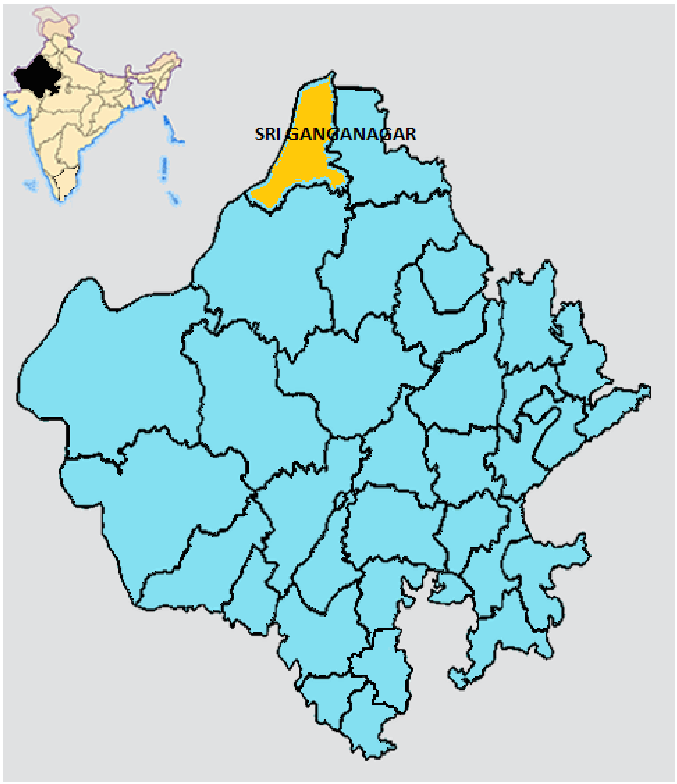
GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

Ground Water Scenario
Ganganagar District
Rajasthan



Western Region, Jaipur
2013

GANGANAGAR DISTRICT AT A GLANCE

S.No.	Item	Statistics
1	**GENERAL INFORMATION**	
	i. Geographical area (sq km)	10978 sq.km.
	ii. Administrative Division (As on 31.3.2011)	
	Number of Tehsils	9 (Sriganganagar, Karanpur, Raisinghnagar, Suratgarh, Anupgarh, Padampura, Sadulshahar, Vijaynagar, Gharsana)
	Number of blocks	7 (Sriganganagar, Karanpur, Raisinghnagar, Suratgarh, Anupgarh, Padampura, Sadulshahar)
	Number of villages	3029
	iii. Population (As per 2011 Census)	1969168
	iv. Average Annual Rainfall	255.09 mm
2.	**GEOMORPHOLOGY**	
	Major Physiographic Units	Alluvial Plains, Flood Plain, Sand dunes and Inter-dunal Depressions
	Major Drainage	Ghaggar river
3.	**LAND USE (ha) (As on 2010-11) (Source: Dte. Of Economics & Statistics, Ministry of Agriculture, GOI)**	
	i. Forest Area	60517
	ii. Net Sown Area	769860
	iii. Total Cropped Area	1072730
4.	**MAJOR SOIL TYPE**	Seirozems, desert soil
5.	**PRINCIPAL CROPS (As on 2011-12) (Source:www.ganganagar.nic.in)**	
	Crop	**Average yield**
	Foodgrain	3070 Kg/ha
	Oil seeds	1185 Kg/ha
	Sugarcane	21672 Kg/ha
	Cotton desi	12 quintals/ha
	Cotton American	14 quintals/ha
6.	**IRRIGATION BY DIFFERENT SOURCES (As on 2010-11) (Source: Dte. of Economics & Statistics, Ministry of Agriculture, GOI)**	
	Source	**Area irrigated (ha)**
	Tubewells	3920
	Other wells	423
	Canal	570799
	Net area irrigated	575142

S.No.	Item	Statistics
	Gross area irrigated	866419
7.	**NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (As on May, 2012)**	
	Dugwells	38
	Piezometers	4
8.	**PREDOMINANT GEOLOGICAL FORMATIONS**	Jodhpur sandstone, Nagaur sandstone, limestone and evaporate sequence, Palana sandstone and Quaternary alluvium
9.	**HYDROGEOLOGY**	
	Major water bearing formation	Alluvium
	Depth to Water Level (Pre-monsoon, 2011) (mbgl)	0.9 to 43.2 m
	Depth to Water Level (Post-monsoon, 2011) (mbgl)	0.6 to 43.34 m
	Long Term Water Level Trend (2002 – 2011) (m/year)	
10.	**GROUND WATER EXPLORATION BY CGWB**	
	Number of wells drilled	EW- 14 , SH- 3, PZ- 17
	Depth drilled (m)	85.39 to 229.82
	Discharge (litre per minute)	180 to 1200
	Transmissivity (m^2/day)	375 to 723
11.	**GROUND WATER QUALITY**	
	Major quality problems	Inland salinity Nitrate, Sulphate, Magnesium and iron contamination at places.
	Type of water	Mix Bi-carbonate
12.	**DYNAMIC GROUND WATER RESOURCES (As on March, 2009) (mcm)**	
	Annual replenishable ground water resource	387.15
	Net Annual Ground Water Availability	348.43
	Annual Ground Water Withdrawal	160.22
	Stage of Ground Water Development (%)	45.98
13.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Water logging in canal command area and along natural depressions Salinity in ground water

GROUND WATER SCENARIO
DISTRICT GANGANAGAR, RAJASTHAN

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GROUND WATER SCENARIO
DISTRICT GANGANAGAR, RAJASTHAN

1.0 Introduction

Ganganagar district is located in the northernmost part of Rajasthan State and extends between latitudes 28o42'30'' and 30o12'00" N and longitudes 72o39'15" and 74o18'30"E. Occupying an area of around 11154.66 sq km, the district is surrounded by Bikaner and Hanumangarh districts of Rajasthan, Ferozpur district of Punjab and International border of Pakistan in the south, east, north and west respectively.

For administrative convenience, the district is divided into 9 tehsils and 7 development blocks viz. Sriganganagar, Karanpur, Raisinghnagar, Suratgarh, Sadulshahar, Anupgarh, Padampura, Vijaynagar and Gharsana tehsils and Sriganganagar, Karanpur, Raisinghnagar, Suratgarh, Sadulshahar, Anupgarh and Padampur blocks. It has a total population of 1969168 as per 2011 Census. The district has 3014 villages and 12 cities and towns. Rural and urban population of the district is 14.34 lakh and 5.36 lakh respectively.

Central Ground Water Board has taken up various scientific studies in the district. A list of studies carried out in the district is given in Table 1.

Table 1: Scientific studies undertaken by Central Ground Water Board

S.No.	Officer/ Project	AAP	Type of Study
1.	M. Mehta	1971-72	Study on hydrogeological conditions (GSI)
2.	O.P. Mathur	1971-72	Study on hydrogeological conditions (GSI)
3.	Ghaggar River Basin Project (UNDP)	1975-78	Water Balance Study
4.	Dr. Ratesh Kumar	1983-84	Systematic Hydrogeological Survey
5.	R.P. Mathur	1983-84	Systematic Hydrogeological Survey
6.	Abrar Hussain	1984-85	Reappraisal Hydrogeological Survey
7.	Suresh Kumar	1984-85	Reappraisal Hydrogeological Survey
8.	S.C. Dhiman	1984-85	Reappraisal Hydrogeological Survey
9.	Suresh Kumar	1985-86	Reappraisal Hydrogeological Survey
10.	S.K. Jain	1984-85	Conjunctive use studies
11.	CGWB	1992-95	Conjunctive use studies

The report on Hydrogeological framework and development prospects in Ganganagar district has been brought out by Central Ground Water Board in the year 2006. During 1969, six observation wells were established by the erstwhile Ground Water Wing of Geological Survey of India for ground water regime monitoring. The number of monitoring wells was increased to 41 by 1978 by Central Ground Water Board to have better coverage of the district. Presently, ground water regime monitoring is being carried out in the district from a network of 42 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.

