GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

GROUNDWATER SCENARIO
JODHPUR DISTRICT
RAJASTHAN

Western Region
Jaipur
2013

DISTRICT AT A GLANCE – JODHPUR DISTRICT, RAJASTHAN

S No	Item	Information	
1	GENERAL INFORMATION		
	(i) Geographical area (sq km)	22,850	
	(ii) Administrative Division (As on 31.3.2009)		
	Number of Tehsils	07	
	Number of Blocks	09	
	Number of Villages	1157	
	(iii) Population (As per 2011 Census)	3687165	
	(iv) Average Annual Rainfall (1969-2012)	374 mm	
2	GEOMORPHOLOGY		
	Major Physiographic Units	Sand Dunes, Alluvial plains, Ridges and Hillocks	
	Major Drainage	Luni River & Mithri River	
3	LAND USE (ha) (2010-11) (Source: Dte. of Economics & Statistics, Ministry of Agriculture, GOI		
	(a) Forest Area	6996	
	(b) Net Sown Area	1371703	
	(c) Total Cropped Area	1580126	
4	MAJOR SOIL TYPE	Red desertic soils, Desert soils, Sand dunes, Lithosols & Regosols of hills, Saline soils and Sierozems.	
5	AREA UNDER PRINCIPAL CROPS (AS ON 2010-11) (Source: Dte. of Economics & Statistics, Ministry of Agriculture, GOI)	Crops	Area in hactare.
		Bajra	635173
		Wheat	59285
		Jowar	57240
		Pulses	296352
		Onion	17236
		Ground nut	49084
		Castor	25682
		Sesamum	29577
		Chilli	10,000
		Rapeseed & Mustard	78487
		Cotton	11611
6	IRRIGATION BY DIFFERENT SOURCES (As on 2010-11) (Source: Dtge. Of Economics & Statistics, Ministry of Agriculture, GOI)		
	Source	Net Irrigated Area (ha)	Gross Irrigated Area (ha)
	Tubewells	260535	401315
	Other wells	4884	5592
	Other Sources	262	262
	Net Irrigated Area (ha)	265681	
	Gross Irrigated Area (ha)	407169	
7	NUMBER OF GROUND WATER MONITORING WELLS OF CGWB(As on May 2011)		
	Number of Dug wells	61	

S No	Item	Information
	Number of Piezometers	32
8	PREDOMINANT GEOLOGICAL FORMATIONS	Quaternary aeolian sand, Alluvium, Bap Boulder Bed, Nagaur Sandstone, Bilara Limestone and Jodhpur Sandstone of Marwar Super Group, Malani Igneous Suite, Erinpura granite & rocks of Delhi Super Group.
9	HYDROGEOLOGY	
	Major water bearing formation	Quaternary alluvium, Nagaur Sandstone, Bilara Limestone and Jodhpur Sand - stone, Rhyolite, Granite, Schist and Phyllite.
	Depth to water level (Pre-monsoon, 2011) (mbgl)	0.01 to 82.51
	Depth to water level (Post-monsoon, 2011) (mbgl)	0.01 to 114.9
10	GROUNDWATER EXPLORATION BY CGWB (As on 31.3.2012)	
	Number of wells drilled (EW, OW, PZ, SH)	EW – 52,OW- 12, SH –17 & PZ- 18
	Depth Range (m)	21 – 339.5
	Discharge (litre per second)	Negligible – 75
	Storativity	-
	Transmissivity (m^2/day)	Up to 832 m^2/day in alluvium
11	GROUND WATER QUALITY	
	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 Replenishable Ground Water Resource	389.01
	Net Annual Ground Water Draft	814.33
	Stage of Ground Water Development	209.33%
13	MAJOR GROUND WATER PROBLEMS AND ISSUES	1. Water level decline. 2. Rising water level in Jodhpur city. 3. Quality Problem. 4. Industrial pollution. 5. Less groundwater recharge due to scanty & uneven rainfall.
14	MASS AWARENESS AND TRAINING PROGRAMMES CONDUCTED BY CGWB	Mass Awareness Program – Bilara, Mandore Training Program – Mathania, Mandore
15	AREAS NOTIFIED BY CGWA	Bilara, Bhopalgarh, Mandore, Osian

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DISTRICT GROUND WATER BROCHURE
JODHPUR DISTRICT

1.0 Introduction

Jodhpur district is situated between $25^0$51'08" & $27^0$37'09" North latitude and $71^0$48'09" & $73^0$52'06" East longitude covering geographical area of 22,850 sq km. This district comes under arid zone of the Rajasthan State. Jodhpur district is part of Jodhpur Division. The district is divided into 5 sub-divisions namely Jodhpur, Shergarh, Pipar City, Osian & Phalodi and comprises of 07 tehsils & 09 blocks. Total number of villages in the district is 1157. Jodhpur district is bounded by Nagaur in the East, Jaisalmer in the West, Bikaner in the North and Barmer as well as Pali in the South. Population of the district is 3687165 including rural and urban populace of 2422551 and 1264614 respectively. Decadal population growth rate of the district is 27.69% since 2001. The district is known for its Guar gum industries and mineral wealth. Map showing administrative divisions of Jodhpur district is presented in Fig. 1.

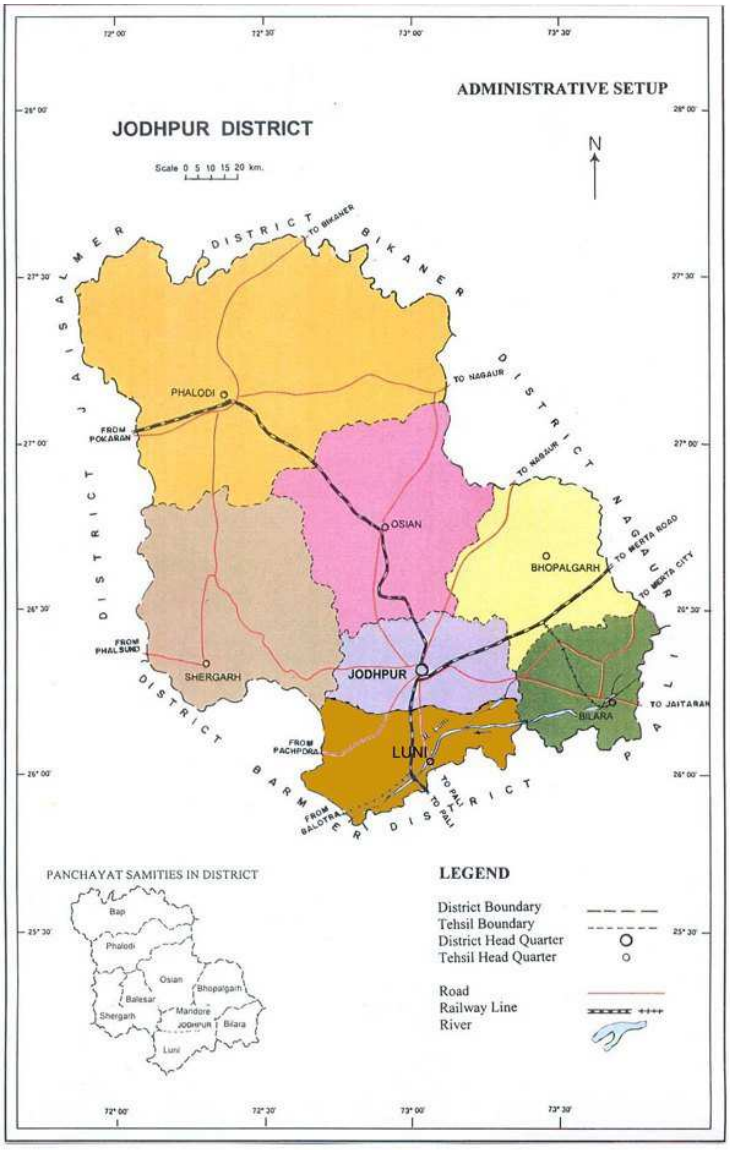

Fig. 1: Administrative Divisions

Systematic hydrogeological survey in parts of Jodhpur district was initially carried out by Kidwai (1963-64), Sangre (1965-66), Khan (1968-70), Karanth and Siddiqui (1970), Siddiqui (1970) of Geological Survey of India. Ground water survey of Borunda area was carried out under UNDP Project (Phase I) during 1967 – 71. Central Ground Water Board has taken up various scientific studies in the district since its inception in 1972. A list of studies carried out in the district is given in Table 1.

