GOVERNMENT OF INDIA

MINISTRY OF WATER RESOURCES

CENTRAL GROUND WATER BOARD

Ground Water Scenario

Udaipur District

Rajasthan

Western Region, Jaipur

2013

UDAIPUR DISTRICT- AT A GL ANCE

Latitude (North)	23°46': 25°05'
Longitude (East)	73°09': 74°35'
Geographical area (sq. km)	13419 sq. km
No. of Tehsils & Name	(11) Girwa, Gogunda, Kotda, Mavli, Vallabhnagar, Sarada, Salumber, Jhadol, Kerwada, Rishabhdeo and Lasadia
No. of Blocks & Name	(11) Girwa, Badgaon, Mavli, Bhindar, Gogunda, Kotda, Jhadol, Sarada, Salumber, Kherwada and Lasadia
No. of Villages	2511
Population (as per 2011 census)	Rural : 2459994 Urban : 608426 Total : 3068420
Average annual rainfall (mm)	637.0 mm
Major physiographical Units	The district has 4 physical divisions namely Valley fills, Pediment, Burried pediment and structural hills
Major Drainage	Jakham, Som, Wakal, Sei, Sabarmati and Berach.

Land Use (ha) (As on 2010-11) (Source: Dte. Of Economics & Statistics, Ministry of Agriculture, GOI)

Forest area	397137
Other uncultivable land excluding current fallows	202888
Fallow land	74856
Land not available for cultivation	471199
Net sown area	242175
Total cropped area	335841
Area sown more than once	93666

Principal crops (Source: Dte. Of Economics & Statistics, Ministry of Agriculture, GOI) (As on 2010-11)

Crop	Area (ha)
Maize	179380
Wheat	55118
Jowar	7477
Barley	7529
Rice	4881
Pulses	22831
Condiments & spices	2021
Oil seeds	30406

Irrigation by different sources (As on 2010-11) (Source: Dte. Of Economics & Statistics, Ministry of Agriculture, GOI)

Source	Net area irrigated	Gross area irrigated
Canals	2275	2275

Tanks	5438	5541
Tubewells	9319	9620
Other wells	56509	58883
Other sources	602	626
Total	74143	76895
No. of observation wells Monitored	45	
Geological formations	Quartzite, Phyllite, Gneisses, Schist, Dolomitic marble	
Principal water bearing Formations	Quartzite, Phyllite, Gneisses, Schist, Dolomitic marble	
Pre-monsoon depth to water level during 2011 (m.bgl)	3.68 – 23.87	
Post-monsoon depth to water level during 2011 (m.bgl)	0.01 – 22.65	
Ground Water Exploration		
Type of wells	Total	
EW	65	
OW	10	
SH	2	
Depth of wells (m)	70 to 200.80	
Discharge (lpm)	1.6 to 625.8	
Electric Conductivity	495–16235 µS/cm at 25°C	
Chloride	35 – 624 mg/l	
Fluoride	0.2 – 1.34 mg/l	
Type of water	Alkaline	
Total annually replenishable ground water resource	265.8324 mcm	
Net annual GW availability	240.5348 mcm	
Gross GW draft for all uses	258.0252mcm	
Stage of GW development	107.27% %	
Area Notified for Ground Water Regulation and Development	-	
Mass awareness programme	-	
Training on Water Management through Rainwater Harvesting	1	

Ground Water Information
Udaipur District

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GROUND WATER SCENARIO

DISTRICT - UDAIPUR, RAJASTHAN

1.0 Introduction

Udaipur district is located between 23°46' & 25°05' North latitude and 73°09' & 74°35' East longitude covering an area of 13419 sq. km. The district is part of Udaipur Division and is divided into eleven sub-divisions, viz. Girwa, Gogunda Kotda, Mavli, Vallabhnagar, Sarada, Salumber, Jhadol, Kherwada, Rishabhdeo, and Lasadiar. Administratively the district is divided into 11 tehsils and 11 development blocks. Total number of villages in the district is 2511. Administrative divisions of Udaipur district are shown in figure 1.

Figure 1: Administrative Divisions

The area was geologically mapped by Heron et al. (1953), Geological Survey of India. During the years 1961-64, systematic hydrogeological surveys and ground water investigations were carried out by Geological Survey of India. These surveys were continued by Central Ground Water Board after its inception in 1972. A list of various scientific studies carried out in the district by Central Ground Water Board is given in Table 1.

Table 1: Studies undertaken by CGWB.

S. No.	Officer	AAP	Type of Survey/Study
1.	B.P. Verma	1977-78	Systematic hydrogeological investigation in parts of tribal areas of Udaipur district
2.	S.K. Jain	1978-79	Systematic hydrogeological surveys in parts of Udaipur district
3.	S.K. Gupta	986-87-78	Reappraisal hydrogeological survey in parts of Udaipur district
4.	M.N. Khan	1986-87	Reappraisal survey in parts of Udaipur and Chittaurgarh districts

S. No.	Officer	AAP	Type of Survey/Study
5.	M.K. Sharma	1987-88	Reappraisal hydrogeological survey in western part of Dungarpur district and Kherwara block of Udaipur district
6.	M.N. Khan	1988-89	Reappraisal hydrogeological survey in Girwa and Jharol blocks of Udaipur district
7.	M.K. Sharma	1988-89	Reappraisal hydrogeological Survey in parts of Sarda and Salumber blocks of Udaipur district district.