Under Ground Water Exploration Programme, 34 exploratory boreholes (14EW+3SH+17PZ) have been drilled till March, 2011. Salient features of ground water exploration are listed in Table 2. A map of the district showing block boundaries and locations of exploratory boreholes is presented in Fig. 1.

Table 2: Salient features of ground water exploration in Ganganagar district

Block	Type of borehole	Formation tapped	Depth drilled (m)	SWL (m)	Discharge (lpm)	Drawdown (m)	T m2/day	S
Anupgarh	EW 3 SH 1 PZ 1	Alluvium	124 to 543.51	7.3 to 18.67	140 to 1200	5.41 to 12.68	535 to 555	0.011 to 0.0015
Ganganagar	PZ 1	Alluvium	200.56	6.5	-	-	-	-
Gharsana	PZ 1	Alluvium	158.36	16.25	-	-	-	-
Karanpur	SH 1	Alluvium	415.88	-	-	-	-	-
Padampur	EW 1 PZ 2	Alluvium	27 to 202	22.2	180	6.25	375	0.01
Raisinghnagar	EW 2 PZ 1	Alluvium	150 to 248	16.46 to 27.18	433	3.79	723	0.022
Sadulshahar	PZ 3	Alluvium	149.32 to 223	22.04 to 42.9	210	-	-	-
Suratgarh	EW 8 SH 1 PZ 8	Alluvium	35 to 229.51	2.95 to 47.28	40 to 400	1.89 to 6.63	-	-

EW : Exploratory well, OW: Observation well, PZ: Piezometer, mbgl: metres below ground level, lps: litres per second

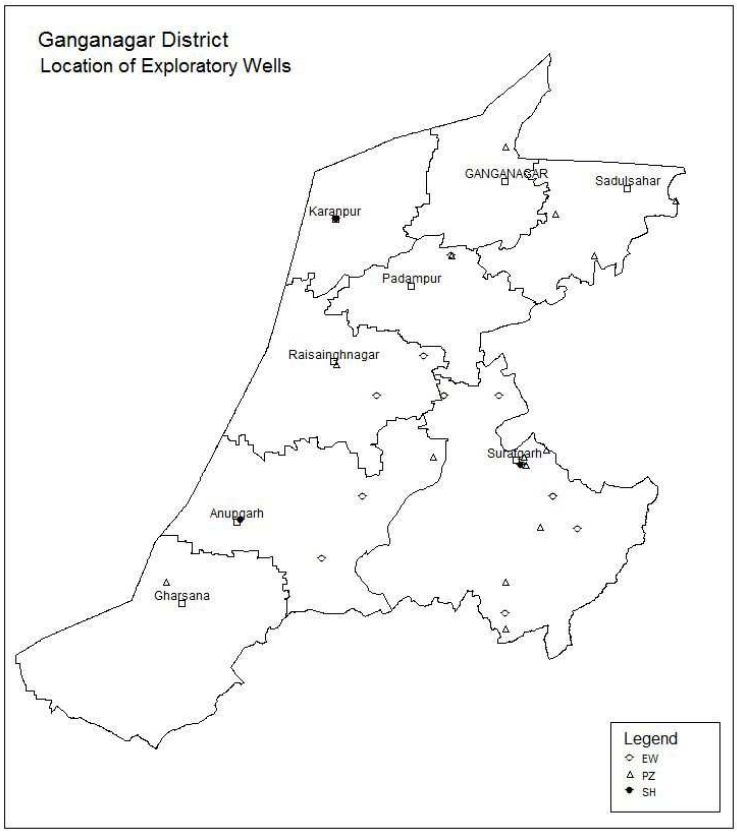

Fig. 1: Map of Ganganagar district indicating locations of exploratory boreholes

2.0 Climate And Rainfall

Arid type of climate prevails in major part of the district. It is characterized by hot summer and cold winter. Mean daily minimum temperature is 4.7^{o}C and mean daily maximum temperature is 42.1^{o}C. Southwest monsoon season prevails during June to mid of September, which is followed by post monsoon period till the end of November. The winter season sets by the middle of November. January is the coldest month with mean daily maximum as well as minimum being the lowest at 20.5^{o}C and 4.7^{o}C respectively. In the end of February temperature starts rising till

June, is the hottest month with mean daily maximum temperature of 42.1^{o}C. Mean daily minimum temperature is highest (28.1^{o}C)(during the month of July. The district on an average receives 293.2 mm of rainfall.

The Normal Annual Rainfall of the district during the period 1901-2008 has been 228.1 mm. The Average Annual Rainfall of the district during the last eleven years (2001 to 2011) was 255.09 mm and varied from 191.27 mm at Raisinghnagar to 361.91 mm at Sadulshahar. Annual rainfall data of the district for the period 2001 to 2011 is presented in Table 3.

Table 3: Annual Rainfall Data (2001 – 2011)

(Rainfall in mm)

Block	Station	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Anupgarh	Anupgarh	250	111	217	85	180.5	349	190	258	229	269	223	214.68
Ganganagar	Ganganagar	305	98	419.5	170	191	292	479	292	350	355	453	309.50
Karanpur	Karanpur	248	73	205	175	105	260	326	234	225	302	389	231.09
Padampur	Padampur	245	50	196	192	156.5	273	628	428	235	477	511	308.32
Raisinghnagar	Raisinghnagar	163	86	208	63	132	135	151	222	178	332	434	191.27
Suratgarh	Suratgarh	331	68	201	117	199	230	242	351	299	432	244	246.73
Sadulshahar	Sadulsahar	498	140	413	237	237	427	455	325	375	296	578	361.91
Anupgarh	Gharsana	277	100	302	121	201	215	235	264	135	190	246	207.82
Anupgarh	Vijaynagar	301	71	173	103	237.5	114.6	257	413	148	390	261	224.46

Drought analysis indicates that either mild or normal type of drought occurs once in two years at Ganganagar and Suratgarh tehsils. Severe droughts have also been recorded four times at Anupgarh and Sadulshahar. Very severe drought has been experienced in the district only once at Raisingnagar, Anupgarh and Suratgarh.

3.0 Geomorphology

The district is a part of Thar desert and is covered by thick layer of alluvium and wind blown sand. Northern part of the district is nearly plain and is underlain by alluvium. South of this alluvial plain are middle sandy plains which are somewhat affected by sand dunes. Central part is characterized by E-W trending longitudinal alluvial belt, the Ghaggar flood plains varying in width from 3 to 12 km. Southern part of the district lies under thick blanket of wind blown sand which at places forms sand dunes varying in height from 5 to 50 m. The district is also characterised by a number of natural depressions bounded by sand dunes of variable geometry.

There is only one marked surface drainage feature viz. Ghaggar river, which traverses from northeast to southwest and finally enters Pakistan. It is an ephemeral river which flows in response to rainfall. Sometimes, the river is flooded during monsoon period. As a flood control measure, excess water during from Ghaggar

river is diverted through a diversion channel into the natural depressions in the southeast of Suratgarh.

The district is drained by canals of (1) Bhakra canal system, (2) Indira Gandhi Nahar Pariyojana and (3) Gang canal system.

Bhakra canal system: Bhakra canal draws water from Govind Sagar which is fed by Sutlej and Beas rivers. Rajasthan's share in Sutlej water is 2096 million cubic metres (mcm)/year. It provides irrigation to 372,000 hectares (ha) area through a total of 1,949 km of canal network. Branches of Bhakra canal irrigate northern and northeastern parts of Ganganagar district.

Indira Gandhi Nahar Pariyopjana: Indira Gandhi Nahar Pariyojana is a multi-disciplinary irrigation project conceived to use 10.69 billion cubic metres (bcm) of water available from Ravi and Beas rivers annually to cultivate 1087 million hectares (mha) of land in Thar desert of western Rajasthan. The IGNP Stage I includes Anupgarh and Suratgarh branches/ distributaries in Ganganagar district.

Gang Canal System: Gang canal begins at Hussainiwala head works in Punjab. The upper section of this canal is lined and is known as Bikaner canal. It enters Rajasthan from the north, and is known by the name Gang canal. It is unlined and irrigates a significant part of Ganganagar district.

