizontal to gently inclined disposition of different beds, which are displaced by different faults. Palana and other Tertiary formations are showing same altitude.

4.2 Hydrogeology

Hydrogeologically the whole district can be classified into three formations viz. consolidated formation, semi-consolidated formation and unconsolidated formation.

4.2.1 Consolidated Formations

The consolidated formations comprise of metamorphics like schists, gneisses, quartzites and phyllites of Precambrian age and limestone & sandstone of Marwar Super Group. Metamorphics are normally impervious except in the presence of a few weak planes, joints, weathered zones and kinks which contain moderate and limited quantity of ground water. These are basically phreatic aquifers and availability of ground water depends on good amount of precipitation. Such aquifers are mainly confined to eastern part of Riyan and Parbatsar blocks, central part of Makarana block, eastern part of Ladnun block and northern part of Didwana block.

Jodhpur sandstone mainly consists of medium to coarse grained sand, cemented with silica and ferruginous matrix. The sandstone is intercalated with siltstone and shale. The sandstone is hard, compact and forms medium aquifer. Wherever, ground water occurs, it mainly occupies either void space between the adjacent grains (primary porosity) and in the secondary porosity zones. Jodhpur sandstone

mainly occurs in southwestern part of Mundwa block and central part of Ladnun block. Ground water in this formation occurs under semi-confined to unconfined condition. Thickness of sandstone varies from 100-250m.

Bilara limestone forms the most important and potential aquifer comprising limestone, dolomite and shale. The limestone is white to grey in colour, hard and compact, cherty and dolomitic in nature. However, it is cavernous at places and susceptible to solution activity which gives rise to high discharge in wells. This formation covers western and north-central parts of Nagaur block, central part of Mundwa block, west central & eastern parts of Jayal block and part of Ladnun block. Thickness of limestone varies from 100- 300 m.

Nagaur sandstone is coarse to fine grained, loosely cemented with gravel at basal part which acts as good aquifer and occupies mainly parts of Nagaur, Jayal, Mundwa and Merta blocks. The associated rocks are siltstone and shale. Its thickness varies from 140-240 m.

4.2.2 Semi-consolidated Formation

These include only Palana sandstone consisting of very coarse grained, gravelly sand with intercalations of clay with kankar and lignite. Ground water occurs under phreatic to confined condition and saturated thickness of 40 m constitutes a potential aquifer. This mainly occurs in parts of Merta, Mundwa and Jayal blocks. Its thickness varies from 100-250 m.

4.2.3 Unconsolidated Formation

Quaternary alluvium is the main aquifer which is comprised of unconsolidated to loosely consolidated fine to coarse grained sand having intercalations and intermixing with silt, clay with `kankar`. Ground water occurs under unconfined to semi-confined conditions, Quaternary alluvium covers parts of Riyan, Merta, Degana, Parbatsar, Makarana, Kuchaman, Didwana, Ladnun and Jayal blocks. Its thickness is limited to 200 m.

A map depicting hydrogeological features is presented as Figure-2.