The report on 'Ground water resources and development potential of Udaipur district' was brought out by Central Ground Water Board in the year 1991. Revised District report was brought out in the year 2003. Since its inception, the Central Ground Water Board has drilled 65 Exploratory wells, 10 Observation wells and 2 piezometers in the district. Salient features of ground water exploration are listed in Table 2. Presently, ground water regime monitoring is being carried out in the district from a network of 37 observation wells. Water levels are monitored 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 (µS/cm) at 25°C
EW	53	12.8 – 202.7	1.92 – 45.12	27 – 662.4	10 - 1003	455 - 22240
OW	3	101.5 – 160.07	4.68 – 27.5	105	35 - 670	680 - 2710
PZ	41	30 – 159.42	2.55 – 62.94	35.66 – 362	15 - 880	540 - 15000

2.0 Rainfall &Climate

Average annual rainfall of the district is 637.0mm. However normal rainfall for the period 1901 to 1970 is 633.50mm. The southern part of the district receives slightly more rainfall.

The climate of the district is dry except SW monsoon season. The cold season is from December to February and is followed by summer from March to June. Period from mid of September to end of November constitutes post monsoon season.

The droughts are in general of mild or normal type. However, severe type of droughts has been recorded at Udaipur, Gogunda, Kherwara, Jharol, Kotra and Vallabhnagar. Very severe type of drought has been recorded in the year 1987 at Kotra.

3.0 Geomorphology & Drainage

The district is characterized by undulating topography. Towards the western part of district, series of Aravalli hills run along NE-SW direction. A typical plain of gneisses and granites without any alluvial cover is observed to the east of Aravalli ridges. Geomorphic units falling in the district are given in Table 3.

Table 3: Geomorphic units in Udaipur district

Origin	Land Forms	Occurrence in the District
Fluvial	Valley Fill	Scattered in the entire district in between structural hill
Denudation	Pediment	Main concentration in north east and scattered in entire district
	Burried pediment	Main concentration in east and scattered in entire district
Hill	Structural hill	Covers entire district except north east

3.1 Drainage

The district has a well developed drainage system. The main rivers of the district are Jakham, Som, Wakal, Sei, Sabarmati, Gomti and Berach. These are monsoon fed rivers and flow more rigorously in rainy season.

Jakham, Gomti and Som drain the south eastern plains of the district. Wakal, Sabarmati and Sei rivers flow through the valley region of Aravalli ranges in the south west of the district. These rivers have been dammed at various sites and thus several artificial lakes have been created in the district. Important ones are Jaisamand, Udaisagar, Pichhola, Fatehsagar, Som Kagdar and Jakham.

Drainage density in most part of the district varies from 0.5 to 0.7 km/km^2. Drainage density is from 0.7 to more than1km/km^2 in the south eastern and south western part of the district. In the north central part of the district it is low and ranges between 0.3 to 0.5 km/km^2.

4.0 Soils & Irrigation Practices

Most of the soil of Udaipur district has developed in situ. It varies from clay loam to heavy clay. The distribution of the soils in the district is given in Table 4.

Table 4: Soil distribution in Udaipur district

S.No.	Type of soil	Tehsils
1	Clay loam	Mavli, Girwa and Vallabhnagar
2	Red clay	Salumbar, Kotra, Sarada, Kherwara and Rashabdev
3	Heavy clay	Gogunda, Jharol and Girwa

4.1 Irrigation

Principal means of irrigation in the district are wells/tube wells, though some areas are irrigated by canals, tanks etc. Ground water is the main source of irrigation and is utilized through dug wells, DCB's, and tube wells. Tanks form the second most important source of irrigation in the district. Canal irrigates only a small area.

5.0 Groundwater Scenario

5.1 Geological Framework

The oldest formation exposed in the area belongs to Bhilwara Super group of Arachean age. The central and western part of the district is occupied by the younger formations of Aravalli super group and Delhi super group of Proterozoic age. Quaternary and recent alluvium overlies most of the formations in isolated patches, along river courses and in the shallow depressions. The stratigraphic

succession of the district is as follows:

Age	Supergroup	Group	Lithology
	Delhi Super group	Gogunda group	Calc-schists, gneisses, mica-schists, garnetiferous biotite-schists, quartzites & migmatites
	Rikhabdeo ultramafic suite		Serpentinite, talc-chlorite-schist, actinolite-tremolite schist & asbestos
Proterozoic		Jharol group	Chlorite-mica schist, calc schist & quartzite
	Aravalli Supergroup	Bari lake group	Meta volcanics, chlorite schists, amphibolite, quartzite & conglomerate
		Udaipur group	Phyllite, mica schists, meta siltstone, quartzite, dolomite, gneisses & migmatites`
		Debari group	Meta arkose, quartzite, phyllite, dolomitic marble & dolomite
---------- unconformity ----------			
Archean	Bhilwara supergroup	Mangalwar complex	Migmatites, gneisses, quartzite, felspathic garneti ferrous mica schists & para amphibolites

5.2 Hydrogeology

The occurrence of ground water in the district is mainly controlled by the topographic and structural features present in the geological formations. Ground water occurs mainly under unconfined condition to semi-confined condition in saturated zone of rock formation. It's occurrence is controlled by topography, physiography and structural features of the geological formations. The movement of the groundwater in hard rock areas is governed by size, openness, interconnection and continuity of structurally weak planes while in unconsolidated formations, ground water movement takes places through pore spaces between grains. Water bearing properties of different aquifers are described below.

5.2.1 Groundwater in Bhilwara Super Group

The eastern part of the district is underlain by the rocks belonging to Bhilwara super group. These aquifers occur predominantly in Bhinder, Salumbar, Sarada and Mavli blocks. Few intrusives are also found which have low permeability. Ground water in these rocks occurs under water table conditions in the zone of weathering and fracturing, joints and foliation planes. When schists are inter mixed with gneisses, they form a better aquifer. The rate of recuperation is slow in gneisses and schists while it is comparatively faster in granites. The depth of dug wells ranges from 15 to 35 metres and the Yield varies from 20m^3/day to 60 m^3/day. The depth to water level in the area tapping this aquifer ranges from 3m to 35m.