4.0 Soil Types and Irrigation Practices

The northern part of the district is characterised by sierozems or arid soils which are light yellowish brown to pale in colour. Presence of kankar layer (calcareous concretions) has been noticed in the depth range of 75 to 100 cm. Soils are deep and moderately drained. Permeability is moderate to moderately slow and water holding capacity and natural fertility are generally poor. Loamy sand and sandy loam are the predominant types of soil met within this soil group. At places, patches of sand also occur.

The southern portion of the district is characterized by desert soils, which are very pale brown to yellowish brown in colour and are generally devoid of lime concretions. Soils are generally well drained to excessively drained and have low moisture holding capacity and high permeability.

Principal means of irrigation in the district is through canals, though some areas are irrigated by wells/ tubewells. As per the data available on the website of Dte. of Economics and Statistics, Ministry of Agriculture, Govt. of India, as on 2009-10, net area irrigated from canals is 526562 hectares while ground water irrigates only a small area of 842 hectares. Total net area irrigated is 527404 hectares and gross area irrigated is 788016 hectares including 786895 hectares of area irrigated by canals and 1121 hectares of area is irrigated by tubewells.

5.0 Ground Water Scenario

5.1 Geological Framework

The entire Ganganagar district is covered by Quaternary Alluvium overlain by thin veneer of wind blown sand in the central part and by high sand dunes in the southern part. In the northern part and in Ghaggar flood plain, alluvium is without any blown sand cover. Quaternary alluvium is mostly fluviatile in origin and consists of alternating sequences of sand, silt and clay. The alluvium is underlain by rocks of Marwar Supergroup and Plana Series of Palaeozoic and Tertiary age respectively.

5.2 Hydrogeology

A map depicting the hydrogeological features of the district is shown in Fig. 2. Sand dunes and intervening depressions comprise of older or newer alluvium depending upon topographic position with respect to the present flood plain. The ground water in the district occurs under water table condition but at a few places, it also occurs under confined conditions due to presence of overlying impermeable clay horizons. Alluvial thickness varies from 10 m to a maximum of 40 m in the northern part and 40 m to 80 m in the southern part of the district.

Depth to confining bed varies from 40 to 100 m in the northern part whereas it lies between 90 m and more than 100m in the southern part. Thickness of confining stratum varies from 10 to 20 m in the northern part and 10 to 40 m in the southern part.

The confined aquifer belongs to basal part of alluvium and those associated with Palana and Nagaur sandstone. Rocks of Palana and Nagaur are not exposed anywhere but have been encountered below the alluvium at varying depths in exploratory boreholes drilled by CGWB.

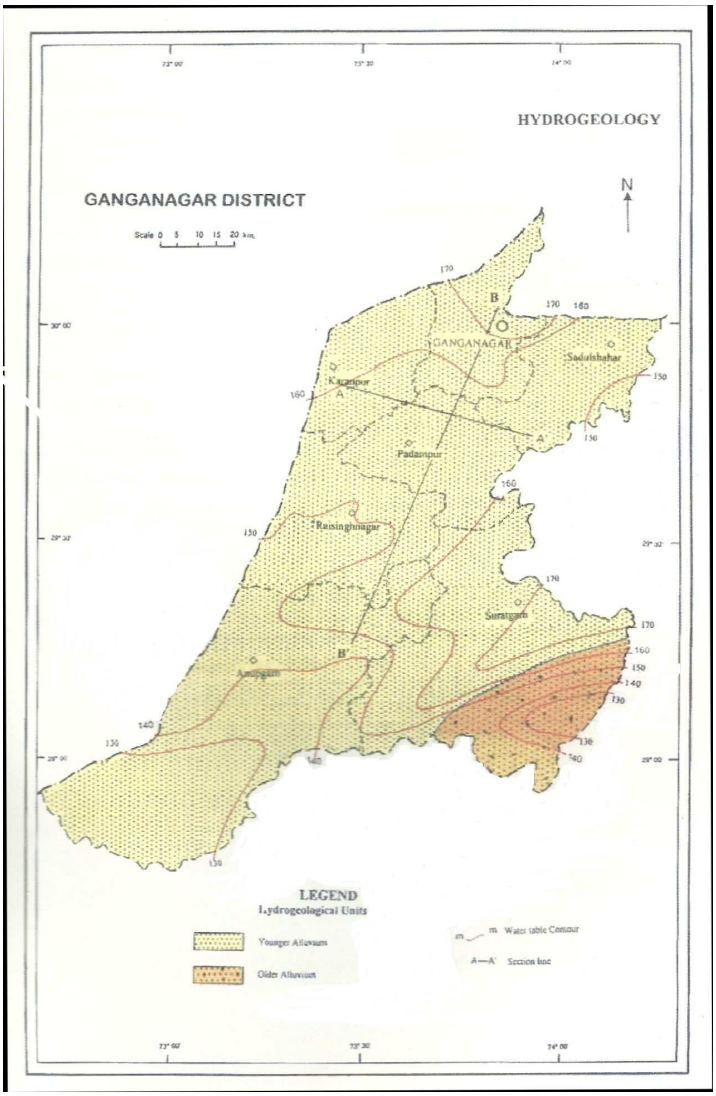

Fig. 2: Hydrogeology of Ganganagar district

Yield of exploratory wells tapping alluvium varies from 180 to 430 lpm for drawdown of 3.75 to 13 m. Transmissivity values of aquifer range from 375 to 723 m^2/day. The Storativity values range from $1.50x10^{-3}$ to $1.0x10^{-2}$ indicating phreatic ground water condition.

5.3 Water level scenario

Central Ground Water Board periodically monitors the ground water on regional scale through a network of 42 observation wells located throughout the district. Water levels are monitored four times in a year during the months of January, May (Premonsoon), August and November (Postmonsoon).

5.3.1 Depth to Water Level (Premonsoon 2011)

The depth to water level varies widely depending upon topography, drainage, bedrock geology etc. Depth to water varies from 0.90m at Mahiyanwali in Ganganagar to 43.20 m at Birdhwali in Suratgarh block. Groundwater is deeper in major part of Sadulshahar block and southeastern part of Suratgarh and southwestern part of Anupgarh block. Water levels are shallower in remaining parts of the district. In general depth to water level varies from 5m to 30mbgl. Block wise details of regional depth to water level as observed during May 2011 are given in Table 4 and depth to water level map as on May, 2011 is presented in Fig. 3.