Table 1: Studies undertaken by CGWB.

S. No.	Officer	AAP	Type of Survey/Study
1.	V. Sharma	1975-76	Systematic hydrogeological investigations covering parts of Ajmer, Jodhpur, Nagaur and Pali districts
2.	B.P. Verma	1978-79	Reappraisal hydrogeological study of ground water resources in Mathania area, district Jodhpur.
3.	S. Kumar	1983-84	Reappraisal hydrogeological investigation in Doli – Jhanwar – Pal area, district Jodhpur
4.	I.K. Sharma	1986-87	Reappraisal survey in Osian block, Jodhpur district
5.	A. Dewan, Rama Kishan and S.K. Gupta	1988-89	Reappraisal hydrogeological survey in parts of Nagaur and Jodhpur districts
6.	Rama Kishan	1992-93	Reappraisal hydrogeological survey in Luni and Bilara blocks of Jodhpur district
7.	N.K. Srivastava	1993-94	Reappraisal hydrogeological survey in drought prone area of Mandore and Balesar blocks
8.	I.K. Sharma	1993-94	Reappraisal hydrogeological survey in drought prone area of Phalodi block
9.	I.K. Sharma	1994-95	Reappraisal hydrogeological survey in Bap block of Jodhpur district
10.	N.K. Srivastava	1994-95	Reappraisal Hydrogeological Survey in Shergarh block of Jodhpur district

The report on Ground Water Resources and Development Prospects in Jodhpur district was brought out by Central Ground Water Board in the year 1988. Revised report was issued in 2005. Exploratory drilling in Jodhpur district was first carried out by the erstwhile Exploratory Tubewells Organization during 1956-57. Detailed exploration was carried out in certain selected patches under UNDP Project (Phase I) implemented during 1967-71. Central Ground Water Board has drilled so far drilled 68 Exploratory wells, 7 Observation wells, 38 piezometers and 12 slim holes in the district. Salient features of ground water exploration are listed in Table 2. Central Ground Water Board also monitors ground water levels through a network of 93 observation wells four times in a year during the months of January, May, August and November. Samples for water quality analyses are collected during May.

Table 2: Salient Features of Ground Water Exploration

Type of well	No.	Depth drilled (m)	SWL (m)	T (m^2/day)	Discharge (lpm)	EC (micromhos/cm) at 25^oC
EW	68	11.6 – 339.5	1.4 – 99.55	373 – 832	4 – 4542	520 -31370
OW	7	35.35 – 230.5	13.5 – 87. 3		8 – 1420	780 -4000
PZ	3	21 – 34.90	3.2 - 144		9.6 - 900	505 – 22360
SH	7	49.38 – 283.77	56.08	-	153	587 – 15512

2.0 Rainfall & Climate

The district experiences arid to semi-arid type of climate. Mean annual rainfall (1971-2012) of the district is 374 mm whereas normal rainfall (1901-1970) is lower than average rainfall and is placed at 314 mm. Rainy days are limited to maximum 15 in a year. Almost 80% of the total annual rainfall is received during the southwest monsoon, which enters the district in the first week of July and withdraws in the mid of September. Probability of annual rainfall exceeding 650 mm is only 10%. However, there is 90% probability that the annual rainfall will be more than 190 mm. The probability of occurrence of mean annual rainfall is 45%. Drought analysis based on agriculture criteria indicates that the district is prone to mild and normal type of droughts. Occurrence of severe and very severe type of drought is very rare.

As the district lies in the desert area, extremes of heat in summer and cold in winter are the characteristic of the desert. Both day and night temperatures increase gradually and reach their maximum in May and June respectively. The temperature varies from 49oC in summer to 1oC in winter.

Atmosphere is generally dry except during the monsoon period. Humidity is the highest in August with mean daily relative humidity at 81%. The annual maximum potential evapotranspiration in the district is quite high and is highest (264.7 mm) in the month of May and lowest (76.5 mm) in the month of December.

3.0 Geomorphology & Drainage

Jodhpur district forms part of Great Thar Desert of Rajasthan. In this arid region, there are sand dunes, alluvial areas dotted with few hillocks and hill chains scattered in the area. In the eastern part of the district, the area between Bilara and Jodhpur is covered by alluvium deposited due to fluvial action of Luni river system. The eastern part of the district exhibits gentle undulating topography interrupted by small ridges of hard rocks. The general elevation of plains varies from 300 m amsl in north to 150 m amsl in south. Regional slope is from north-east towards south-west direction. Orientation of alluvial plain area follows the Luni River and its tributaries. Sand dunes occupy a major part of the district north of Vindhyan escarpment in northern and northwestern part of the district. The sand dunes are transverse and longitudinal types formed due to aeolian action and overlie the denuded consolidated formations. Ridges and hillocks are common features in Bilara and Osian tehsils. A chain of escarpments and ridges composed of comparatively resistive rocks like granite, rhyolite and Jodhpur sandstone are found extending from Shergarh in the west to Bilara in the east. The alluvial and sand filled valleys are separated by the ridges whose crest elevation ranges from 325 to 460 m amsl. In the northern part of the district, highest peak of the hill is 284 m amsl. Presence of boulder beds exhibits striking plain topography around Bap and low lying outcrops of limestone, shale and sandstone layers are observed in northern part of the district near Phalodi. Distribution of various geomorphic units in the district is shown in Table 3.

Table 3: Distribution of various geomorphic units in Jodhpur district

Origin	**Landform Unit**	**Occurrence**
Aeolian	Sand dunes	North and northwestern part of the district.
	Sandy Plains	North and northwestern part of the district.
Fluvial	Alluvial Plains	Eastern part of the district along rivers- Luni, Mithri etc.
	Interdunal Plains	Scattered in entire district, mainly in north and western part of the district.
Denudational	Pediments	Scattered in district, mainly in east & west.

Hills	Linear Ridges	Occur in Bilara and Osian Blocks. Extend from Shergarh in the west to Bilara in the east.
	Structural Hills	In northwestern & eastern parts of the district and Jodhpur town.

Jodhpur district falls in the Luni & Barmer Basins. Major River of the district is Luni, which flows in ENE – WSW direction. It enters Jodhpur district near village Jhak in Bilara tehsil and leaves the district near village Dhundhara. Total length of the Luni River in Jodhpur district is 125 km. Channel pattern of Luni is dendritic to sub-parallel. However, in major part of the district, the drainage is essentially ephemeral and internal. Important tributaries to the Luni river are Mithri and Bandi. Other streams in the district are Jojri, Golasmi, Guniamata and Bastua, which are all ephemeral.