5.2.2 Groundwater in Aravalli Formation

Aravalli Supergroup consisting of Phyllites, Quartzites and dolomite form important aquifer especially around Jharol, Udaipur and Barapal. Ground water occurs in weathered zones like schistosity, joints, fissures and bedding planes. Quartzites generally occur intercalated with phyllites and are well jointed. Ground water in phylites occurs mainly in fractured cleavages. Carbonate formations are cavernous, wherever calcium content is high. Area around Jhamarkotra of Girwa block is potential and supplies water to Udaipur city. The depth to water level varies from 5 to 20 metre below ground level whereas depth of wells varies from 8 to 30 metres below ground level. The average yield of wells is around 40 m^3/day. In carbonates, the yield of wells varies from 20 to 200m^3/ day.

5.2.3 Groundwater in Delhi super group

The formations belonging to Delhi super group are exposed in the western part of the district. Ground water in Quartzites occurs in the joints and fractures. Depth to water level is generally shallow. The yield of wells averages 50m^3/day. Ground water in biotite schist and hornblende schist occurs in joints and fractures. The depth to water level ranges from 5 to 20 metre below ground level and yield of wells varies from 12 to 250 m^3/day. In calc schist and calc gneiss, the yield of dug wells varies from 10 to 100m^3/day. The yield is high when the lenticular cavities along calc bands are saturated and interconnected.

5.2.4 Groundwater in Alluvium

Ground water occurs under unconfined condition in the unconsolidated formations consisting of sand, gravel, pebbles, cobles and boulders in areas close to river courses near Kanpur area. This aquifer has already dried out due to over exploitation.

5.3 Depth to Water Level

The depth to water level during May, 2011 varies widely depending upon topography, drainage, bedrock geology etc. Depth to water varies from 3.68 to 23.87 m bgl. In general DTW varies from 5 to 20m in greater part of the district. Deep water levels (>20m) are observed in parts of Bhinder and Mavli blocks. Shallow water levels in the range of 2 to 5, m have been observed in Girwa, Kherwara, Gogunda and Salumber blocks.

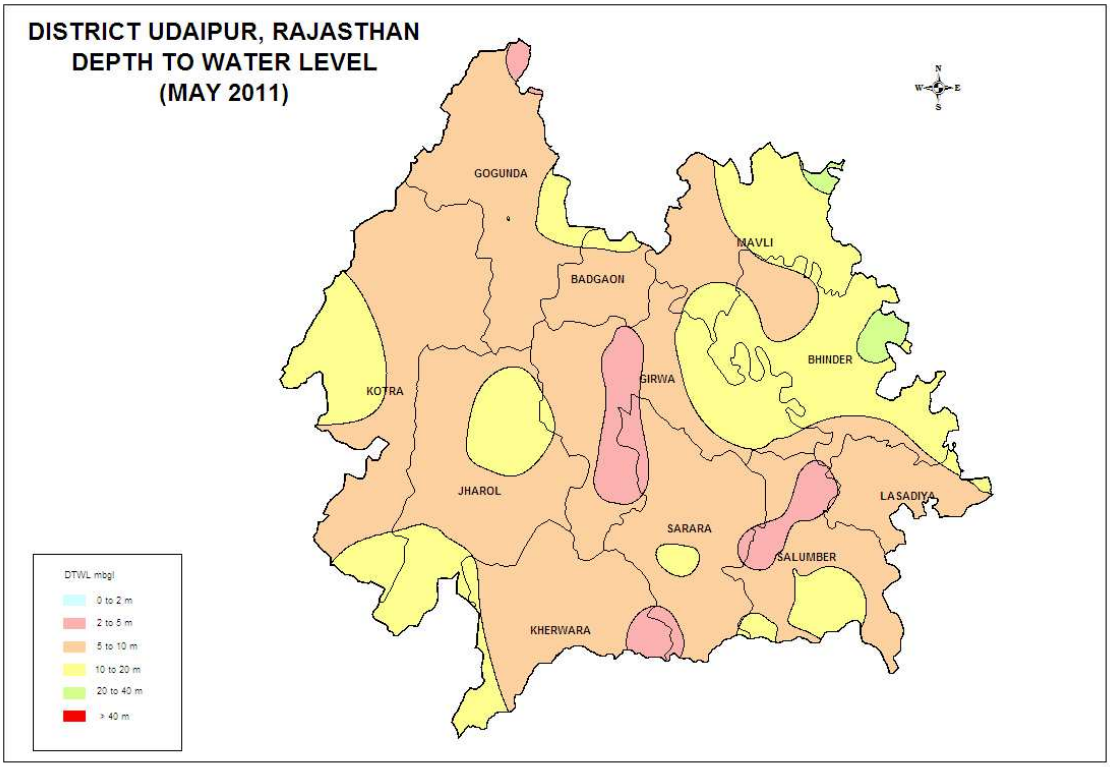

Figure 2: Depth to water level (May, 2011)

During post monsoon period (November, 2011) depth to water level varied widely from 0.01 to 22.65 m bgl. Majority of observation wells (73%) in the district have recorded water level in the range of 0 to 5 m (Figure 3). However, deeper water levels have been observed in 26% of observation wells. In general DTW varies from 2m to 15m in Jharol, Kherwara, Gogunda, Salumbar, Sarara & Girwa blocks and between less than 2 to 30m in Bhinder block.