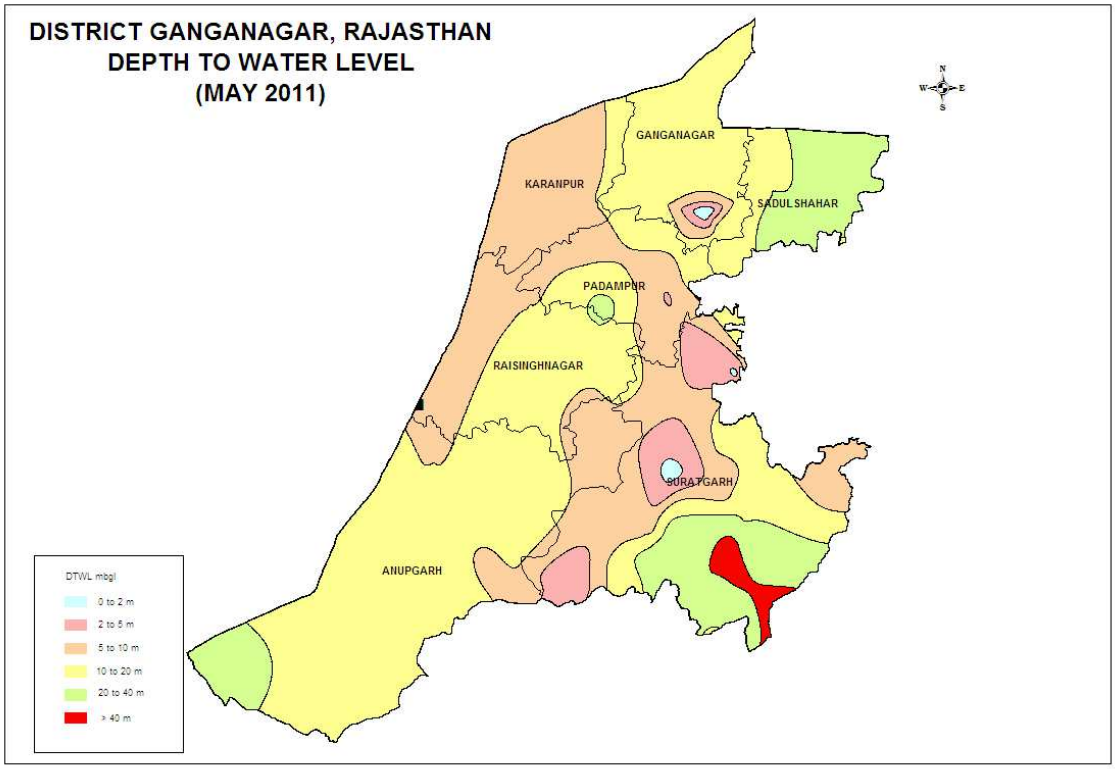

Fig. 3: Depth to Water Level (May, 2011)

Table 4: Block wise details of depth to water level during May, 2011

Block	No. of wells	Depth to water (mbgl)		No. of wells showing depth to water level in the range					
		Min.	Max.	0-2	2-5	5-10	10-20	20-40	>40
Ganganagar	4	0.9	15.97	1	-	-	3	-	-
Karanpur	3	5.55	9.36	-	-	3	-	-	-
Sadulshahar	2	20.05	23.33	-	-	-	-	2	-
Padampur	4	4.95	21.97	-	1	1	1	1	-
Raisinghnagar	5	9.68	12.55	-	-	1	4	-	-
Suratgarh	11	1.61	43.2	2	1	3	1	3	1
Anupgarh	7	8.06	14.99	-	-	4	2	-	-

5.3.2 Depth to Water Level (Post Monsoon 2011)

During November, 2011, water level varied widely from 0.6 m at Mahiyanwali in Ganganagar block to 43.34 m at Birdhwali in Suratgarh block. Water level is shallower in central and western part of the district. In general, depth to water level varies from 5 to 20 m in the district. Block wise details of regional depth to water level as observed during November, 2011 are given in Table 5 and depth to water level map as on November, 2011 is presented in Fig. 4.

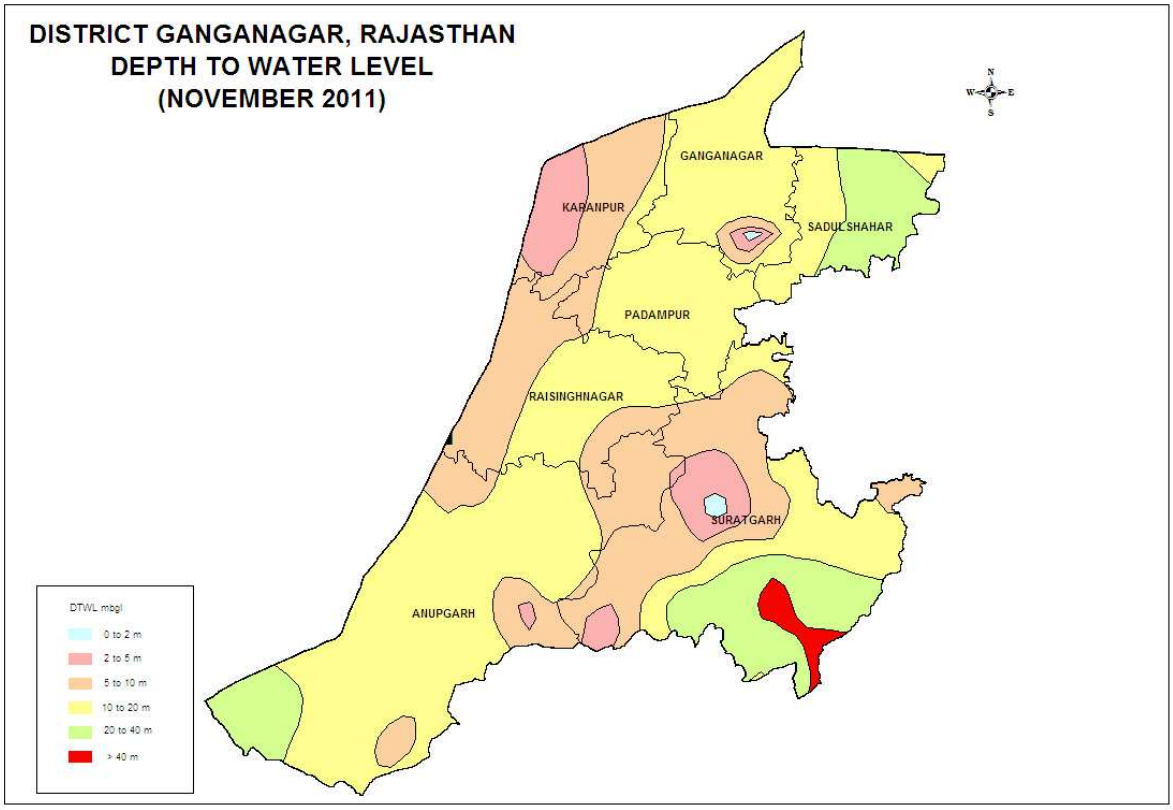

Fig. 4: Depth to Water Level (November, 2011)

Table 5: Block wise details of depth to water level during November, 2011

Block	No. of wells	Depth to water (mbgl)		No. of wells showing depth to water level in the range					
		Min.	Max.	0-2	2-5	5-10	10-20	20-40	>40
Ganganagar	4	0.6	17.03	1	-	-	3	-	-
Karanpur	3	3.75	10.04	-	1	1	1	-	-
Sadulshahar	2	19.8	21.21	-	-	-	1	1	-
Padampur	4	11.63	17.59	-	-	-	4	-	-
Raisinghpura	5	9.27	12.65	-	-	1	4	-	-
Suratgarh	11	1.55	43.34	1	1	4	1		
Anupgarh	7	4.16	15.01	-	1	4	2	-	-

5.3.3 Water Level Fluctuation

Map on seasonal fluctuation in water level based on Pre and Post-monsoon 2011 indicates that there has been rise in water level in major part of the district (Fig. 5). Decline in water level has been observed in central part of the district comprising major part of Padampur block and small areas in Ganganagar, Sadulshahar and Karanpur blocks and in the southern part of the district in parts of Suratgarh and Anupgarh blocks. Blockwise details of water level fluctuation during Pre- and Post-monsoon periods, 2011 are given in Table 6.