4.0 Soil, Land Use & Irrigation Practices

Soils of the district have been classified as follows:

Red desertic soils: This type of soils are predominant in central, eastern and southern parts of the district. These are pale brown to reddish brown soils, loose and well drained and texture varies from sandy loam to sandy clay loam.

Desert soils: Desert soils occupy a considerable area covering northern and western parts of the district. These are mainly wind blown sand and soils of interdunal depressions.

Sand dunes: Sand dunes occupy a small part in northern and north-western margin of the district. These are sandy to loamy sand, loose, structure less and well drained.

Lithosols and regosols of hills: These types of soils are found in hills and hill slopes of central and western parts of the district. These are shallow, light textured, fairly drained and reddish brown to grayish brown in colour.

4.1 Land-Use Pattern

Total reported area for land utilization statistics is 22,56,405 hectares and about 70.03% of the total area are being cultivated. The district is very poor in forest covering only 6996 hectares, which forms only 0.31% of the total area of the district. Agriculture is the main occupation of the rural population. Net cultivable area of the district is 131703 hectares whereas non agriculture land area including fallow land is 514159 hectares. Maximum cultivated area lies in Osian tehsil followed by Bhopalgarh tehsil. Land use pattern of Jodhpur district as on 2010-11 is given in Table 4.

Table 4: Land use pattern of Jodhpur district (2010-2011)

Classification	Area (Hectares)	Percentage
Total Geographical Area	22,56,405	100.00
Areas under forest	6,996	0.31
Area under non agriculture use	2,25,711	10.00
Permanent Pastures and other grazing lands	1,22,349	5.42
Miscellaneous trees crops and Groves not included in the net area Sown.	89	0.004
Non Agricultural Land including Fallows	5,14,159	22.79
Net area Sown	13,71,703	60.79
Area Sown more than One time	2,08,423	9.24
Total area Sown	15,80,126	70.03

4.2 Crops

The district comes under arid zone of the State and on account of non-availability of adequate water, cropping pattern is, by and large, single only. Only 15% of the net cultivated area is being utilised for double/ multiple cropping. The total area under *Kharif* crop is 962964 hectare (As on 2009). During kharif, millet, jawar, pulses, groundnut and guar are the main crops cultivated and during Rabi wheat, barley, isabgol and mustard are the main crops cultivated in the district.

4.3 Irrigation

Ground water is the only source of irrigation in the district. Gross area of irrigated land by wells and tubewells works out to 407169 hectares. Maximum irrigated area is in Osian tehsil followed by Bhopalgarh and Bilara tehsils respectively. Minimum area under irrigation is in Luni tehsil due to poor ground water potential. Source wise details of area irrigated in the district are given in Table 5.

Table 5: Source wise area irrigated in Jodhpur district (2010-11)

Source	Net Irrigated Area (ha)	Gross Irrigated Area (ha)
Tubewells	260535	401315
Other wells	4884	5592
Other sources	262	262
Total	265681	407169

5.0 Ground Water Scenario

5.1 Geological Framework

Geological set-up of the district is represented by various igneous, metamorphic and sedimentary rocks. Delhi Super Group litho units are very limited and occur in the form of isolated pockets. Erinpura granites and Malani igneous rocks cover large area in the southern part of the district. Marwar Super Group of rocks occupy maximum geographical area covering the central, western, and eastern parts of the district. The rock units of various formations belonging to Cenozoic epoch/era occupy very small area and lie in the north-western part of the district. In the entire district, hard rocks are overlain by thin blanket of alluvium and wind blown sand.

5.2 Hydrogeology

Ground water occurs under unconfined to semi-confined conditions in rocks of Delhi Super Group, Jodhpur sandstone, Bilara limestone, Nagaur sandstone, Lathi sandstone and unconsolidated sediments (valley fills and alluvium). These form the chief source of ground water in the district. Confined condition is also met sometimes at deeper levels in the northwestern part of the district. Hydrogeological map of the district is presented in Fig. 2.

Delhi Super Group: Rocks comprising of schists, phyllites, slates and quartzites form aquifer in isolated patches in small area in south-eastern part of the district. These patches occur within the granitic terrain. These generally form poor aquifer. Ground water occurs under unconfined condition in weathered mantle and fractured zone. Yield of existing open wells generally varies from 30 to 90 m^3/day and discharge of bore wells is also very poor (below 160 lpm).

Granites and Rhyolites: Granites and rhyolites covering a vast area in the southern part of the district, form poor aquifers. Ground water occurs under unconfined conditions in secondary spaces in weathered and fractured zones. The fractures tend to die out with depth. Yield of open wells in these formations varies from 10 to 50 m^3/day. Yield of wells tapping

good weathered zone in granites is up to 80 m^3/day. Dug-cum bore wells and bore wells in favourable selective locations can yield up to 120 m^3/day.

Jodhpur and Nagaur Sandstone: Jodhpur and Nagaur sandstones form aquifer over a large area in central and northern parts of the district. These cover maximum area among all aquifers. These are generally hard and compact layered rocks with intermittent shale and clay layers. Softer and friable sandstone layers and patches do occur in these formations making it a good yielding aquifer tapped by open wells and bore wells. Sandstone is fine to medium grained, sometimes coarse to gritty and friable. In such formations, friable and soft nature often leads to formation of small cavities in saturated zones. This makes it a very good aquifer forming chief source of ground water in the area. A large number of light to medium duty bore wells have been constructed in such areas for irrigation and water supply purposes. In the central part of the district, ground water occurring in this formation is generally free from salinity problem. Ground water in sandstone occurs under unconfined to semi-confined conditions. Open wells tapping sandstone generally yield low to moderate quantity of water with yield varying from 30 to 180 m^3/day. Bore wells tapping saturated zones down to depth of 200 m yield 7 to 55 m^3/hr water with 5m to 8m drawdown.

Bilara limestone: Bilara limestone is the most potential aquifer in the district. The limestone exposures are found between Khawaspura & Bilara in eastern part of the district and between Phalodi & Chadi in northern part. Siliceous and cherty limestone and dolomites with association of shale beds are quite common. In Borunda - Bilara area, limestone is mostly dolomitic, grey to dark grey at places, inter bedded with thin cherty layers. In Chadi - Phalodi area, limestones are predominantly cherty or siliceous. Further north-west of Phalodi, limestone is overlain by thick cover of shale. In Borunda - Ransigaon - Bilara area, limestone shows steep dips and pitching folds. These beds are highly crumpled and show development of caverns formed due to solution activities. In Phalodi - Chadi area, limestone are not so much disturbed having low angle of dip towards north and show development of caverns to lesser extent. Thickness of limestone varies from a few meters to more than 100 m. The yield of wells in both the areas varies largely because of considerable variation in limestone characters. In Phalodi area, yield of wells generally lies between 10 & 40 m^3/hr for 2 to 9 m drawdown. In Borunda - Bilara area, discharge of wells varies from 12 to 272 m^3/hr with a drawdown in the range of 3 to 16 m.