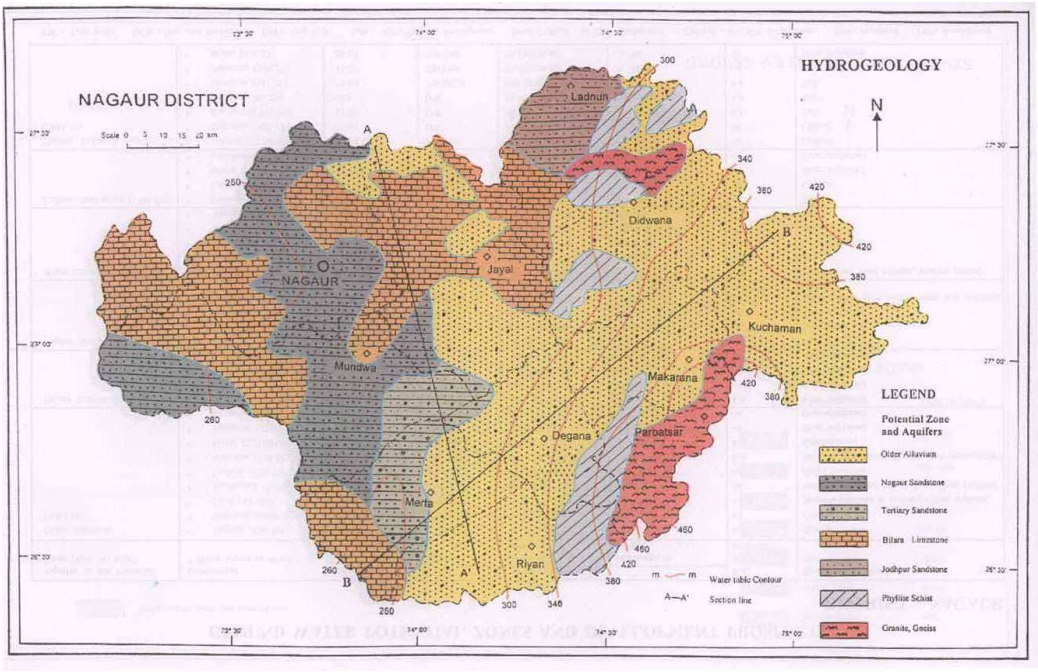

Figure 2- Hydrogeology

4.2.4 Aquifer Parameters

The aquifer parameters of dug wells and tube wells have been studied from pumping tests. The yield of tube wells\ dug wells in metamorphic rocks like schists, gneisses, quartzites, phyllites and gneisses ranges from 5-20 m³\hr. The tube wells in Jodhpur sandstone give discharge in range of 12 to 32 m³\hr. Discharge\yield of tube wells in Bilara limestone varies from 5 to 40 m³\hr and that of Nagaur sandstone varies from 6.5 m³\hr to 36 m³\hr. The discharge of tube wells in Palana sandstone ranges from 5.0 m³\hr to 30 m³\hr and that of tube wells\dug wells in Quaternary alluvium varies from 12 m³\hr to 32 m³\hr. The deeper aquifers are being exploited extensively through low to medium duty tube wells.

4.3 Water Level Scenario

Central Ground Water Board periodically monitors ground water levels four times in a year during the months of January, May (Pre-monsoon), August and November (Post-monsoon). In Nagaur district water levels are monitored through a network of 89 observation wells (National Hydrograph Network Stations).

4.3.1 Depth to Water Level (2011)

Depth to water level in the district varied from 5.00 to 68.46 mbgl and 4.97 to 68.06 mbgl during Pre-monsoon (May, 2011) and Post- monsoon (November, 2011) periods respectively. Block-wise depth to water levels during Pre-monsoon and Post-monsoon and water level fluctuation between the two seasons are given in Table 3.

Table 3: Block wise details of depth to water level during May, 2011 and November, 2011 and water level fluctuation during May – November, 2011

Block	Pre-monsoon water level in m bgl		Post-monsoon water level in m bgl		Water level fluctuation in m (Pre– Post)			
					Rise		Fall	
	Min	Max	Min	Max	Min	Max	Min	Max
Degana	5.00	36.74	5.34	45.22	0.90	1.05	-	-
Didwana	5.37	30.47	4.97	28.67	0.40	9.70	0.00	0.30
Jayal	37.06	51.43	37.36	51.53	-	-	0.10	0.30
Kuchaman	22.12	-	21.19	-	0.93	-	-	-
Ladnun	19.87	-	25.62	28.47	-	-	8.60	-
Merta	-	-	-	-	-	-	-	-
Mundwa	53.68	-	53.88	54.81	-	-	0.20	-
Nagaur	32.30	68.46	32.30	68.06	0.00	0.40	0.30	-
Parbatsar	-	-	-	-	-	-	-	-
Riyan	-	53.00	12.99	50.66	2.34	-	-	-
District	**5.00**	**68.46**	**4.97**	**68.06**	**0.00**	**9.70**	**0.00**	**0.30**

Depth to water level maps for Pre-monsoon 2011, Post Monsoon 2011 and Seasonal water level fluctuation (Pre & Post monsoon, 2011) of district have been presented in figure 3, 4 & 5 respectively.

During Pre-monsoon, the water levels in major part of the district varied in depth from 20 to 40 m. Deeper water levels (> 40 m) were observed in northwestern, northeastern, western, southwestern and central parts of the district (Fig. 3). Shallow water levels (5 to 20 m) were observed in localized pockets in the northern part of the district.

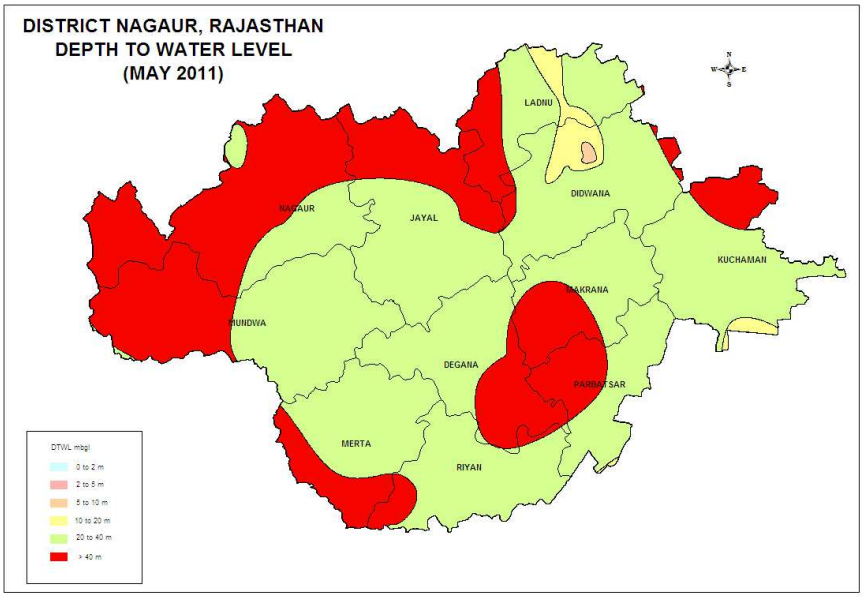

Figure 3: Depth to Water Level - Pre-monsoon 2011 (May, 2011)

During Post-monsoon season again, water levels in major part of the district varied from 20 to 40 m and deeper water levels (>40 m) were observed in northwestern, western, southwestern and northeastern parts and localized pockets in central part of the district. Water levels in the range of 5 to 20 m were observed in the southeastern part of the district.