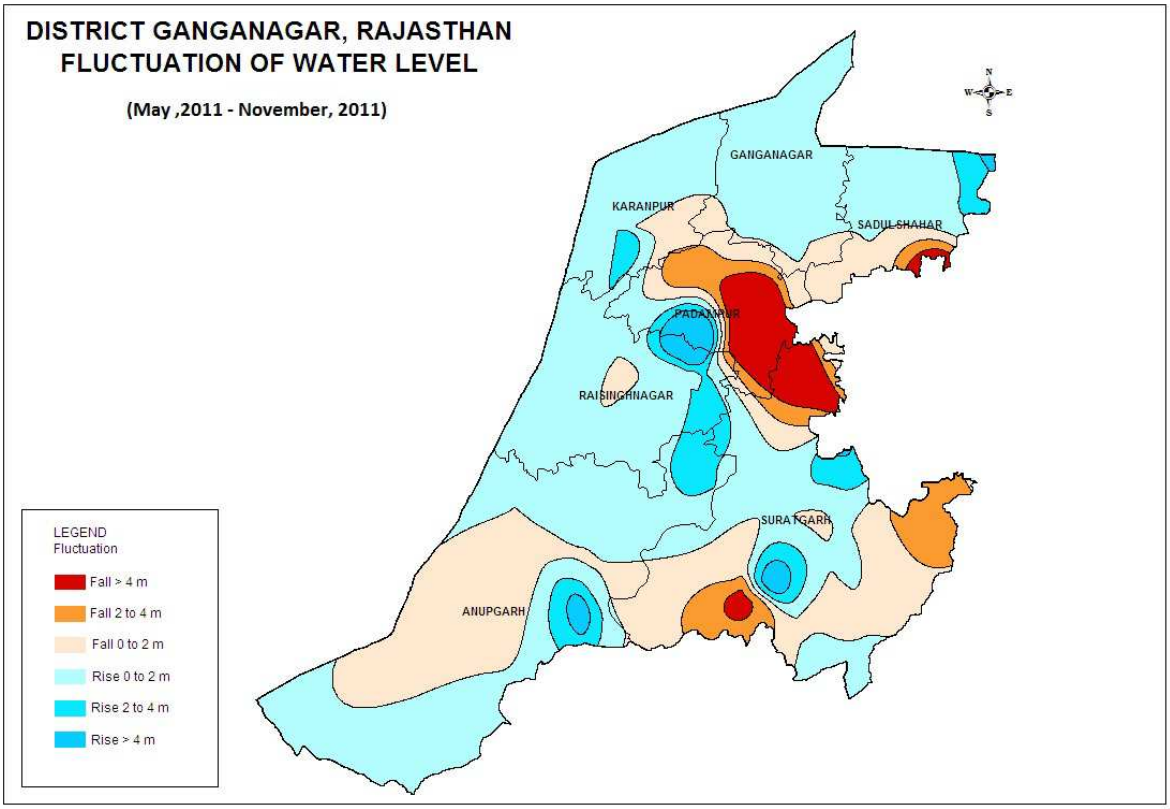

Fig. 5: Water level fluctuation (May, 2011 – November, 2011)

Table 6: Block wise details of water level fluctuation in Ganganagar district (May – November, 2011)

Block	Rise			Fall		
	No. of wells	Minimum	Maximum	No. of wells	Minimum	Maximum
Ganganagar	3	0.14	0.3	1	1.06	
Karanpur	2	0.26	3.46	1	0.68	
Sadulshahar	2	0.25	2.12	-	-	-
Padampur	1	8.84		3	0.07	10.29
Raisinghpura	4	0.12	3.12	1	0.1	
Suratgarh	3	0.06	4.98	8	0.14	4.64
Anupgarh	5	0.49	4.6	2	0.02	1.58

5.3.4 Water Level Trend (2002-11)

Trend of water levels for pre-monsoon and post-monsoon periods for last 10 years (2002-2011) has been computed. The analysis of water level trend indicates that during pre-monsoon period, majority of monitoring stations in the district have registered rising trend upto 0.25 m/yr except in some parts of Suratgarh, Sadulshahar, Padampur and Raisinghnagar blocks where declining trend upto 0.25 m/yr has been observed. During post-monsoon period also, major part of the district has registered rising trend upto 0.25m/yr. Declining trend has been observed only in a few isolated pockets in Suratgarh, Anupgarh, Padampur, Ganganagar and Sadulshahar blocks.

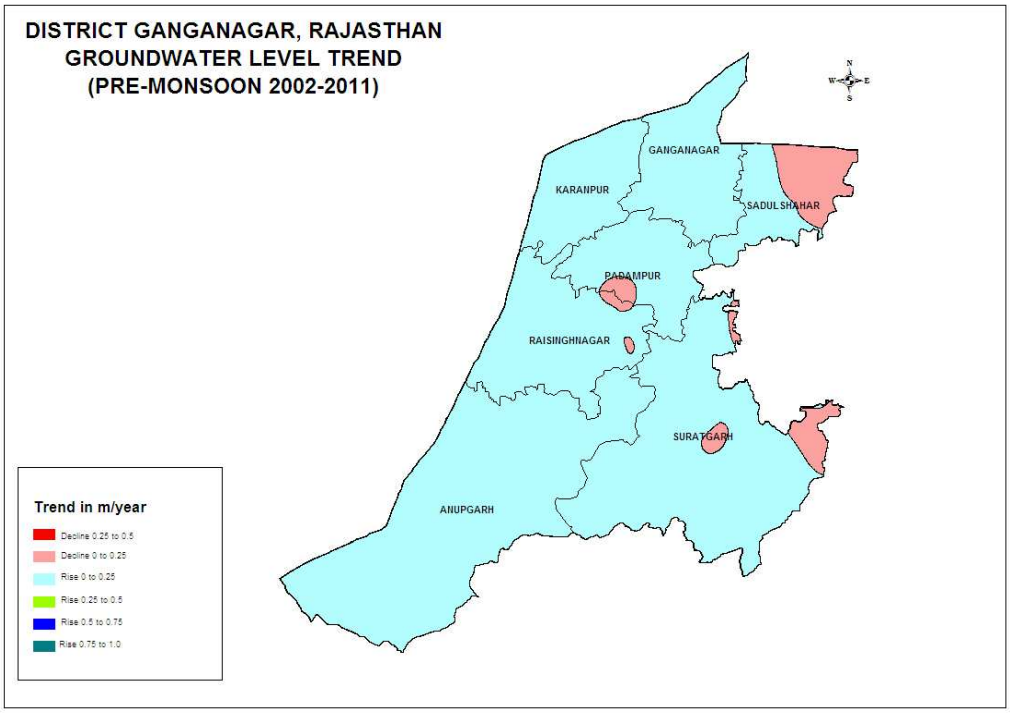

Fig. 6: Decadal water level trend during Pre- monsoon (May, 2002-May,2011)

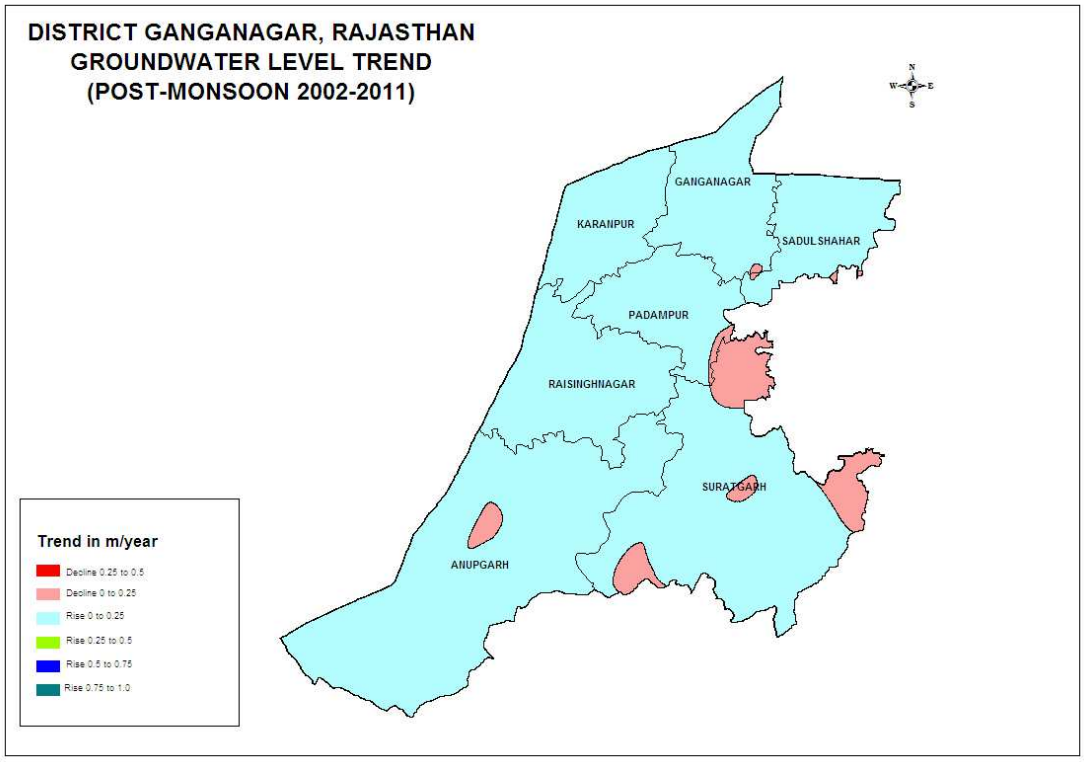

Fig. 7: Decadal water level trend during Post-monsoon (November, 2002-November,2011)