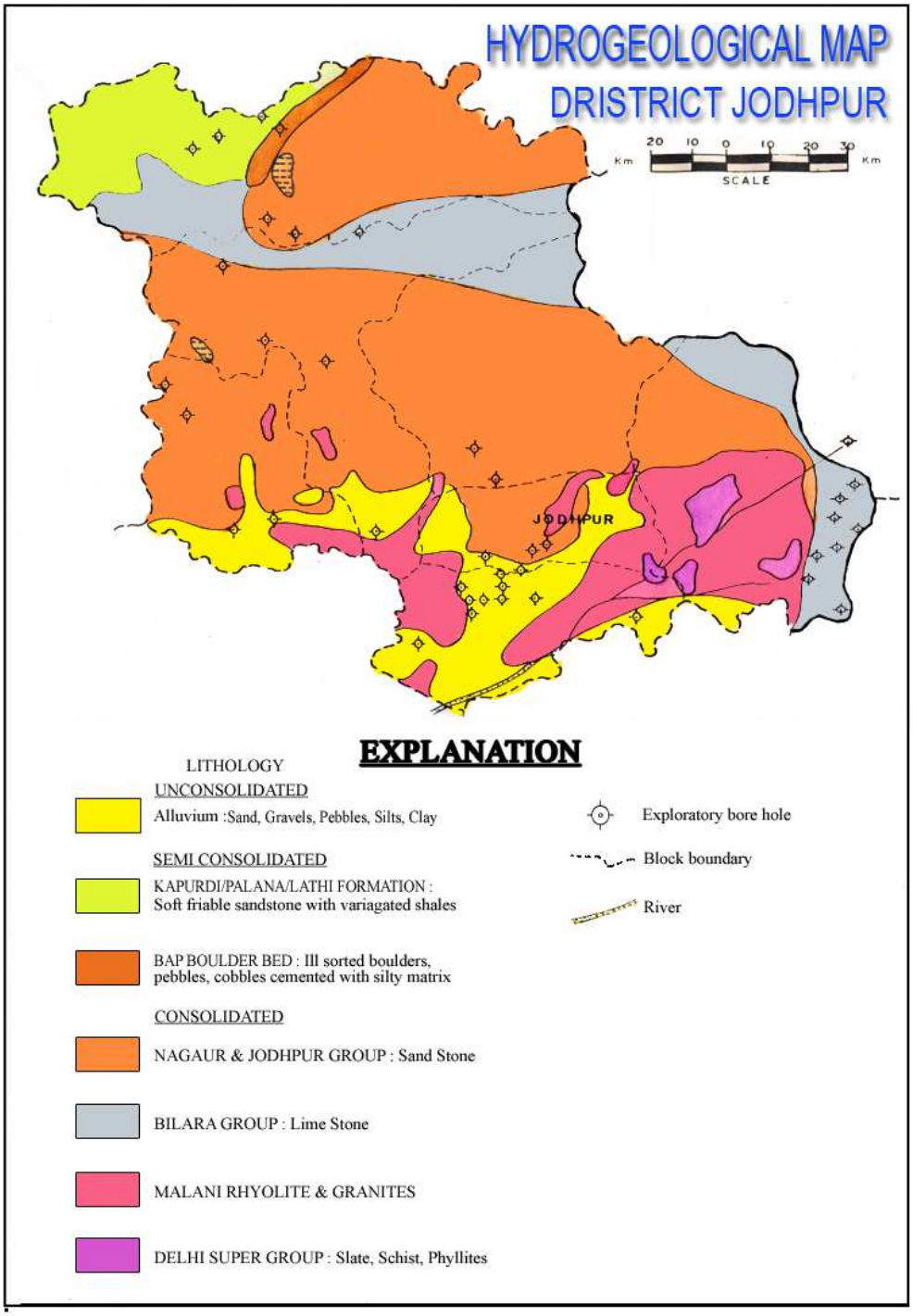

Fig. 2: Hydrogeology

Bap boulder bed: Bap boulder bed occurs in narrow stretch in northern part of the district having NE-SW extension. It consists of ill-sorted boulders, pebbles, cobbles embedded in silty matrix. Ground water occurs under unconfined condition. Wells in this formation yield meager quantity of water, which is saline.

Paleocene and associated formation: Semi-consolidated formations comprising of soft, friable sandstone, grit and conglomerate ranging from Permian to Paleocene age form aquifer

in extreme north- western part of the district. There is association of varying amount of shales and clays with the above sediments, which causes great variation in the yield of wells. Among semi-consolidated formations, Lathi sandstone does not form prominent aquifer in the district. Yield of wells varies largely but generally lies in the range of 15 to 60 m^3/hr. There is also quality zonation due to intermittent shale/clay layers.

Unconsolidated sediments: The unconsolidated Quaternary sediments comprising of alluvium, valley fills and aeolian sands form important aquifers in some parts of the district mainly in Shergarh, Luni and Bilara blocks. In major part of the area, these sediments occur as thin blanket over the older sediments but in certain areas, they are upto 70 m thick and as such form aquifers. In a narrow strip extending east-west wards between Shergarh- Balesar-Agolai-Doli- Jodhpur, alluvium forms aquifer. Thickness of alluvium varies from 47 to 69 m in this area. Yield of open wells varies from 20 to 100 m^3/day in alluvium. Yield of exploratory tube wells constructed in alluvium ranges from 22 to 55 m^3/hr. In Shergarh and Balesar, yield of tube wells tapping valley fills varies from 20 to 36 m^3/hr. Thickness of alluvium in southern part of the district along the course of Luni river and its tributaries is comparatively less and water is generally brackish.

5.3 Depth to Water Level

Depth to water level in the district generally ranges from less than 1m to more than 100 m below ground level (mbgl). It varied from and 0.01 to 82.51 m during pre-monsoon (May, 2011). Depth to water level in major part of the district varied from 20 m to more than 40 m bgl except for parts of Luni, Mandore, Bilara, Osian, Bhopalgarh and Bap blocks where shallower water levels upto 20 m bgl were observed (Fig. 3).

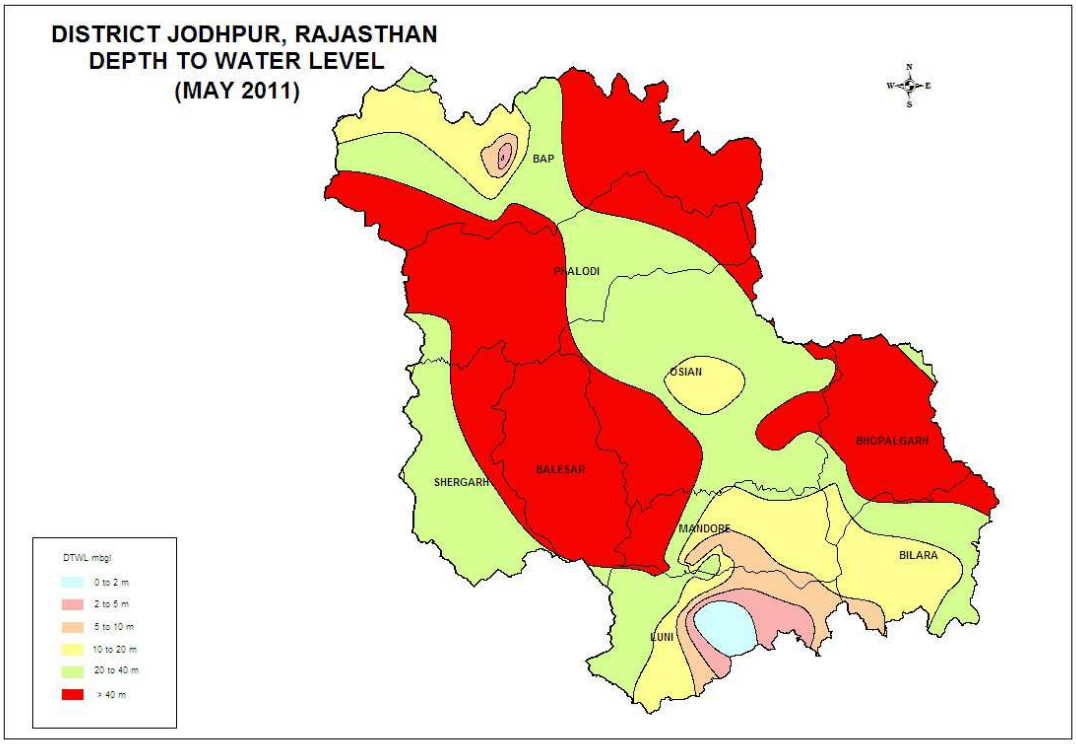

Fig. 3: Depth to Water Level Pre-monsoon (May, 2011)

During post monsoon (November, 2011), depth to water level varied from 0.01 to 114.9 m bgl. Shallow water level upto 20 m bgl has been observed in western half of Bap, central part of Osian, southern part of Balesar, southern and eastern parts of Mandore and major parts of

Luni and Bilara blocks Fig.4. Water levels in the remaining areas have been found to be 20 to more than 40 m bgl.