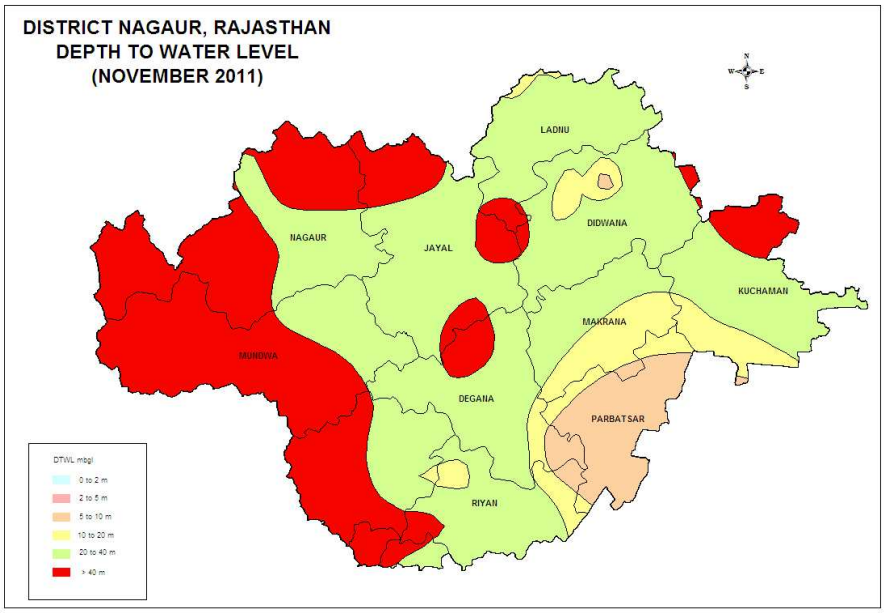

Figure 4: Depth to Water Level - Post-monsoon 2011 (November, 2011)

4.3.2 Seasonal water level fluctuation (May,2011 – November, 2011)

Seasonal water level fluctuation map (Fig. 5) during Pre and Post-monsoon season indicates rise in ground water levels in all the blocks except, parts of Mundwa, Nagaur, Jayal and Ladnun blocks. Major part of the district has registered rise in the range of 0-2 m. Decline of >4m has been observed in parts of Ladnun and Didwana blocks.

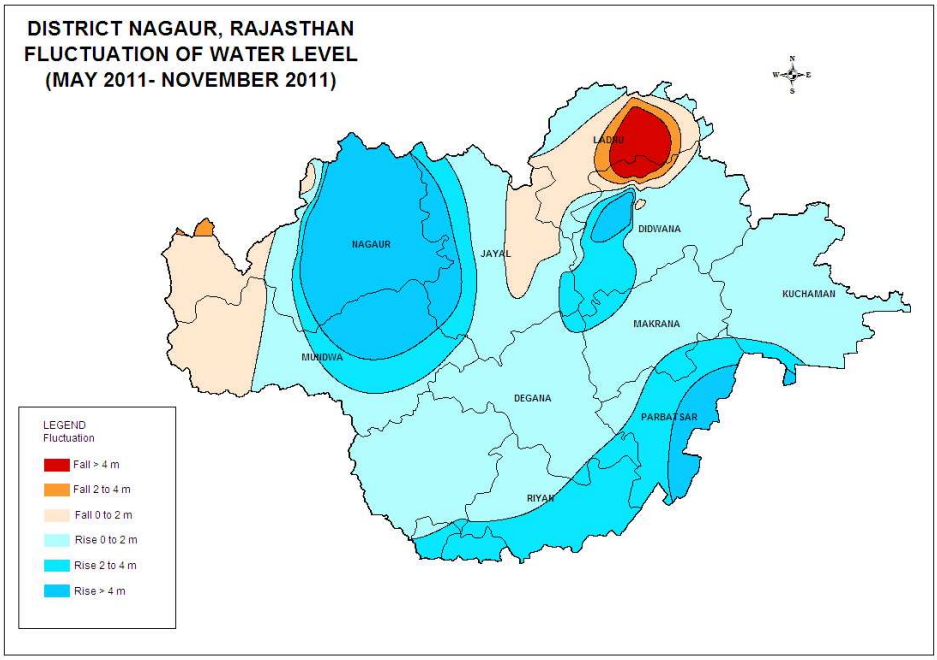

Figure 5: Seasonal water level fluctuation (Pre & Post-monsoon, 2011)

4.3.3 Water Level Trend (2002 – 2011)

Decadal Water Level Trend for Pre monsoon, 2002–2011 and Post monsoon, 2002 - 2011 have been presented in figure 6 & 7 respectively. During Pre-monsoon period in the long term, declining trend of ground water levels in the range of 0 to 0.25 m/year has been observed in major part of the district except parts of Mundwa, Merta, Didwana, Parbatsar blocks where rising trend in the range of 0 to 0.5 m/year in ground water levels has been noticed.