5.4 Groundwater Quality

5.4.1 Water Quality in Shallow Aquifer

The native groundwater in Ganganagar district is brackish to saline except for Ghaggar flood plain area and along major unlined canals in the area. Distribution of Electrical conductivity in the district is shown in Fig. 8. EC varies from 2000 to 10000 ms/cm at 25^{o}C in most part of the district. In the area occupied by Ghaggar flood plain, EC is found to be below 2000 ms/cm at 25^{o}C. EC value has been found to range from 252 ms/cm at 25^{o}C at Chunawala, Ganganagar block to 10490 ms/cm at 25^{o}C at Jagatsinghwala in Raisinghnagar block. As large part of the district falls under canal commands, quality of shallow ground water in the wells located extensively in irrigated tracts or along unlined canal is potable and the electrical conductivity of water is within 2000 ms/cm at 25^{o}C. Seepage from canals has, therefore, improved the quality of phreatic aquifer. Concentration of carbonates is nearly negligible and that of bicarbonates varies from 66 to 683 mg/l. Chlorides vary from 21 mg/l at 22 LGW in Suratgarh block to 2258 mg/l at Jagtasinghwala in Raisinghnagar block. Ground water quality is fresh down to depth of 50m at Anupgarh and Raisinghnagar. Below the shallow fresh water zone, ground water is highly saline.

Concentration of fluoride in all the ground water samples is found to be within the permissible limit of 1.5 mg/l varying from 0.002 mg/l at Sangita in Suratgarh block to 1.134 mg/l at Banda Colony, Anupgarh block. Fluoride distribution in ground water in the district is shown in Fig. 9.

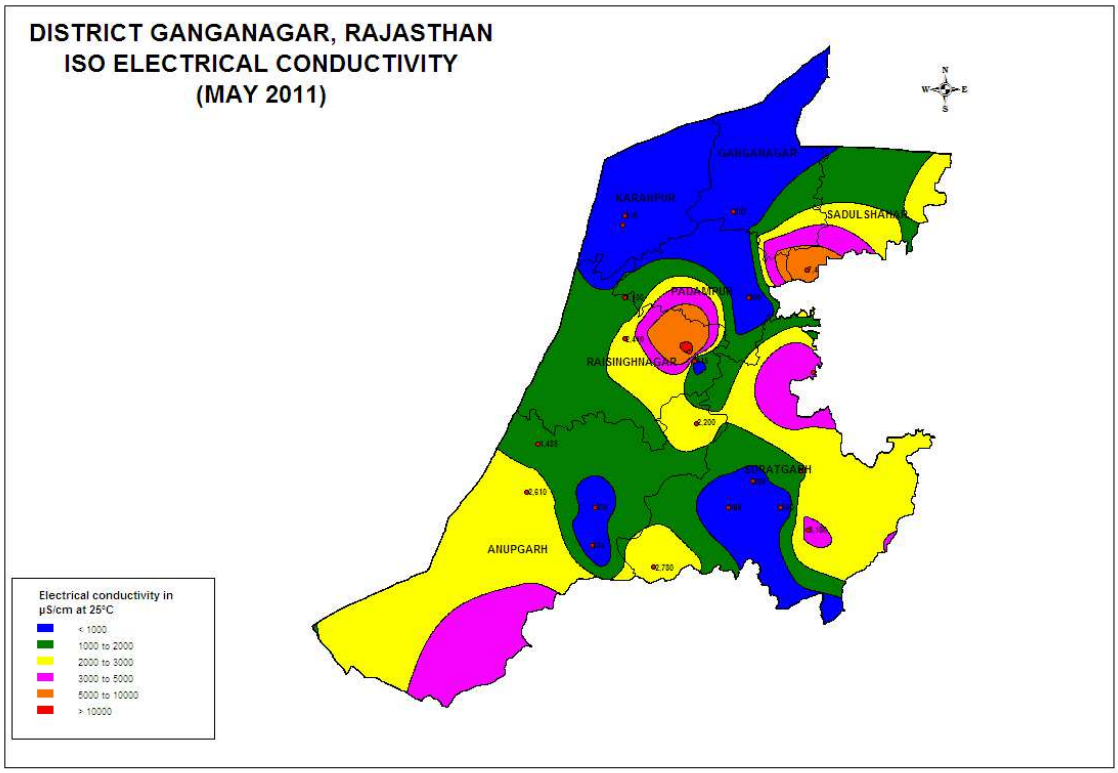

Fig. 8: Distribution of Electrical Conductivity in ground water

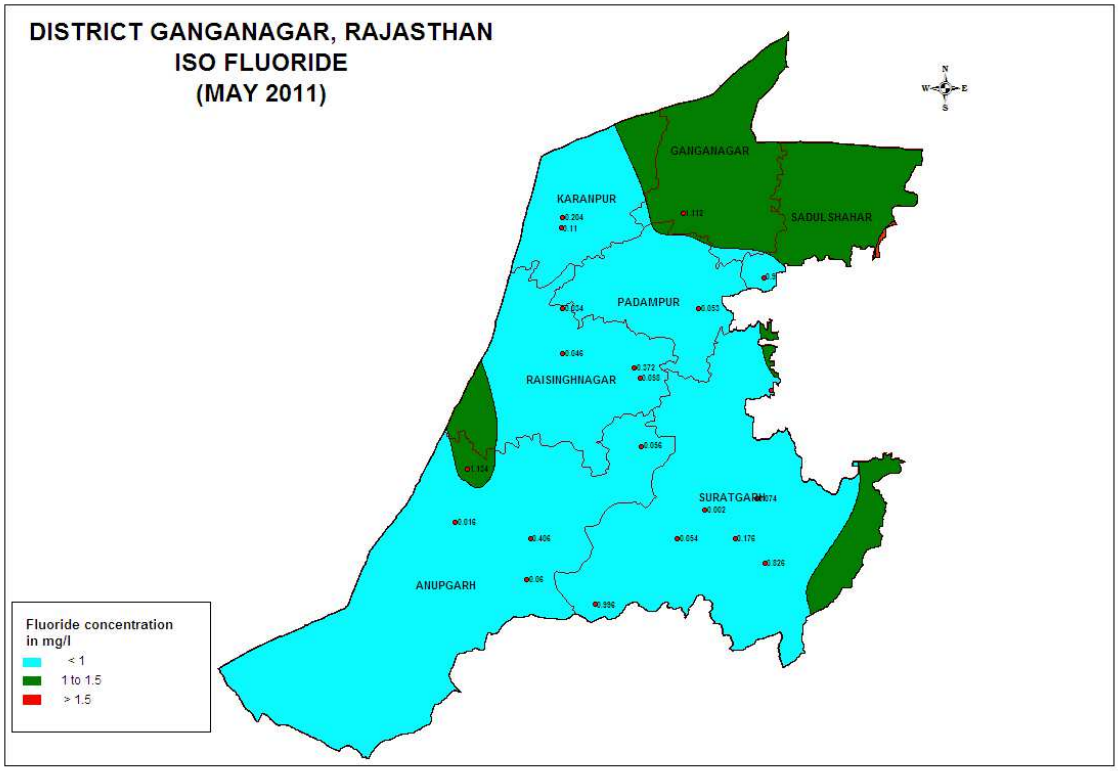

Fig. 9 Distribution of Fluoride in ground water

Nitrate concentration in the district has been found to vary from 0.20 to 375 mg/l. Nitrate concentration in excess of permissible limit (45mg/l) has been reported from Anupgarh and Jaitsar in Anupgarh block, Jagatsinghwala and Raisinghnagar in

Raisinghnagar block and Bhopalpura, Birdhawal and Suratgarh in Suratgarh block. Nitrate distribution in ground water is shown in Fig. 10.