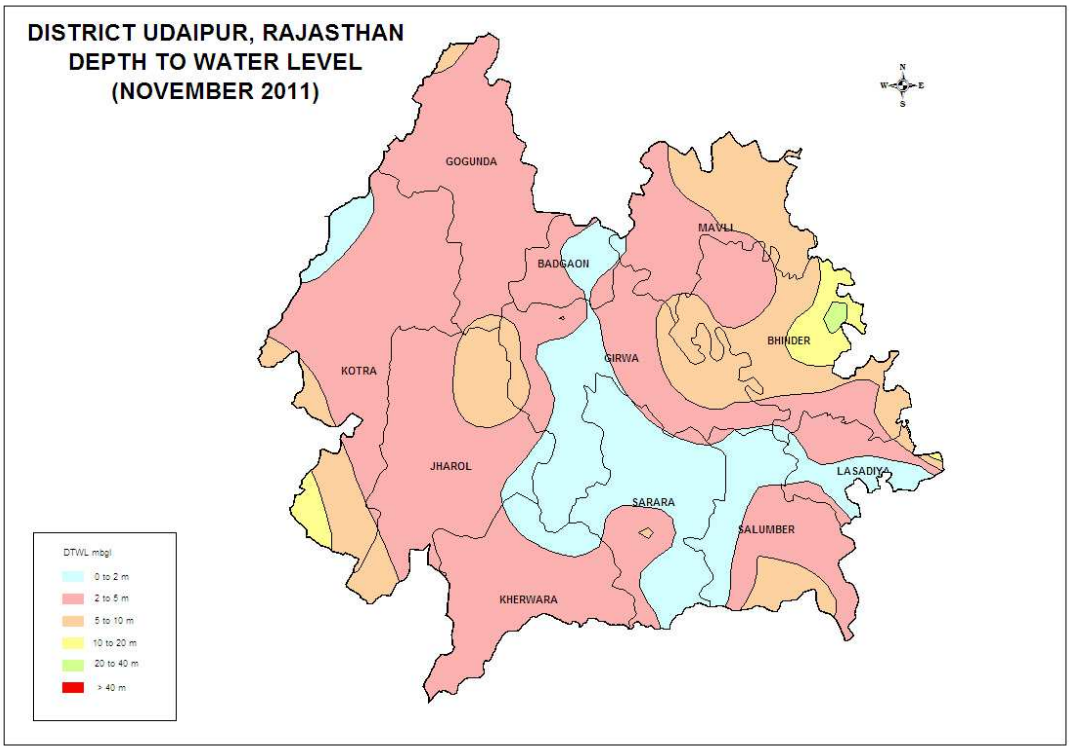

Figure 3: Depth to water level (November, 2011)

5.4 Water Level Fluctuations

Comparison of water level data of Pre and Post-monsoon (May and November, 2011) has indicated that there has been rise of more than 4 m in water level in the most part of the district (Figure 4). Fall of upto 2 m has been observed in south western part of Kotra block.

Analysis of long term Pre-monsoon water level data (May, 2002 to May, 2011) indicates that there has been rising trend in water levels of upto 25 cm/ year in major part of the district (Figure 5). Declining trend of upto 25 cm/ year has been observed in pockets in Gogunda, Mavli, Bhinder, Girwa, Jharol, Kotra, Kherwara, Sarada and Salumber blocks.

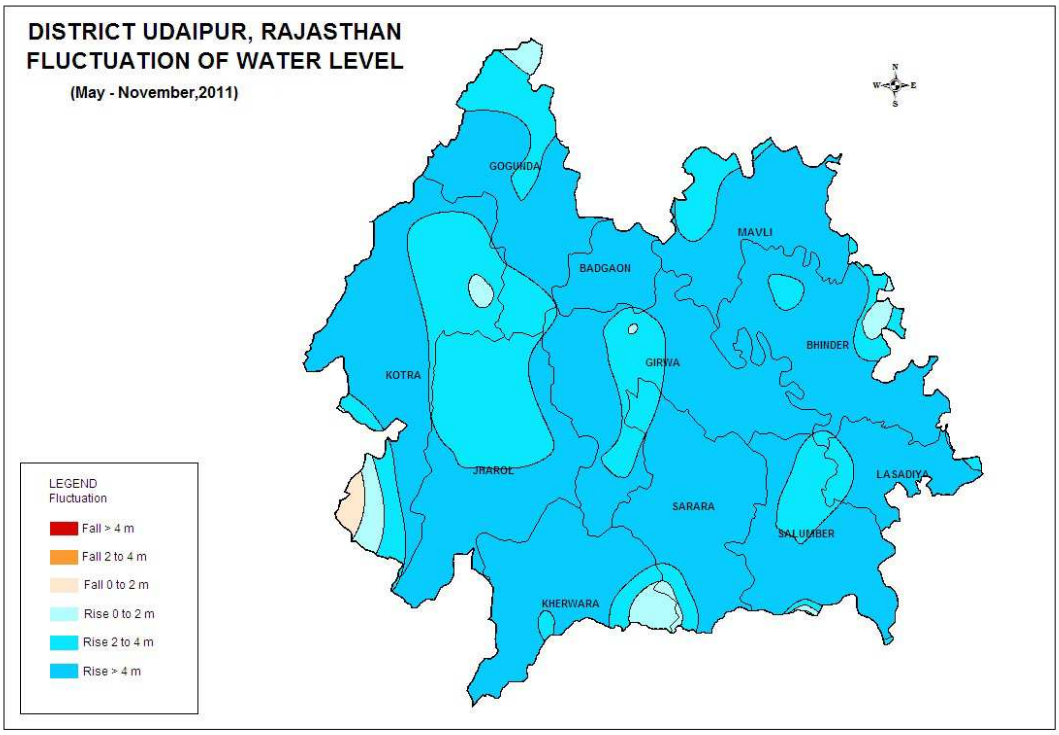

Figure 4: Seasonal water level fluctuation (May – November, 2011)