During Post-monsoon period in the long term, major part of the district has registered declining trend in the range of 0 to 0.25 m/ year while the remaining part of the district has registered rising trend in water levels in the range of 0 to 0.25 m/ year.

Increased ground water draft to meet the increased demand of agriculture and domestic sector is the main cause for declining trend of ground water levels.

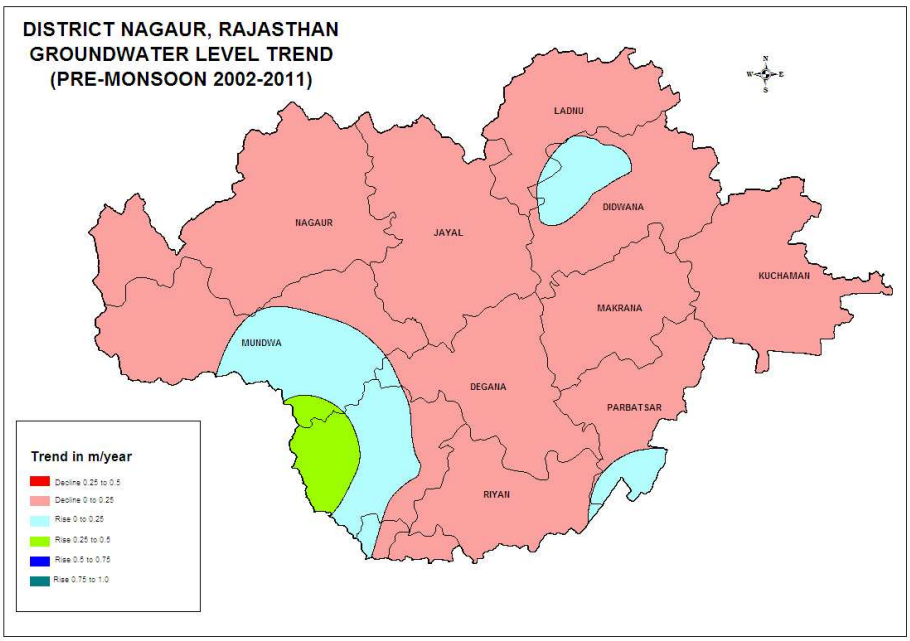

Figure 6: Water Level Trend (Pre-monsoon, 2002 - 2011)

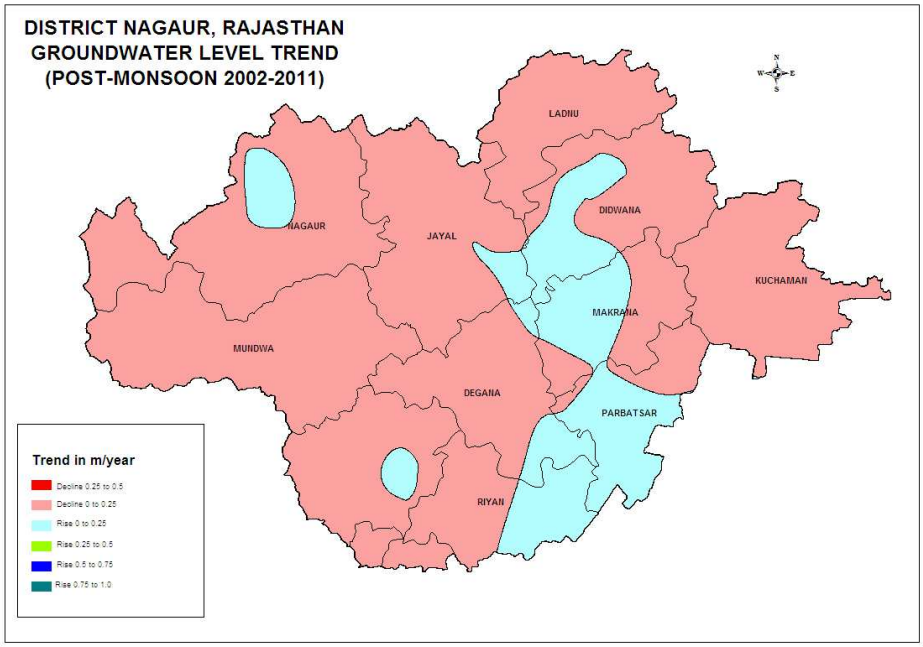

Figure 7: Water Level Trend (Post-monsoon, 2002 - 2011)

4.4 Ground Water Resources

Central Ground Water Board and Ground Water Department, Government of Rajasthan have jointly estimated the ground water resources of Nagaur district based on GEC-97 methodology. The same are presented in Table 4 below. Ground Water Resources estimation was carried out for 17718.25 sq. km. area out of which nil sq. km. is under command, 16378.50 sq. km. area is non-command. Ground Water Resources estimation was also carried out for 1339.75 sq. km. of saline area.