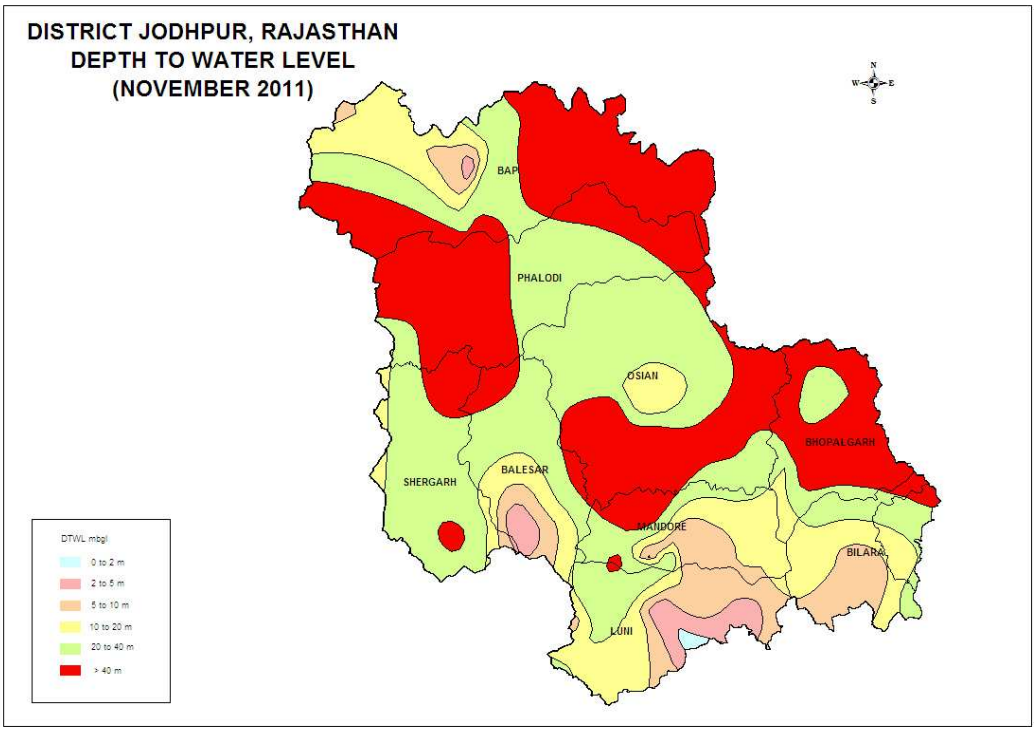

Fig. 4: Depth to Water Level Post-monsoon (November 2011)

5.4 Water Level Fluctuations

Analysis of Pre- and Post-monsoon water level data of 2011 (May and November) indicates that there has been rise of upto 2 m in major part of the district. Rise of 2 to 4 m has been noticed in parts of Phalodi, Luni, Mandore and Bilara blocks and that of more than 4 m has been noticed from isolated pockets in Phalodi and Bilara blocks (Fig. 5). Decline in ground water levels of upto 2 m has been observed in along the western boundary and eastern half of Bap, western and eastern parts of Phalodi, eastern half of Osian, northern parts of Balesar and Shergarh and small pockets in Mandore, Luni, Bhopalgarh and Bilara blocks.

Analysis of decadal water level data of pre-monsoon (May, 2002- May, 2011) indicates declining trend of upto 25 cm/year in major part of the district. Rising trend of upto 25 cm/year has been observed in major parts of Bhopalgarh and Bilara blocks, western and southern part of Osian, central part of Mandore, western and central parts of Luni, and small parts of Bap, Phalodi, Balesar and Shergarh blocks. Rising trend of 25 to 50 cm/ year has also been observed along the eastern border of Bhopalgarh block.

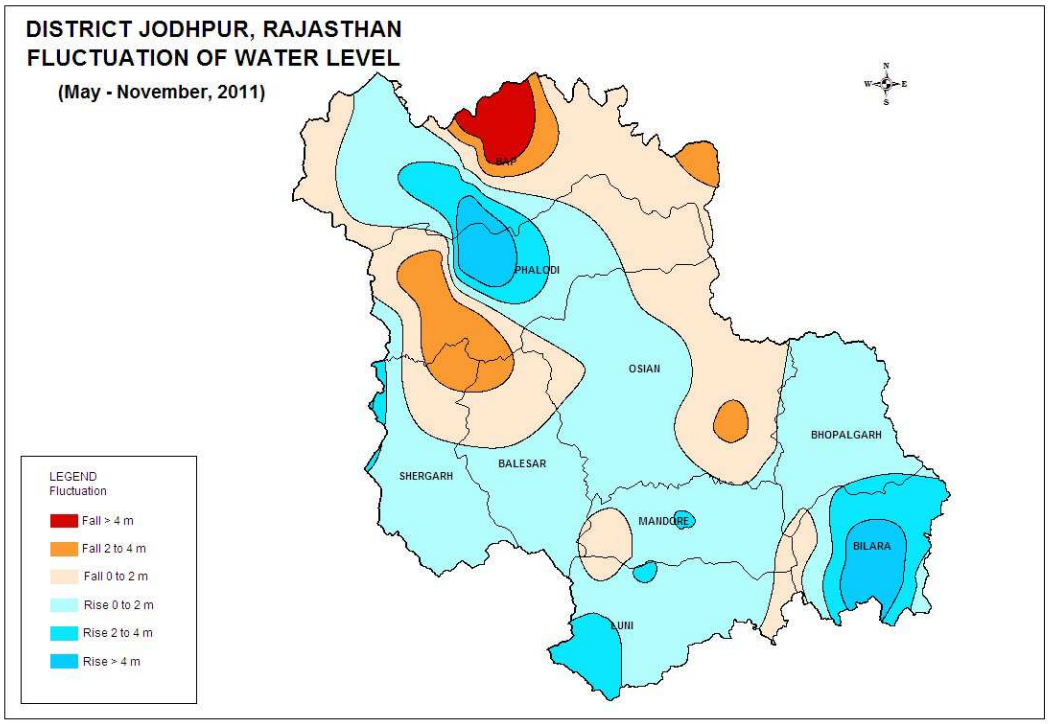

Fig. 5: Seasonal Water Level Fluctuation Map (May – November, 2011)