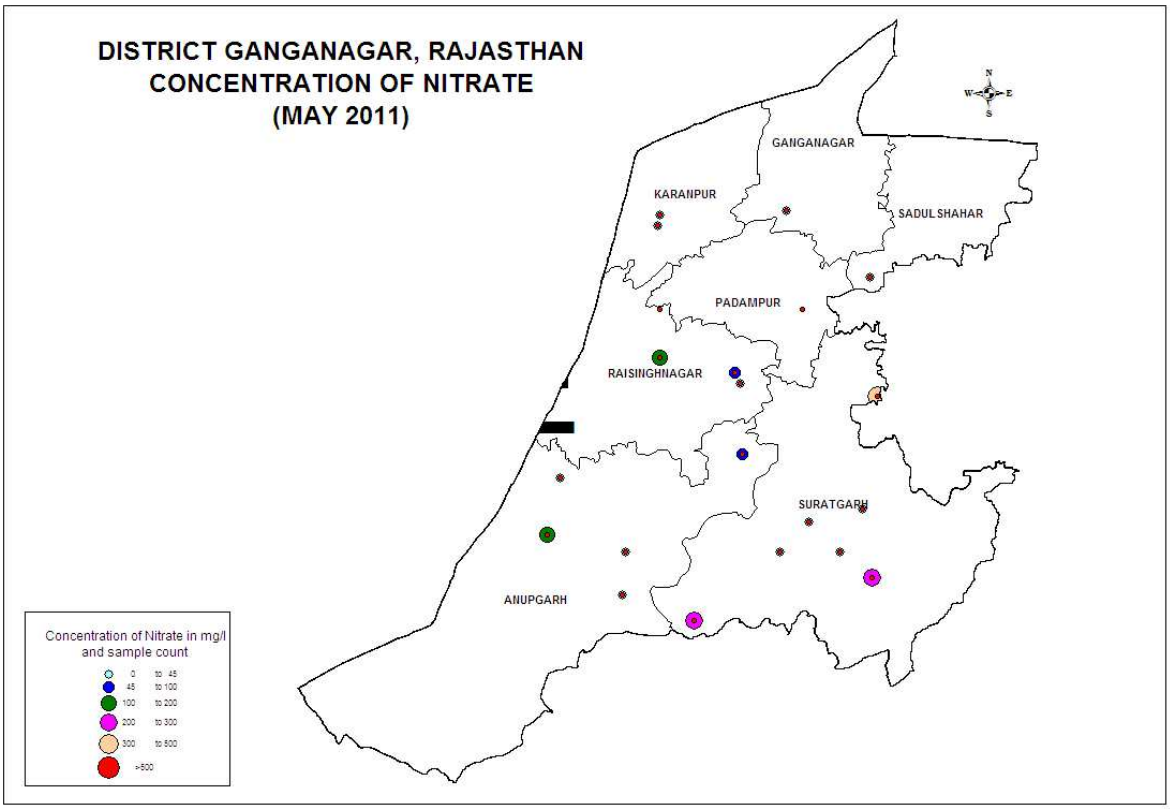

Fig. 10: Distribution of Nitrate in ground water

Iron concentration in ground water in most part of the district is within the permissible limit of 1 mg/l except a few isolated pockets in Anupgarh and Suratgarh blocks (Fig.11). Iron concentration has been found to vary from 0.01 mg/l at Anupgarh to 1.765 mg/l at Piperan, Suratgarh block.

Sulphate concentration has been found to range between 8 mg/l at Birmana, Suratgarh to 1742 mg/l at Suranwali, Sadulshahar. Excess Sulphate content (>400 mg/l) in ground water has also been reported at Karanpur village, Karanpur block, Jagatsinghwala village, Raisinghnagar block and Birdhawal, Suratgarh block. Magnesium content in excess of permissible limit of 100 mg/l has been found at a few places in the district viz. Karanpur, Suranwali and Suratgarh in Karanpur, Raisinghnagar and Suratgarh blocks respectively.

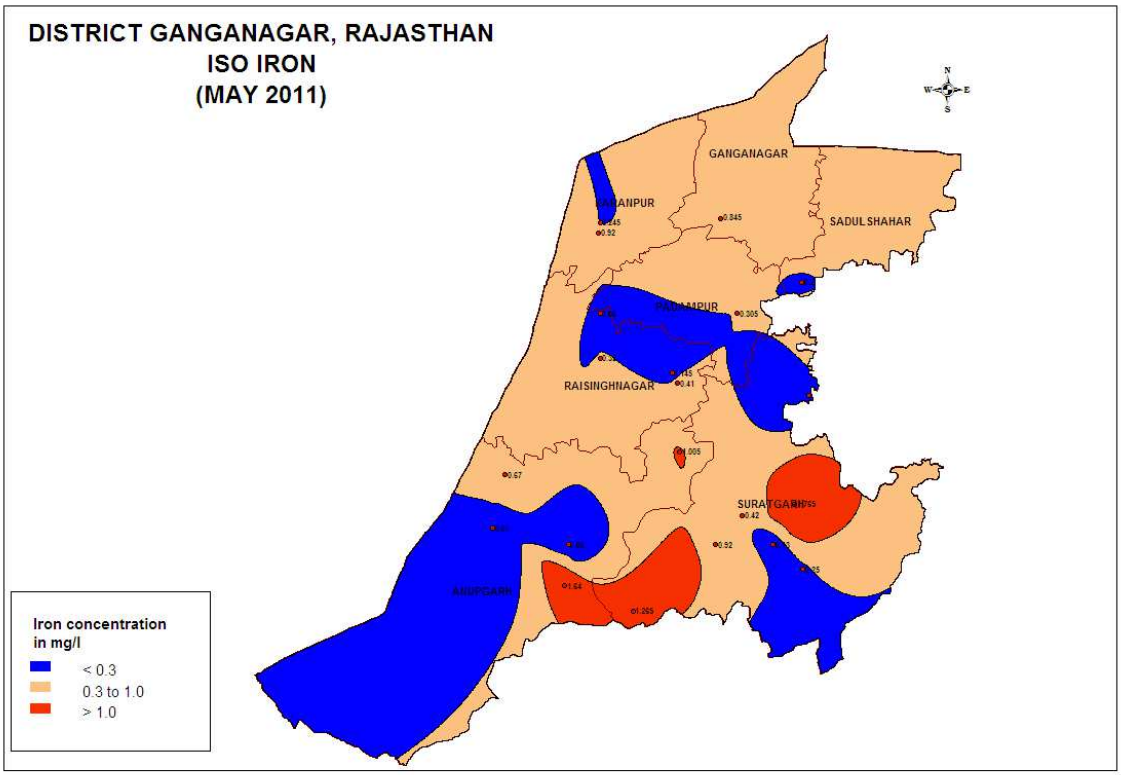

Fig. 11: Distribution of iron in ground water

5.4.2 Water quality in Deeper Aquifer

Chemical analysis of water samples collected from tubewells shows that salinity increases with depth. The deep groundwater is highly saline and cannot be used for any purpose. The EC of ground water in confined aquifers varies from less than 3000 to 32,000 ms/cm at 25^{o}C. Confined aquifer in the entire district is saline except at Anupgarh, Raisinghnagar and Srivijaynagar, where ground water in confined aquifer has EC values of 671, 2677 and 5548 ms/cm at 25^{o}C respectively.

Chloride concentration in deeper aquifers varies from less than 100 to 10000 ppm except at Anupgarh, Raisinghnagar, Ratewala and Suratgarh.

High value of nitrate and fluoride has also affected the potability of groundwater. However groundwater with EC < 5000 µS/cm at 25^{o}C can be used for domestic purposes after blending with fresh water so that levels of health affecting constituents fall within safe/ permissible limit.

6.0 Ground Water Resources

Ground water resources have been re-estimated, as on March 2009, jointly by Central Ground Water Board and State Ground Water Department as per the norms recommended by GEC‘97. While assessing the fresh ground water resources, saline area has not been considered. As per the estimation, the total annual ground water recharge of the district based on water level fluctuation method is 387.14 mcm with the natural discharge of 38.71 mcm. Thus the net annual ground water availability is estimated to be 348 mcm. Annual withdrawal of ground water for all uses has been estimated as 160.22 and overall stage of development is 45.98%. Summarized block wise estimates of fresh groundwater resources are given in Table 8.