Table 4: Estimates of fresh ground water resources in Nagaur district (As on 2009)

Block	Type of area	Total annual replenishable resource (mcm)	Net annual ground water availability (mcm)	Annual ground water withdrawal for irrigation (mcm)	Annual groundwater withdrawal for domestic and other uses (mcm)	Annual ground water withdrawal for all uses (mcm)	Stage of ground water develop-ment (%)	Category
Degana (Excluding Saline)	NC	42.7205	38.4485	46.7125	14.9088	61.6213	160.27	OVER EXPLO.
Didwana (Excl. Saline)	NC	63.2149	56.8934	74.0685	18.1200	92.1885	162.04	OVER EXPLO.
Jayal (Excl. Saline)	NC	59.3985	53.4587	37.4225	19.9040	57.3265	107.24	OVER EXPLO.
Kuchaman (Excl. Saline)	NC	72.3797	65.9525	160.0143	16.2400	176.2543	267.24	OVER EXPLO.
Ladnun (Excl. Saline)	NC	42.8697	38.5827	23.6406	11.8307	35.4714	91.94	CRITICAL
Makrana (Excl. Saline)	NC	49.2807	44.3526	32.2364	14.9456	47.1820	106.38	OVER EXPLO.
Merta (Excl. Saline)	NC	50.7527	45.6774	120.8390	13.4400	134.2790	293.97	OVER EXPLO.
Mundwa (Excl. Saline)	NC	70.8171	63.7354	170.5655	29.9520	200.5175	314.61	OVER EXPLO.
Nagaur (Excl. Saline)	NC	55.8985	50.5966	24.7045	17.0560	41.7605	82.54	SEMICRITICAL
Parbatsar (Excl. Saline)	NC	38.4671	34.6204	42.0653	7.9083	49.9736	144.35	OVER EXPLO.
Riyan (Excl. Saline)	NC	58.3085	52.4776	61.4845	11.2704	72.7549	138.64	OVER EXPLO.
TOTAL OF DISTRICT (Excluding Saline)	NC	604.1080	544.7959	793.7536	175.5758	969.3294	177.93	
TOTAL OF SALINE		54.9100	49.4189	8.3073	4.9440	13.2513	26.81	

Stage of ground water development in the district as on 31.3.2009 is 177.93%, which indicates that the scope of ground water development is already exhausted. Nine blocks viz. Degana, Didwana, Jayal, Kuchaman, Makarana, Merta, Mundwa, Parbatsar and Riyan have been categorized as “Over-exploited”. Ladnun block has been categorized as “Critical” and Nagaur block as “Semi-critical. Stage of ground water development is even more than 300% in Mundwa block, above 250% in Kuchaman and Merta blocks, above 150% in Degana and Didwana blocks, above 125% in Riyan and Parbatsar blocks and above 100% in Makarana and Jayal blocks.

4.5 Ground Water Quality

A perusal of analytical results of water samples collected during May 2011 indicates that the quality of ground water in phreatic aquifer varies widely from saline to fresh (Fig. 8). Electrical Conductivity (EC) ranges between 1380 to 16240 µS/ cm at 25°C. It has been observed that by and large, EC conforms broadly with chloride concentration. In greater part of the area, it is within 5000 µS/cm at 25°C. Higher values of EC have been observed in the west central part of the district and also in depressions in the vicinity of the saline lakes. The chloride content ranges from 50 to 5069 ppm in phreatic aquifer.

Fluoride in the ground water ranges between traces and 11.20 mg/l (Fig. 9). Fluoride concentration in excess of maximum permissible limit of 1.5 mg/liter has been noticed in central and northeastern parts of the district.

Nitrate concentration in ground water varies widely. Its concentration ranges between traces to as high as 1000 ppm. Different ranges of Nitrate concentration in Nagaur district are depicted in Fig. 10.