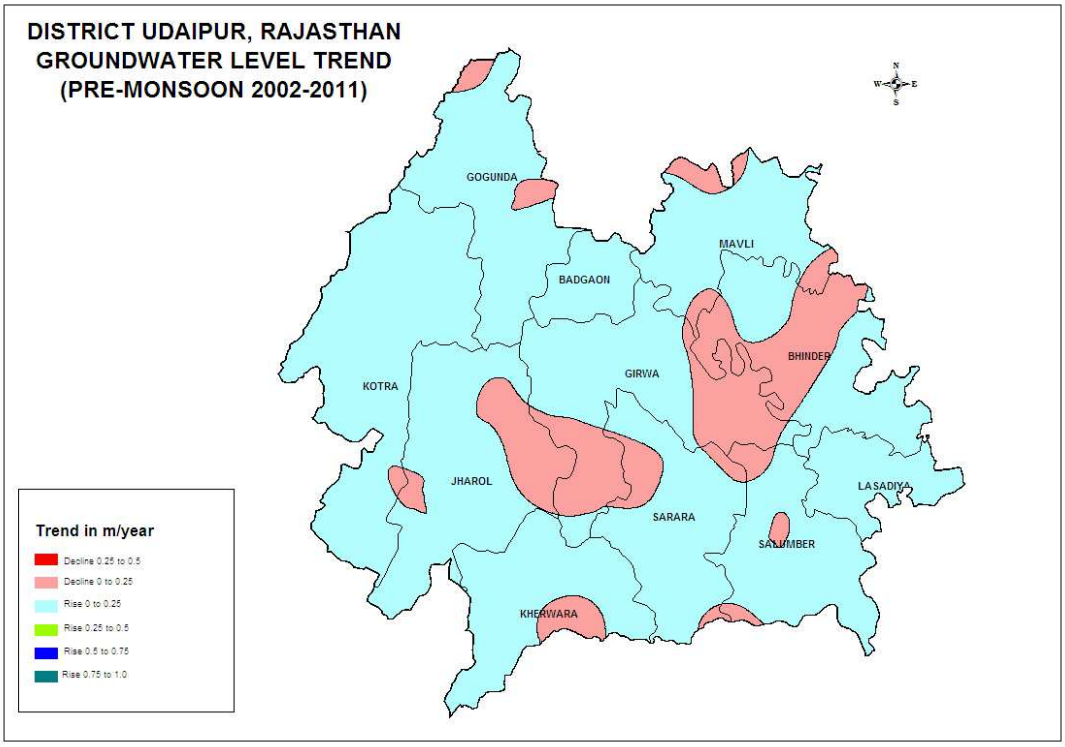

Figure 5: Decadal Pre-monsoon water level trend (May, 2002 – 2011)

5.5 Groundwater Quality

5.5.1 Water Quality in Shallow Aquifer

In general the chemical quality of ground water is very good except for small pockets. The pH of ground water varies from 7.3 to 8.04 indicating alkaline nature of ground water. The specific conductance ranges from 545 µS/cm at 25^0C at Paduna, Girwa block to 4370 µS /cm at 25^0C at Salumber (Figure 6). EC values are within 2000 µS/cm at 25^0C in major part of the district. EC values in the range of 2000 to 3000 µS/cm at 25^0C in parts of Mavli, Girwa, Kotra and Salumber blocks and higher EC values in excess of 3000 µS/cm at 25^0C have been reported from isolated pockets in Salumber and Kotra blocks.

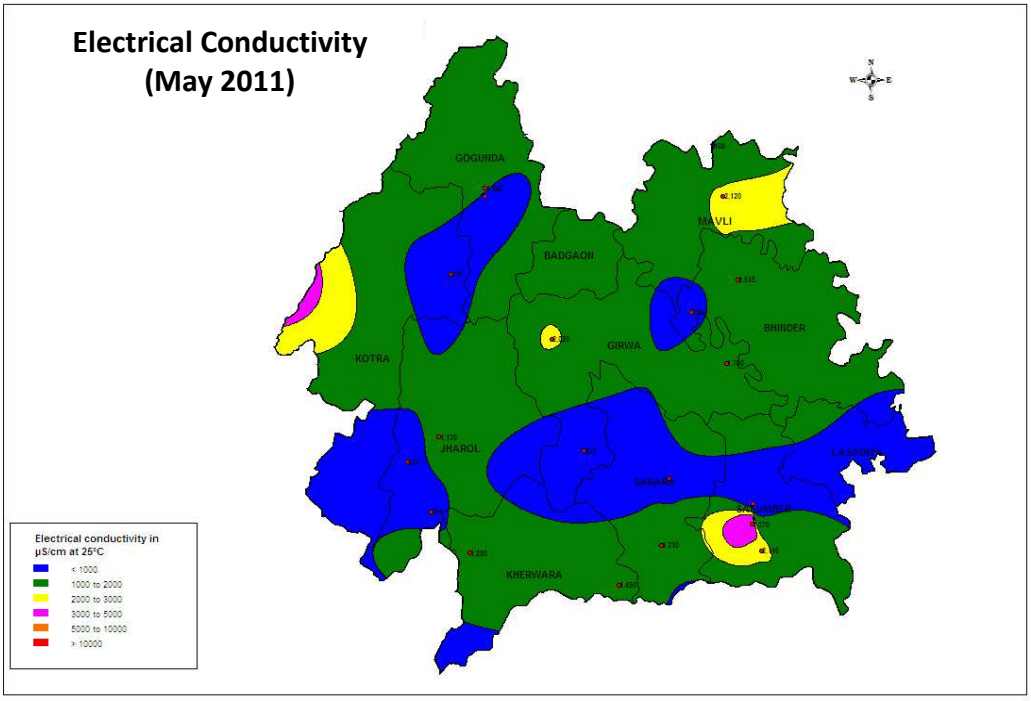

Figure 6: Iso Electrical Conductivity (May, 2011)

The concentration of chloride in major part of the district is within 500 ppm. It varies from 35 mg/l at Paduna, Girwa block to 624 mg/l in Salumber block.