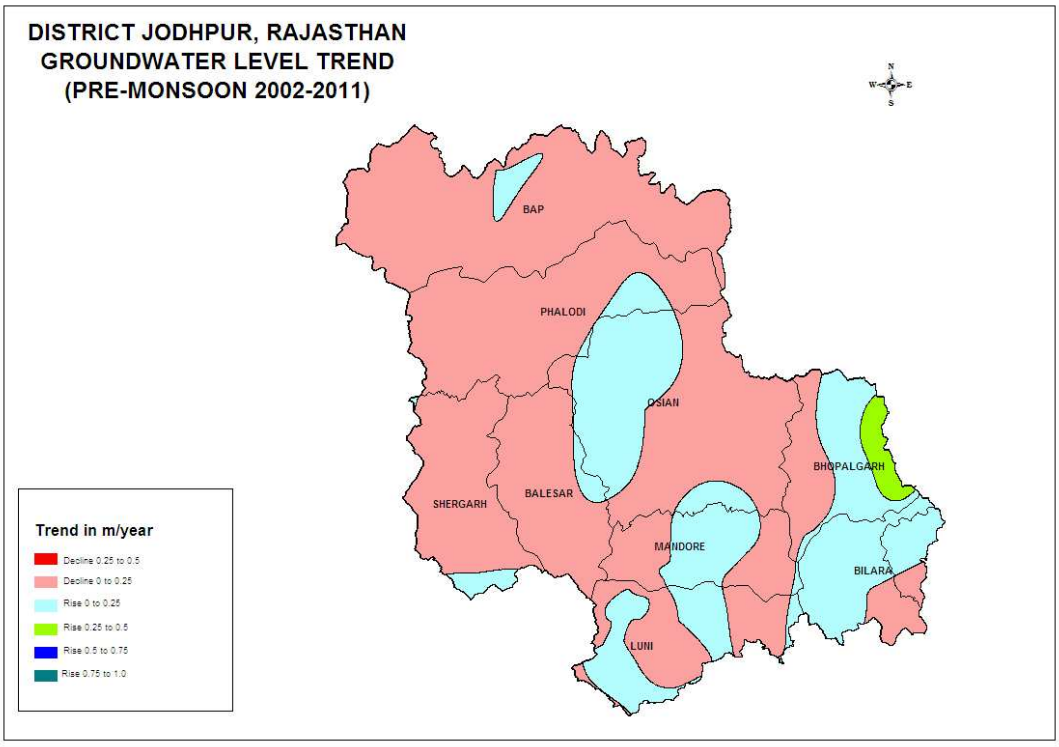

Fig. 6: Decadal Pre-monsoon Water Level Trend (May, 2002 – May, 2011)

5.5 Ground Water Quality

There is a large variation in chemical quality of ground water in the district depending on the characteristics of water bearing formation, movement of ground water, depth to water levels etc. It is seen that in shallow ground water zone, the electrical conductance varies generally from 570 ms/cm at 25^0C at Balarwa to 10210 ms/cm at 25^0C at Raron ki dhani. Highly mineralized ground water occurs in Rann area. The ground water in southern, southeastern, and southwestern parts of the district is saline. In Bap block, northern and western parts have brackish ground water. The electrical conductance is less than 3000ms/cm at 25^0 C in major part of the district. In the central part of the district where sandstone forms the aquifer, electrical conductance generally varied from less than 1000 to 2000 ms/cm at 25^0 C

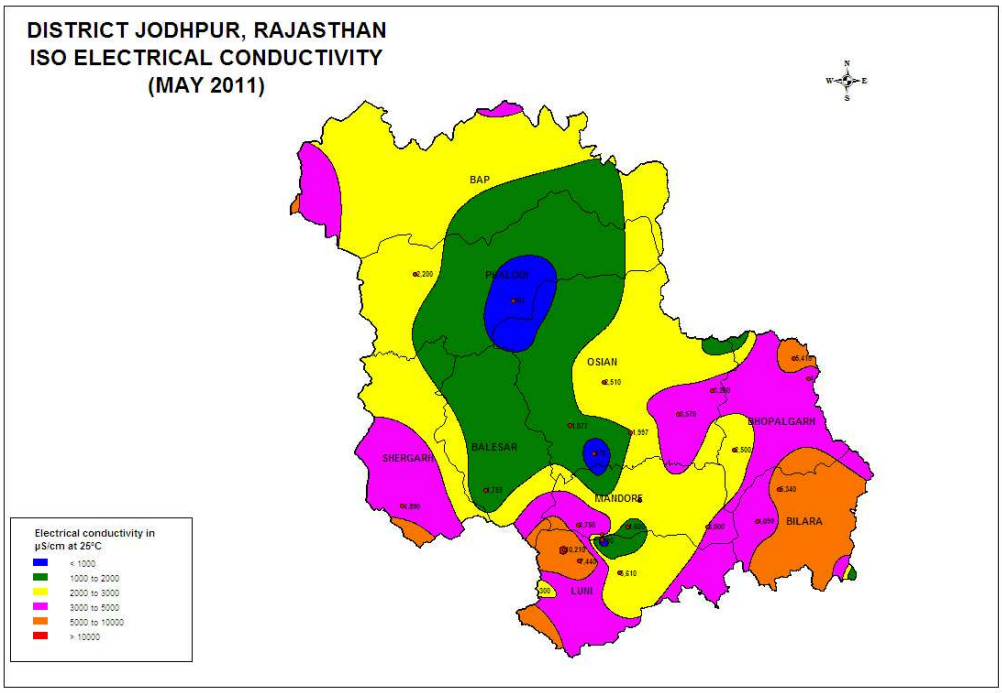

Fig. 7: Iso Electrical Conductivity (May 2011)

Fluoride concentration in ground water was found to vary between 0.124 mg/l at Rohila Kalan, Osian to 2.552 mg/l at Nandwan, Mandore. Fluoride content in excess maximum permissible limit of 1.5 mg/l has been reported from major parts of the district covering western halves of Bap, Balesar and Phalodi blocks, major part of Shergarh block, eastern and southcentral parts of Osian block, southwestern part of Mandore block, northwestern, southwestern and southeastern part of Luni block, northern part of Bhopalgarh and eastern and western part of Bilara block (Fig. 8).

Nitrate concentration in ground water varied from 8 mg/l at Balesar to 199 mg/l at Baori, Osian. Exceptionally high concentration of 536 mg/l was observed at Mandore. Nitrate in excess of maximum permissible limit of 45 mg/l has been reported from parts of Osian, Bhopalgarh, Mandore and Luni blocks (Fig. 9).

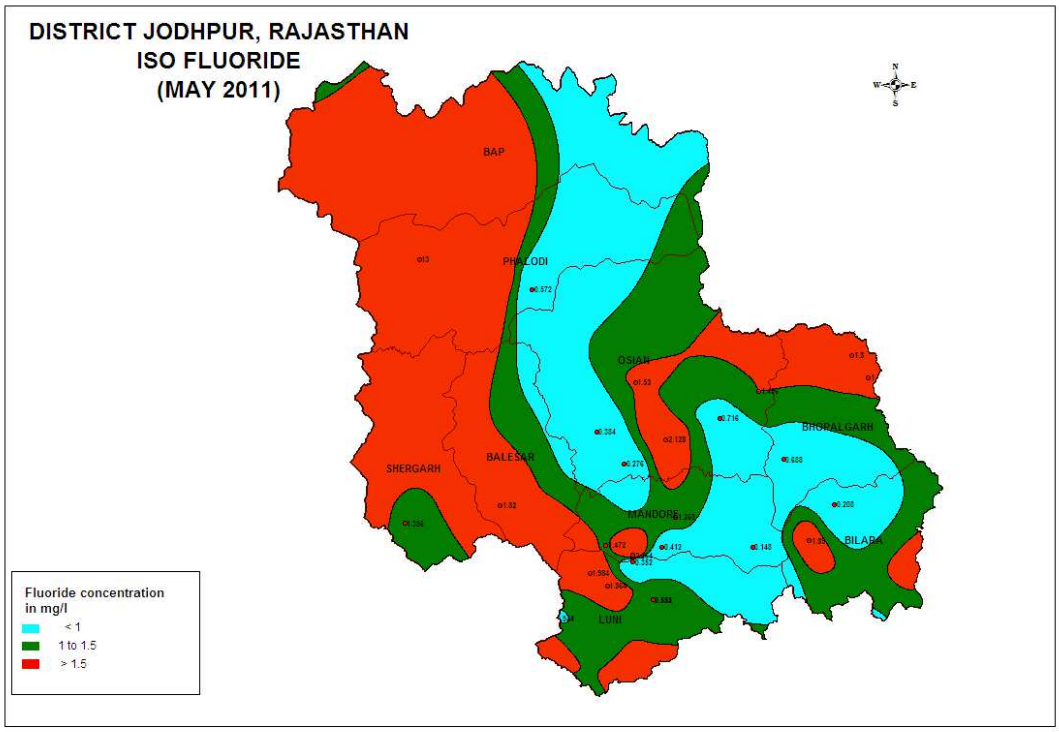

Fig. 8: Iso Fluoride (May 2011)