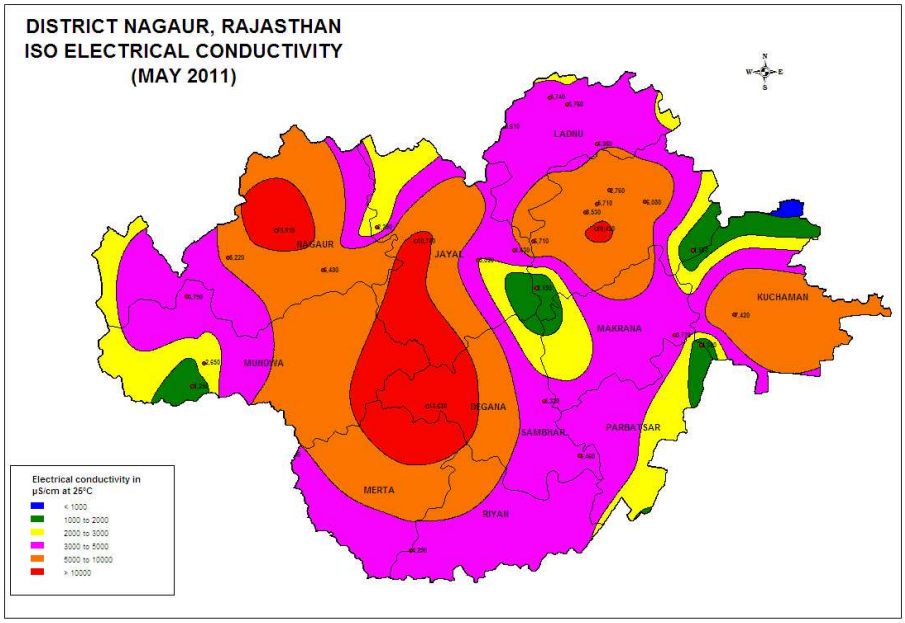

Figure-8: Map showing distribution of Electrical Conductivity in Nagaur District

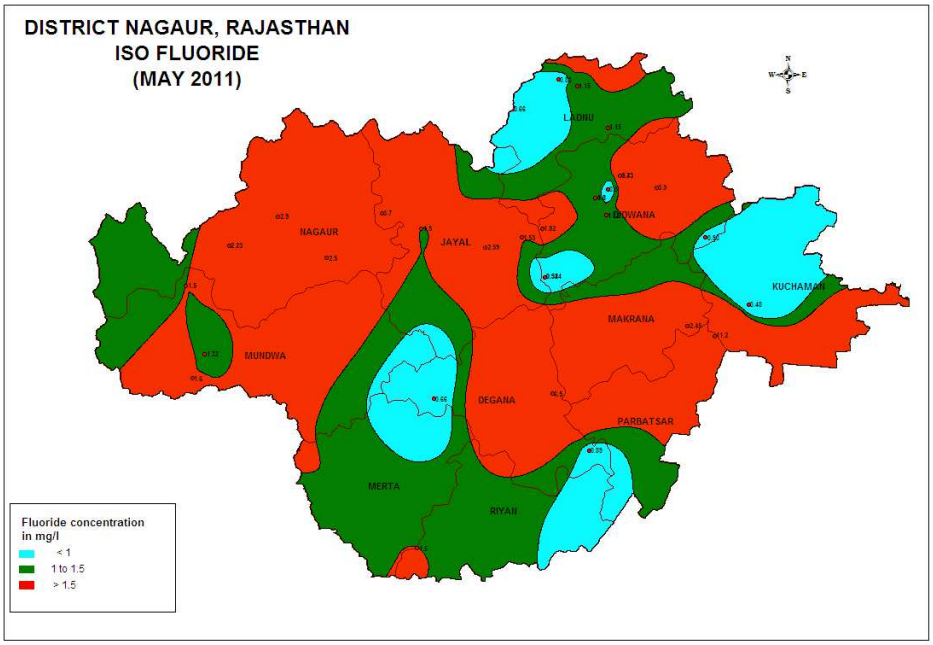

Figure-9: Map showing distribution of Fluoride in Nagaur District

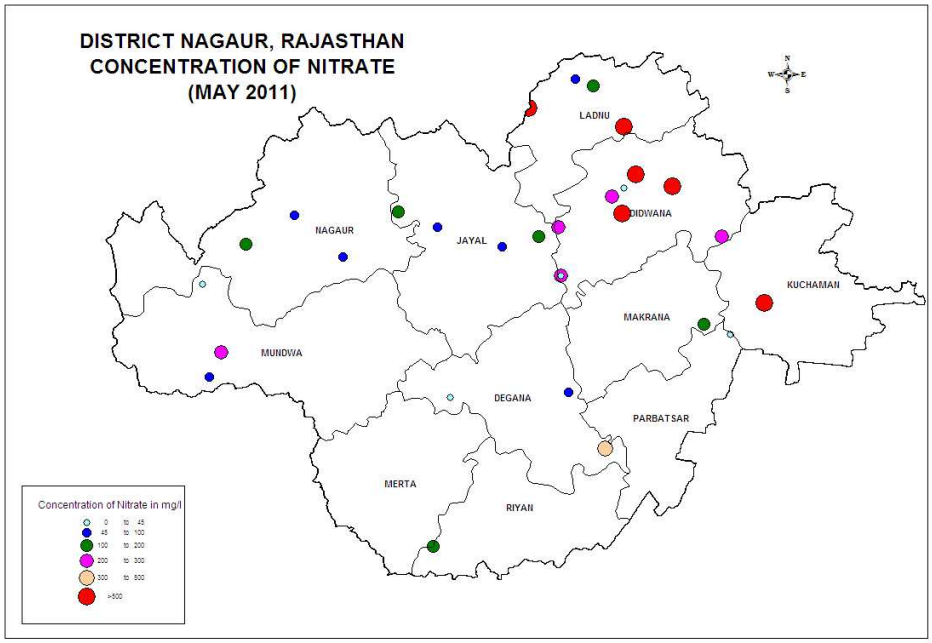

Figure-10: Map showing distribution of Nitrate in Nagaur District

The Iron concentration ranges between nil to 2.21 mg/l in the district. Iron concentration in excess of permissible limit of 1 mg/liter has been noticed in localized pockets in Nagaur, Mundwa and Didwana blocks.

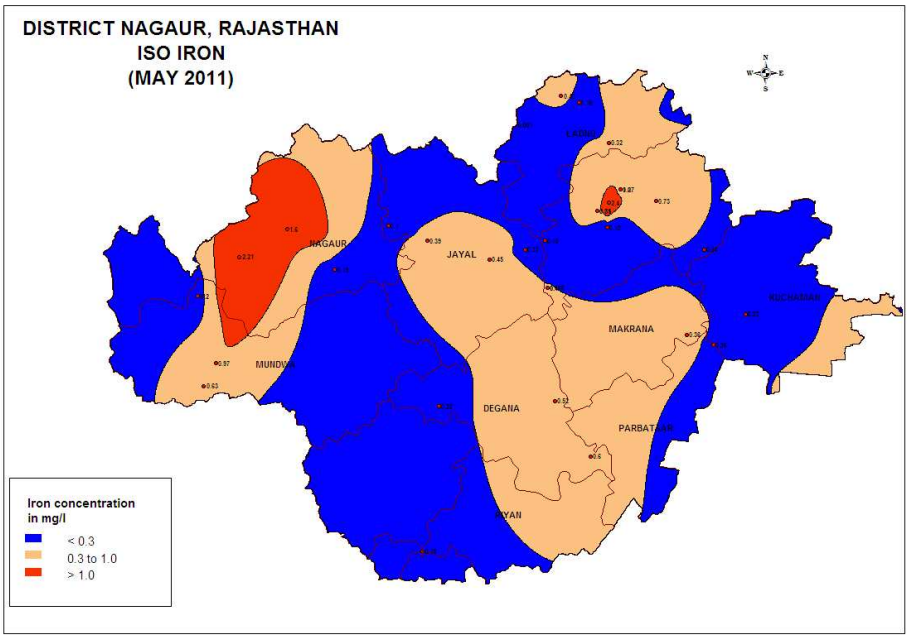

Figure-11: Map showing distribution of Iron in Nagaur District

4.5.1 Ground water quality in deeper aquifers

Ground water quality is brackish to saline from east of Merta to Degana and from Didwana to Nagaur via Jayal block in the central part of the district. In this big pocket covering about 6000 km2 area the E.C. of ground water is more than 5000 µS / cm at 25°C. There are three pockets namely around Nimri in Ladnun block, around Gotan in Merta block and in a longitudinal belt in the eastern part of the district where the E.C. of ground water is within 2000 µS /cm at 25°C.

Ground water in the alluvium is in general better in quality than that found in the sandstones of Nagaur and Palana series. Ground water in Quaternary alluvium has T.D.S. less than 1000 ppm (E.C. less than 2000 micro mhos/ cm) only, whereas in the eastern part, the range of T.D.S is between 1000-3000 ppm. In the wells penetrating Tertiary sediments the T.D.S exceeds 3000 ppm.

The E.C. of ground water in the shallow aquifer of Nagaur and Palana sandstone varies from 900 to 6000 micro mhos/cm at 25°C. However the quality of water deteriorates with depth. In a borehole of 421.20 m depth at Merta City, EC as high as 28496 µS/cm was observed. In tube wells of average depth of around 80 m tapping sandstones, the EC of ground water is around 2000 µS/cm. In tube wells tapping phyllites, schists and gneisses, quality of ground water is very poor.

The fluoride content in ground water of tube wells constructed at Kanwai (Didwana block) and Roru and As Ki Dhani (Ladnun block) was observed to be more than 3 ppm. The production well at Luniawas (Merta block) and Gorera (Nagaur block) also yielded water with more than 3 ppm fluoride.

4.6 Status of Ground Water Exploration

Status of ground water exploration as on 31.03.2012 in Nagaur district is furnished in Table 5.