The fluoride in ground water generally falls within the maximum permissible limit of 1.5 mg/l (Figure 7). High fluoride is found in an localised pockets located in the northern & southern part of the district covering parts of Mavli, Gogunda, Sarada & Salumber blocks.

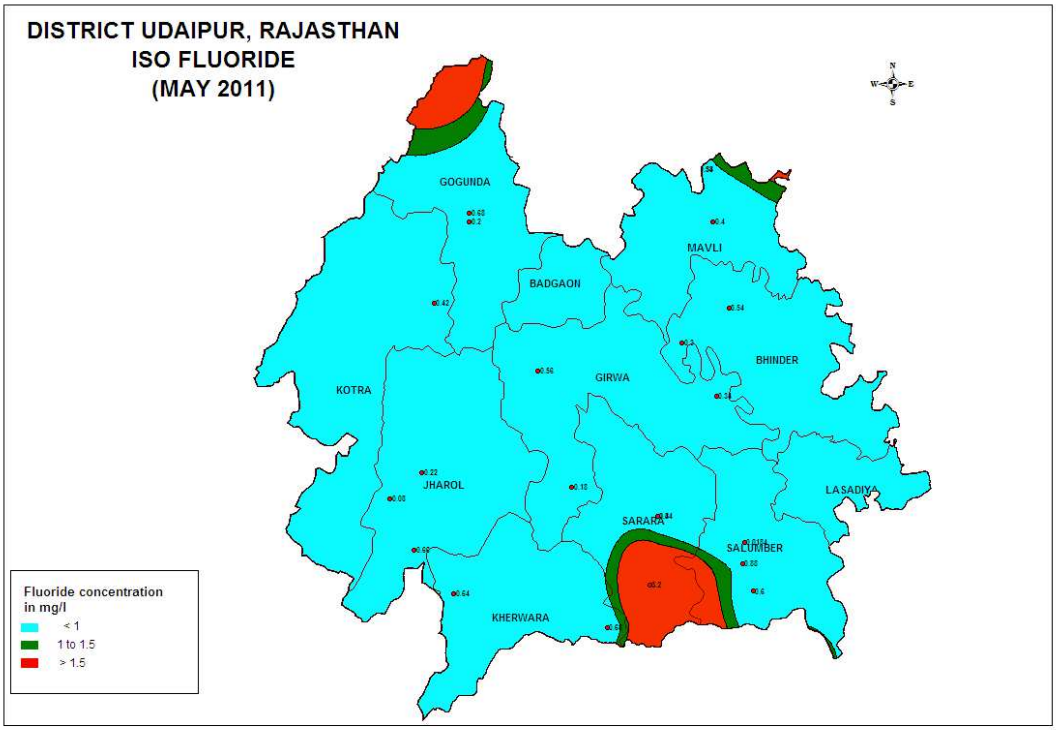

Figure 7: Iso Fluoride (May, 2011)

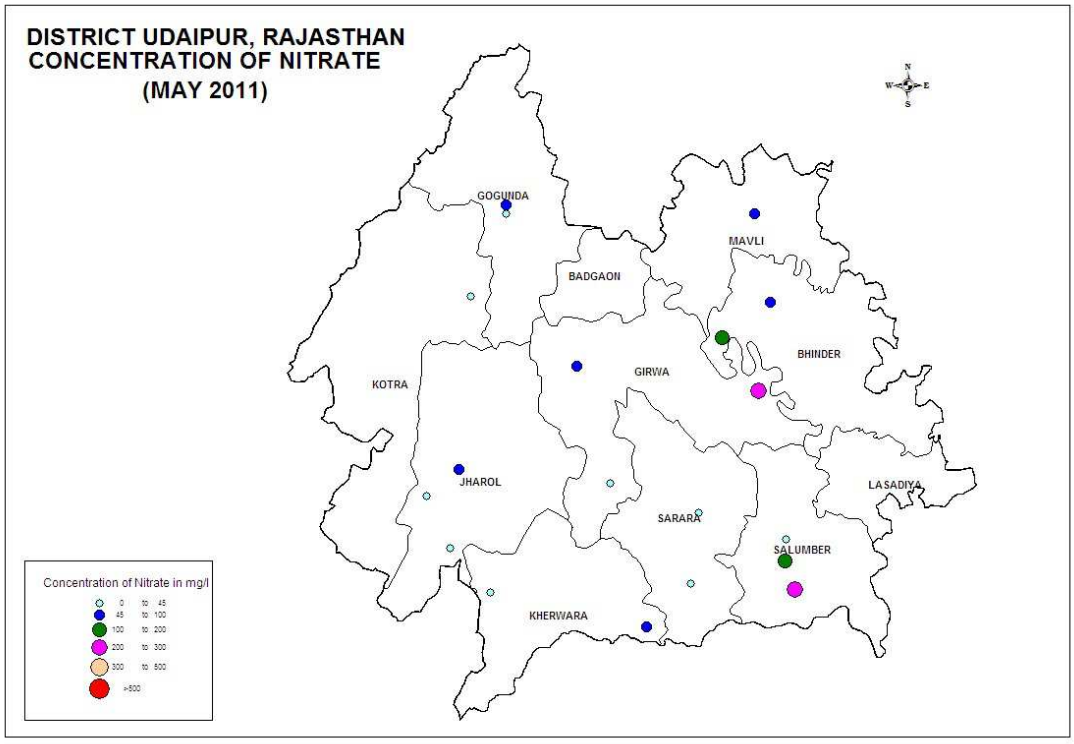

Figure 8: Nitrate distribution (May, 2011)