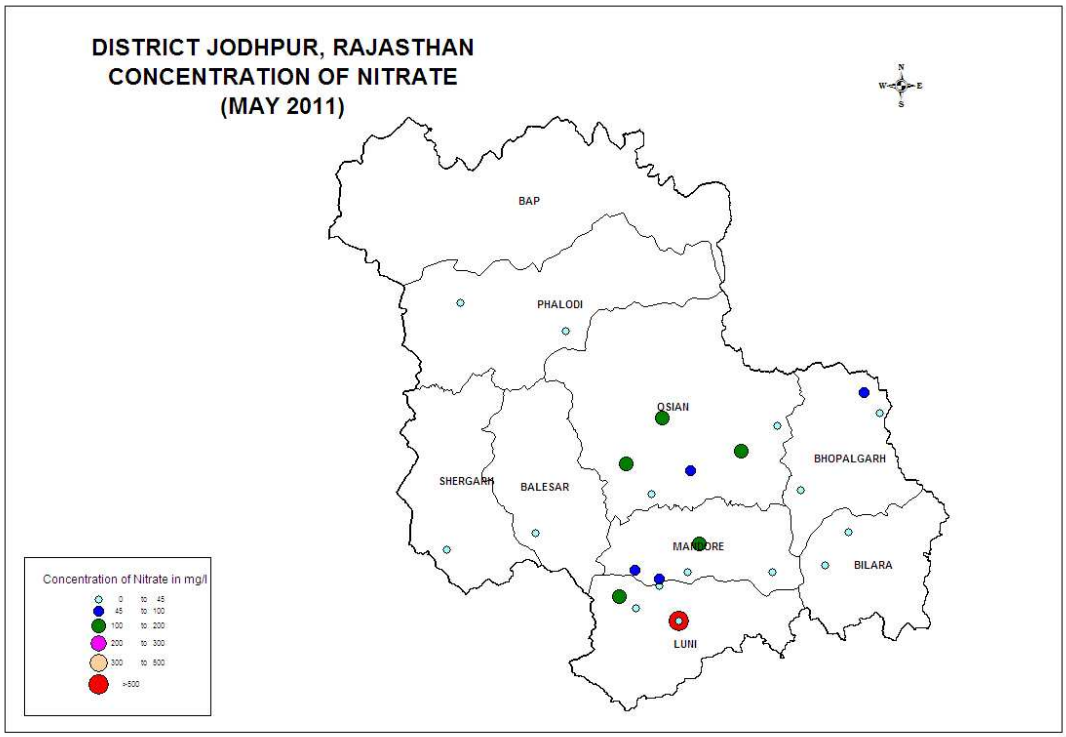

Fig. 9: Nitrate distribution (May 2011)

Iron concentration in ground water has been found to be mostly within the maximum permissible limit of 1 mg/l. Isolated pockets of excess iron have been noticed in western extremity of Bap, southern part of Shergarh, southeastern part of Luni, eastern part of Osian, northern part of Bhopalgarh and southern, southeasten and eastern parts of Bilara block (Fig. 10).

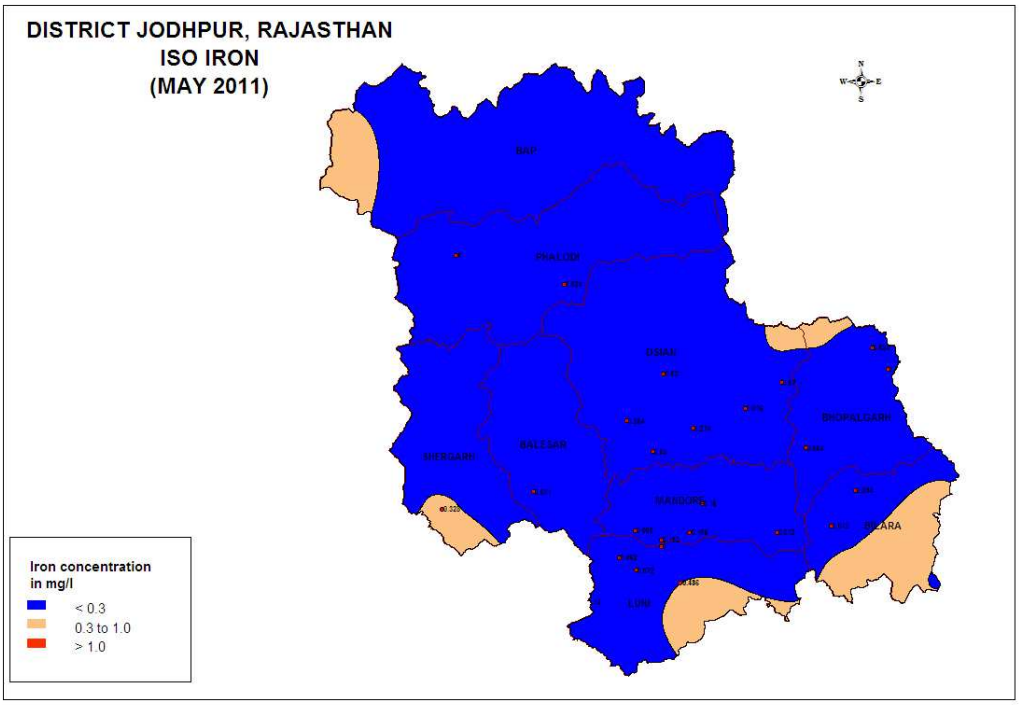

Fig. 10: Iso Iron (May 2011)

Textile and steel rolling mills are most polluting industries in Jodhpur city. The effluent mainly contains alkalies residual dyes, starch and cellulose, soluble sodium salts, silicates, sulphates and nitrates. In discharge area of effluents, the ground water quality is brackish to saline. Due to pollution, there is an increase in concentration of sodium, sulphate, chloride and nitrate in ground water which further deteriorates already existing poor quality of ground water making it unfit even for cattle in the nearby areas of discharging point of waste water.

Chemical quality of deeper ground water as revealed by the exploratory drilling indicates large variation having electrical conductance from 520 ms/cm at 25^0 C (Ranja Ki Dhani) to 31370 ms/cm at 25^0 C (Ghataur). High salinity of more than 10000 ms/cm at 25^0 C electrical conductance has been noticed at Sangaria Ki Dhani, Narnadi, Agolai, Lunawas Charnan, Sajjara and Jhanwar. Ground water quality in deeper zones in the area north of Phalodi is better due to encountering of Bilara Limestone below Nagaur sandstone.