Table 5: Status of exploratory wells drilled in Nagaur district

Type of borehole	Formation			Total
	Unconsolidated	Semi-consolidated	Consolidated	
EW	16	15	22	53
OW	-	19	-	19
SH	17	4	1	23
PZ	4	6	-	10

A total of 16 exploratory wells, 17 slim holes and 4 piezometers have been drilled in unconsolidated formation. Most of the exploratory wells drilled in alluvium have been drilled in the depth range of 32 to 275 meters with depth of well construction varying from 58 to 80m. Discharge of wells ranges from 220 lpm to 1513 lpm for drawdown up to 15 meters indicating potential of aquifer. Transmissivity value varies from 50 to 156 m^2/day.

A total of 15 exploratory wells, 19 observation wells, 4 slim holes and 6 piezometers have been constructed in semi consolidated formation [Tertiary sandstone (Palana) and Nagaur Sandstone]. Depth of drilling varied from 49 to 443 m and depth of construction of wells varied from 49 to 257 m. Discharge of wells varied from 100 to 550 lpm with draw down varying from 1.14 to 4.05 m. Transmissivity of formation varies from 51 to 528 m^2/day.

A total of 22 exploratory wells and 1 slim hole have been drilled in consolidated formation (Jodhpur sandstone, Bilara limestone of Marwar Super Group, quartzite, schist, limestone of Delhi Super Group and schist and gneisses of Bhilwara Super Group). The depth of bore wells ranges from 80 to 223.30 m. Discharge of wells varies from <50 lpm to 800 lpm.

5.0 Ground Water Related Issues & Problems

Major part of the disctrict is covered by hard rock formations such as Jodhpur sandstone, Nagaur sandstone Bilara Limestone, Delhi Super Group metamorphics and granites. These have poor water yielding capacity except rocks of Marwar Super Group. Also such areas suffer from water quality problem and in some of the areas ground water is highly saline. Villages located in such areas have the basic problem of scarcity of drinking water and the situation becomes very critical in summers and in drought years.

Another problem of concern in the district is that most of the potential zones have witnessed heavy ground water development causing lowering of water table and drying up of large number of shallow wells or reduction in their yields. Heavy decline of more than 15 m has been observed in Mundwa, Merta, Jayal and Kuchaman blocks during last 10 years.

6.0 Ground Water Management Strategy

6.1 Regulation of Ground Water Development

Out of nine Over-exploited blocks, three blocks viz. Mundwa, Merta and Kuchaman have been notified by Central Ground Water Authority vide notifications dated 5.12.2005, 13.08.2011, 27.11.2012 respectively for control and regulation of ground water development in the district. The CGWA has appointed the concerned District Collectors as the authorized officers for implementation of regulatory measures. In notified areas, drilling/ construction of new tube wells is banned without prior permission of the Authority.

6.2 Water Conservation and Artificial Recharge

Precious ground water resources have to be conserved for sustainable availability. Artificial recharge measures need to be implemented on large scale for augmenting ground water resources by roof top rain water harvesting, construction of sub surface barriers, anicuts and other suitable recharge structures at appropriate locations.

7.0 Mass Awareness And Training Activities

Central Ground Water Board regularly organizes mass awareness campaigns to educate the stakeholders regarding conservation of water and need for adoption of rain water harvesting and artificial recharge measures. The Board also conducts training programmes for capacity building of officers from various Central/ State Government Organizations, educational institutions, industries, NGOs etc. So far one mass awareness and one water management-training programme have been organised at Mundwa and Nagaur blocks respectively.

8.0 Recommendations

- Awareness programme to educate about conservation of precious ground water resources and training on rainwater harvesting will be beneficial to check decline in water level and justified use.
- Ground water development in over-exploited, critical and semi-critical areas should not be encouraged.
- Use of water saving devices like sprinklers, drip irrigation, close field distribution channels etc. should be promoted.
- Modern agricultural management techniques have to be adopted for effective and optimum utilization of the available water resources. This can be achieved by maintaining irrigation through minimum pumping hours as per

minimum requirement of water by the crop and also selecting the most suitable cost effective crop pattern.

- High water requiring crops need to be discouraged. Proper agriculture extension services should be provided to the farmers so that they can go for alternate low water requirement economical crops. Changing from higher water intensity to low water intensity cropping pattern & adoption of sprinklers & drip irrigation techniques can minimize heavy exploitation of ground water for irrigation.
- Salt resistant crops can be sown in the area having brackish to saline ground water.
- Areas having EC values more than 3000 micro mhos/ cm should be avoided for drinking water supply. The areas having high fluoride & nitrate should be mixed with piped water supply schemes for drinking purpose from the areas where T.D.S. are within permissible limit.
- Traditional rainwater harvesting structures like ‘Tankas’ for roof top rain water storage should be encouraged for meeting day to day requirements. This will help in reducing ground water withdrawal.
- Large-scale recharge potential exists in depleted aquifers. Artificial recharge in such areas through outside surface water sources like lift canal from IGNP system or floodwater during excess rainy years needs to be promoted.
- Small check dams or earthen dams, at suitable sites, may be constructed to store rainwater. This will increase recharge to ground water which ultimately result in increase of yield of wells.