The concentration of Nitrate ranges from 1.8 mg/l at Srimali ki Kadia, Badgaon to 241 mg/l at Kurabar, Girwa (Figure 8) . Nitrate values in major part of the district are within 45ppm. Higher values of nitrate occur in parts of Bhinder, Gogunda,

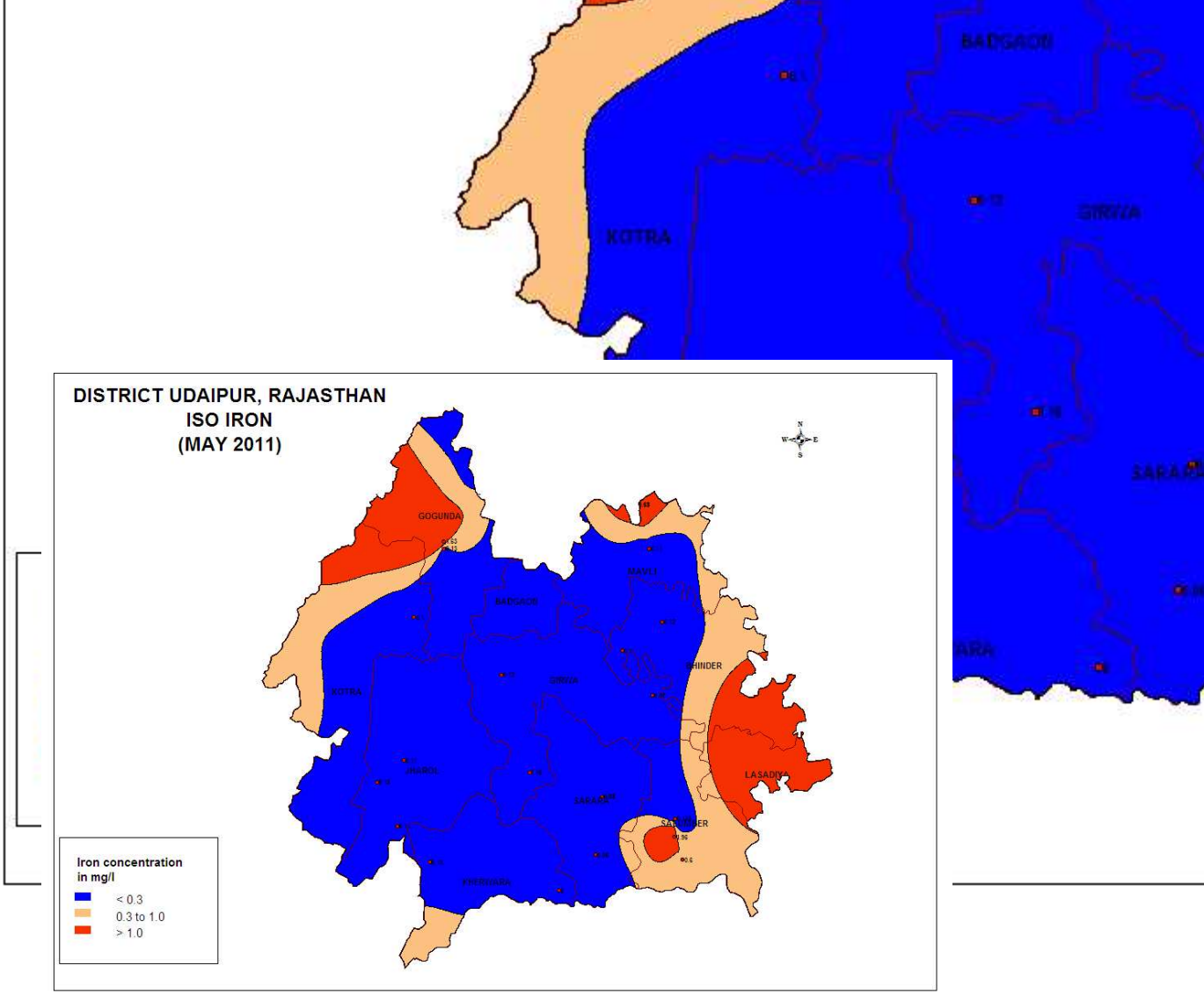

Figure 9: Iso Iron (May, 2011)

The groundwater is moderately hard to very hard in major part of the district.

5.6 Water quality in Deeper Aquifers

Electrical conductivity of water samples collected from tube wells varies from 495 to 16235 µS/cm at 25°C. In general electrical conductivity is within 3000 µS/cm at 25°C. Fluoride varies from 0.10 mg/l to 6.20 mg/l. The nitrate varies from 2 to 252 ppm in the deeper aquifer.

6.0 Groundwater 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. While assessing the ground water resources, hilly areas have not been considered. Annual replenishable ground water resource of he district has been estimated as 265.83 mcm and net annual ground water availability as 240.53 mcm. Gross ground water draft for all uses is estimated as 258.03 mcm and over all stage of development is 107%. Summarized block wise estimate of dynamic groundwater resources is given in Table 5.