6.0 Ground Water Resources

Ground water resources have been estimated jointly by Central Ground Water Board and State Ground Water Department as per the norms recommended by GEC' 97 as on 2009. Annual replenishable ground water resource of the district has been estimated as 420.8565 mcm and net annual ground water availability as 388.8043 mcm. Gross ground water draft for all uses is estimated as 809.7057 mcm and over all stage of development is 208%. Summarized block wise estimate of dynamic groundwater resources is given in Table 6.

Table 6: Block wise ground water resources of Jodhpur district

(in mcm)

S. No.	Block	Annually replenishable ground water resource	Net Annual Ground Water Availability	Gross ground water draft for irrigation	Gross ground water draft for domestic and industrial uses	Gross Ground Water Draft for All uses	Stage of Ground Water Development (%)	Cagtegory
1	Balesar	23.3075	20.9767	37.293	7.28	44.573	212.49	OE
2	Bap	63.0217	57.8811	16.2012	6.176	22.3772	38.66	Safe
3	Bhopalgarh	56.1313	51.7093	145.201	11.3474	156.5484	302.75	OE
4	Bilara	46.637	43.2667	119.8089	16.3428	136.1517	314.68	OE
5	Luni	23.6439	21.9851	17.32	4.506	21.826	99.28	Critical
6	Mandore	28.7029	25.8325	53.4438	13.9724	67.4162	260.97	OE
7	Osian	87.5936	81.8455	230.557	34.656	265.213	324.04	OE
8	Phalodi	53.4109	50.7404	33.6192	19.1952	52.8144	104.09	OE
9	Shergarh	38.4077	34.567	35.235	7.5508	42.7858	123.78	OE
TOTAL		**420.8565**	**388.8043**	**688.6791**	**121.0266**	**809.7057**	**208.26**	**OE**

In the district an area of 3321.80 sq.km having saline ground water in different blocks (chemical unsuitable). Assessment of these area has been computed separately. Net annual ground water availability of saline ground water resource has been estimated as 89.1176 mcm. The existing annual ground water draft has been estimated to be 11.7672 mcm with stage of ground water development at 13%.

7.0 Status Of Ground Water Development

Ground water is the only source of irrigation in the district. Ground water development in the district is being done by dug wells and tube wells. Present stage of ground water development in the district is 208%, which indicates that the scope of ground water development is already exhausted. Out of 9 blocks, 7 fall under “Over-exploited” category, 1 block under “Critical” category, and 1 block under safe category. General depth of dug wells and bore wells ranges from 20 to 80 m and up to 250 m respectively.

8.0 Ground Water Management Strategy

8.1 Ground Water Development

Stage of ground water development in the district is 208%, which indicates that the scope of ground water development is already exhausted in 7 blocks where groundwater development has already exceeded 100% and categorized as “Over-exploited”. One block falls under “Critical” category, where caution needs to be exercised in further development of ground water resources and one block (Bap) fall under safe category, which has problem of salinity in ground water. Stage of groundwater development has even reached above 300% in some limestone and sandstone aquifer zones of Bhopalgarh, Bilara, Mandore and Osian blocks. There is no scope for further groundwater development in the district except in Bap block. However, exploratory drilling can be taken up in unexplored area for estimation of aquifer parameters.

8.2 Water Conservation and Artificial Recharge

Precious Groundwater resources have to be conserved for sustainable availability. Artificial recharge measures need to be employed for augmentation of ground water resources through construction of roof top rain water harvesting structures in urban areas and construction of sub surface barriers and anicuts at suitable locations in rest of the areas. Inferior quality water can be blended with fresh water for irrigation use. Watershed Development & Soil Conservation Department has constructed permanent (masonry) check dams under Irrigated Watershed Development Project to harvest rain water, reduce soil erosion and check runoff velocity.

8.3 Awareness & Training Activity

Central Ground Water Board regularly organizes mass awareness programmes in different parts of the country to create awareness on the need for rain water harvesting, artificial recharge and conservation of water. So two mass awareness programmes have been organized at Bilara and Mandore on 14.2.2003 and 10.3.2007 respectively. A painting competition was also organized at Jodhpur on 26.3.2000. Besides these, two Water Management Training Programmes have also been conducted by the Board at Mathaniya and Jodhpur during 2000-01 and 2002-03 respectively.

8.4 Areas notified by CGWA

Central Ground Water Authority (CGWA) has notified four blocks viz. Bilara, Bhopalgarh, Mandore and Osian for regulation of ground water withdrawal. In such areas, construction of new ground water abstraction structures is banned without prior permission of the District Advisory Committee formed by CGWA. The District Collector is authorised for implementation of regulatory measures. NOC for drilling of tubewells by Industries/infra structure projects is not granted in the notified areas.

9.0 Ground Water Related Issues & Problems

Major part of the district is covered by hard rock formations such as Jodhpur sandstone, Malani rhyolites, granites, and Delhi Super Group metamorphics. These formations have poor water yielding capacity. Also such areas suffer from water quality problems and in some of the areas ground water is highly saline. Villages located in such areas have the basic problem of drinking water scarcity 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 registered heavy ground water development causing lowering of water table and drying up of a large number of shallow wells or reduction in their yields. Heavy decline of more than 15 m observed in Tinwari- Mathania, Bilara, Ransigaon- Borunda area, part of Bhopalgarh area during last 10 years.

Jodhpur is the second largest urban agglomerate of the State and has a developed industrial center. The textile processing and stainless steel re-rolling industries generate industrial waste effluent, which contains toxic elements. These industries are located in Basni industrial area of Jodhpur city. The combined industrial effluents are carried through drainage and discharged in the river Jojri having its course south of city. Industrial effluents have caused ground water pollution in down stream of the river in villages viz. Salawas, Nandwan, Bhandu Kallan etc. which is harmful for irrigation also.

Suitable measures are also ired to be adopted to tackle the rising water level problem observed in the Jodhpur city during last few years.

10.0 Recommendations

- Heavy ground water withdrawal from potential zones of Bhopalgarh, Bilara, Osian and Mandore for agriculture use, where stage of ground water development has reached more than 300%, has to be controlled.
- Awareness program 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.
- Financial assistance/loans for ground water exploitation in over-exploited, critical and semi-critical area should not be provided.
- Use of water saving devices like sprinklers, close field distribution channels etc. should be promoted.
- Modern agricultural management techniques have to be adopted for effective and optimum utilization of the 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 most suitable cost effective crop pattern.
- Sowing of high water requirement crops needs 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.
- Salt resistant crops can be sown in the areas having brackish to saline ground water.
- Ground water development in Bap block, which falls under safe category, is suggested through financial institutions.
- In the limestone and sandstone areas of the district, deep ground water exploration is suggested by suitable combination rigs.
- Traditional rainwater harvesting structures like Tankas, roof top rain water storage should be encouraged for day to day requirements which will reduce ground water draft.
- Industrial effluents should be treated before being discharged in Jojri river through a Combined Effluent Treatment Plant.
- To combat rising water table problem in Jodhpur city area, measures are required to be adopted to avoid damage to civil structures. This includes pumping of water from unutilized surface water bodies and use withdraw ground water from existing structures.
- Large-scale recharge potentials exists in depleted aquifers. Mega ground water recharge to such areas through outside surface water sources like lift canal from IGNP system or floodwater during excess rainy years be implemented.
- Small check dams or earthen dams, at suitable sites, may be constructed to store rainwater. This will increase recharge to ground water which would ultimately result in increase of yield of wells.
- Ground water legislation should be implemented for regulation and control of ground water in over-exploited areas with immediate effect.