Table 8: Estimates of fresh ground water resources in Ganganagar 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 development (%)
Anupgarh	C	101.7342	91.5608	10.3650	0.35	10.715	11.70
Ganganagar	C	117.4772	105.7295	64.395	0.84	65.235	61.7
Karanpur	C	47.044	42.3396	25.425	0.84	26.265	62.03
Padampur	C	52.451	47.2059	26.34	0.756	27.096	57.40
Raisinghnagar	C	21.8063	19.6257	7.986	0.462	8.448	43.05
Sadulshahar	C	20.9416	18.8474	6.525	0	6.525	34.62
Suratgarh	C	25.691	23.1218	13.734	2.205	15.939	68.93
Total District		387.1453	348.4307	154.77	5.453	160.223	45.98

No significant decline in ground water levels has been observed both during Pre- and Post- monsoon period except in Suratgarh block where significant decline has been observed in some parts. All the blocks fall under 'Safe' category.

In addition, saline ground water resources in the district have been assessed separately. Annual replenishable saline ground water resource of the district has been assessed to be 1180 mcm. Net annual availability of saline ground water resources has been estimated as 937.5333 mcm, against which annual ground water withdrawal for al uses has been assessed to be 94.325 mcm.

7.0 Status of Ground Water Development

The principal aquifer in the district is alluvium comprising sand, silt, clay, and gravel. Its thickness varies from 10m to 80m. The bed rock below alluvium consists of Palana or Nagaur series of rocks, which do not outcrop anywhere in the district. Groundwater occurs both under water table and confined conditions.

Shallow Water Table Aquifer: The thickness of water table aquifer varies from a few meters to about 80m. Depth to water level varies from less than 2m to more than 40m, being 2 to 20m in Ghaggar flood plain.

Deeper Confined Aquifer: Exploratory drilling carried out by Central Ground Water Board has indicated that confined aquifer is found both in alluvium and under lying Palana and Nagaur sandstone. The first confined aquifer is encountered at depths ranging from 90 to 100m.

Yield of Wells: The yield of dug-cum-bore wells is reported to be between 42 to 110 m3/hr. Yield of wells tapping alluvium varies from 180 to 430 lpm. Transmissivity of aquifer varies from 375 to 723 m2/day, reaching maximum in Ghaggar flood plain. Yield of wells in confined aquifer varies from 20m 3/hr to 120m3/hr for a drawdown of 15m. Transmissivity varies from 100 to 3000 m^2/ day.

7.1 Urban And Rural Water Supply

Since the native groundwater of entire district is brackish to saline except in small pockets, the urban and rural water supply schemes primarily depend upon surface water source. Maximum requirement is fulfilled from surface water supply through Bhakra canal and Indira Gandhi Canal system.

8.0 Ground Water Related Issues & Problems

8.1 Water Logging

Problem of water logging occurs in the IGNP canal command. Most of the water logged areas are located in Ghaggar river bed along depressions and in the head reaches of State I in Tibi sector and Vijaynagar area. Nineteen natural inter-dunal depressions occur in the south and east of Suratgarh town. These depressions are used to store excess floodwaters of Ghaggar river. Occurrence of impermeable or poorly permeable layer at shallow depth impedes the downward percolation of seepage and return flow from irrigation, which leads to water logging. Because of absence of natural drainage system also adds to the problem of water logging. Impounding of Ghaggar flood water in depressions in Baropal – Suratgarh – Manaktheri areas and lack of ground water development in salinity affected areas have also contributed to the problem of water logging.

Study on conjunctive use of surface and ground water in IGNP Stage I area was under taken by CGWB during 1992-1995. The following recommendations were made:

- To mitigate the problem of water logging, ground water development should be 18% of canal water release at the head.
- A total of 10.023 shallow tube wells be constructed in the command area. Depth of tubewells recommended is 50 to 60 m in Suratgarh and Anupgarh, Pugal and direct outlets and 40 to 50 m in Rawatsar and Gang canal areas.
- In areas where water level is shallow (< 10m,bgl) skimming wells have been recommended.

8.2 Salinity

There is a wide variation in the quality of ground water. The salinity varies from low (<1500 µS/cm) to very high (> 8000 µS/cm). Patches of very high EC are observed at places in Sadulshahar, Anupgarh, Padampur, Raisighnagar and Suratgarh blocks. In the region comprising Ghaggar flood plain, EC ranges from 300 to 3000 µS/cm indicating medium to low salinity of ground water. EC of confined aquifer varies from 3000 to 3500 µS/cm. In the entire district the confined aquifer is saline except locally.

9.0 Ground Water Management Strategy

9.1 Ground Water Development

Groundwater estimation reveals that all the blocks in the district fall under safe category. Ground water development in the district needs to be promoted. Irrigation wells are required to be constructed in Ghaggar Plain area and irrigation commands where groundwater levels are shallow and ground water is suitable for irrigation.

9.2 Well Design

The district is underlain by unconsolidated to semi-consolidated formations where direct rotary drilling technique is used for construction of wells. Tube wells of screened assembly with gravel pack are recommended in the area. As in the alluvial area, grain size of aquifer material varies widely, 1.59 mm slot size screen with 14%

total open space is generally used to tap the aquifer zones. Wells are gravel shrouded with gravel having 2-3 mm diameter. Length of scree depends upon the thickness of aquifer available. Normally for confined aquifers, it is advisable to tap 75% to 80% of aquifer thickness leaving some portion at the top and bottom of the aquifer. For shallow unconfined aquifer, 25 to 30% of the total aquifer thickness at the top should not be screened as during pumping, dewatering of aquifer occurs. Further, quality of ground water near surface may not be potable.

9.3 Ground Water Management Options

As the principal cause of water logging in the district is excessive availability of surface water, it is essential that a conjunctive use of surface and ground water be promoted in canal command areas. This will lead to reduction in the rate of rise in water table due to reduced availability of surface water and resultant fall in the ground water levels due to extraction of ground water.

Construction of ground water abstraction structures and withdrawal system involve substantial capital investments. Since irrigation supplies are available free of cost, there is discrimination on the part of farmers to adopt ground water irrigation. In such areas, to encourage development of ground water, liberal subsidy or if need be incentive may be provided to farmers for construction of wells and installation of pump sets. Supply of quality power for irrigation wells must be assured at least six hours a day during irrigation season. Further, system of pricing of surface water must be introduced to recover at least the O& M costs.

Adoption of micro irrigation techniques must be encouraged in areas where feasible. Change in cropping pattern and cropping intensity by the farmers due to prolific availability of surface water has led to increased seepage and recharge to ground water consequently leading to rise in water levels. Cropping pattern and cropping intensity need to be suitably changed by the farmers so as to reduce the problem of water logging. Bio-drainage to lower water levels has been proved to be effective in IGNP area. Such practice needs to be promoted.

10.0 Recommendations

Anti water logging measures need to be taken to avoid further water logging in the area east and south east of Suratgarh around natural depressions. Water level in the depressions should be maintained below 178 mamsl.

Water logged areas need to be reclaimed.

Ground water development programme may be launched in areas falling in Gang canal command especially between Raisinghnagar and south east of Karanpur.

Batteries of tubewells tapping saline water can be constructed along Anupgarh and Suratgarh branches.

Modern agricultural management techniques have to be adopted for effective and optimum utilization of the 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 achieve this.

High water requirement 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.

Sewage reclamation should be an important part of the development of irrigation sector. It is required to avoid contamination of water resources. This source of irrigation water is highly reliable, albeit only for non-edible crops.

A close network of piezometers should be established in waterlogged areas to precisely monitor ground water level to aid in further planning.

Sowing of salt tolerant crops needs to be encouraged for utilization of saline water. Saline ground water available in the district can also be used for agriculture by blending with canal water or using in lean period.