Table 5: Block wise ground water resources (As on 2009)

(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	Badgaon	10.4620	9.4158	8.6844	1.9798	10.6642	113.26	OE
2	Bhinder	28.4174	25.5757	32.5116	3.0937	35.6053	139.22	OE
3	Lasadia	11.1924	10.0732	8.1546	1.0351	9.1897	91.23	C
4	Girwa	38.2564	34.4307	32.94	7.2227	40.1627	116.65	OE
5	Gogunda	24.9391	22.4452	22.1814	1.5761	23.7575	105.85	OE
6	Jhadol	22.1655	20.1994	17.718	2.2396	19.9576	98.80	C
7	Kherwara	24.8495	22.5430	18.105	2.9846	21.0896	93.55	C
8	Kotra	21.0424	18.9381	15.12	1.3396	16.4596	86.91	SC
9	Mavli	24.1304	22.6066	27.444	3.7588	31.2028	138.03	OE
10	Salumbar	34.2150	30.7935	24.9504	2.8693	27.8197	90.34	SC
11	Sarada	26.1623	23.5137	19.782	2.3345	22.1165	94.06	C
TOTAL		**265.8324**	**240.5349**	**227.5914**	**30.4338**	**258.0252**	**107.27**	**OE**

7.0 Status of Ground Water Development

Gneisses, granites, schist, phyllite, quartzite, calc-schist & calc-gneiss and alluvium form the aquifers in different parts of the district. Alluvial area is restricted to river beds. Ground water occurs under unconfined to semi-confined conditions. Depth and diameter of the dug well depends on formation and geomorphology. However, general depth of dug well ranges from 15 to 30m, details of dug wells in different formations are given in Table 6.

Table 6: Formation wise average yield and depth of dug wells

Formation	Block	Average Yield (m^3/day)	Depth in m
Calc-schist & gneiss	Gogunda	40-60	15-20
	Kotra	40-50	15-20
Granite	Kotra	35-50	15-20
Quartzite	Jhadol	25-35	20-25
Phyllite &schist	Bargaon	40-60	15-20
	Girwa	50-80	25-30
	Gogunda	50-80	20-25
	Jhadol	40-60	25-30
	Kherwara	40-60	20-25
	Kotra	`40-60	20-25
	Mavli	40-60	25-30
	Salumbar	40-60	15-20
	Sarada	40-60	15-20

Formation	Block	Average Yield (m^3/day)	Depth in m
Granites & gneiss	Bhinder	35-50	15-20
	Sarada	35-45	15-20
	Salumbar	35-45	20-25
	Mavli	35-45	20-30
	Girwa	35-45	20-25

8.0 Ground Water Development Strategy

8.1 Ground Water Development

Stage of ground water development in the district is 107%, which indicate that the scope of ground water development is already exhausted in 5 blocks where ground water development has already exceeded 100% and blocks have been categorized as “Over-exploited”. There is no scope for further development in the district for irrigation or industrial use. Moreover, 3 blocks are critical and 2 are semi critical, caution has to be exercised while planning of ground water development. Ground water resources need to be used judiciously.

8.2 Water Conservation and Artificial Recharge

Artificial recharge is not feasible in the district as the country rock is composed exclusively of hard rocks. The water level is shallow, water level gradient is steep and transmissivity is low. Under such conditions, there is likelihood that recharged water will reappear as base flow. Any induced water application will create localized mound with no change in trend of declining water level in adjacent areas.

Since the stage of ground water development has already crossed 100%, for sustainable utilization of water resources, conjunctive use of surface and ground water is inevitable. Water harvesting is the only solution through construction of bunds, anicuts, and rooftop rain water harvesting structures. The area has undergone polyphase deformation in geological past, which has resulted in a complex structure (folded, faulted and jointed) that may not be conducive for such structures. Therefore, site of these structures should be selected carefully. In last decade many water harvesting structures have already been constructed in the district. The impact of such structure needs to be studied for further implementation. CGWB has also constructed one Roof top Harvesting structure at College of Engg. And Technology, Maharana Pratap Agriculture University for the purpose of demonstration among young agriculture engineers and the farmers.

9.0 GROUND WATER RELATED ISSUES & PROBLEMS

Almost entire district is facing problem of ground water scarcity. However, there are some areas vulnerable for pollution and depleted water table. Major issues in the district are as follows:

9.1 Groundwater Depletion Hazard

Ground water in the valley fills near Ahar river, around Kanpur, has already dried up during the last decade. Most of the wells and shallow tube wells go dry during the summer season through out the district.

9.2 Water Quality Hazard

The district is well known for its Lead-Zinc deposits and related mining and smelting industry, though the effluent is treated. CGWB in its study has reported ground water pollution in nearby areas. There are many minor minerals occurring in the district like marble, soapstone and rock phosphate and also mineral based industries. The industrial and mining areas need constant monitoring for any water quality deterioration.

The ground water in many areas is hard and also brackish. At many locations in the eastern part of the, underlain by Bhilwara super group formation, salinity increases with increasing depth. Higher fluoride concentration has also been reported from many locations.

10.0 Recommendations

- Ground water draft is very high in all the blocks. Stage of ground water development in the district has reached 107.27% due to indiscriminate use. It has to be controlled by preventing further development.

- Water scarcity is a perpetual phenomenon in Udaipur inspite of many manmade lakes. The lakes which were used for domestic and irrigation purpose now are used exclusively for drinking purpose. The degradation of catchment and rapid urbanization has reduced the capacity of lakes. Now even with average annual rainfall many lakes go dry. If adequate efforts are not made to restore the catchment area, there is a possibility of losing lakes for ever.

- Revival of traditional ground water storage system i.e. *Baori*, open wells, etc. for rainwater conservation for use in day to day life will reduce ground water draft. Now most of dug wells and Baoris are not used by public because of pumped supply available and comparatively easy to use hand pumps.

- Awareness programmes and training on rainwater harvesting will be beneficial to check decline in water level and justified use.

- Taking advantage of uneven topography of the area, small WHS or earthen dams, upstream of irrigation commands, at suitable sites, may be constructed to store rainwater. This will increase recharge to ground water and would ultimately result in increase of yield of wells.

- Modern agricultural management techniques have to be adopted for effective and optimum utilization of water resources. Maintaining irrigation through minimum pumping hours as per minimum requirement of water by the crop and also selecting most suitable cost effective cropping pattern can help in water conservation.

- Surface runoff can be harnessed by constructing tanks at feasible sites in the area occupied by the hard rock terrain for supplementing irrigation potential to increase the agricultural production.
- High water requirement crops are 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.