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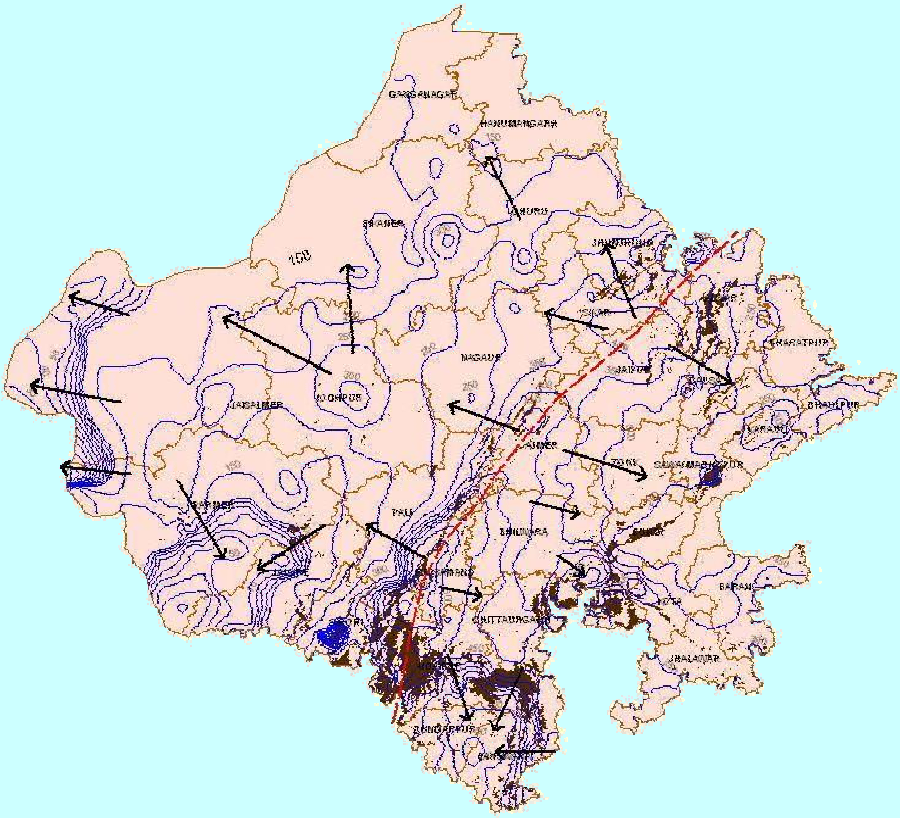
GROUND WATER YEAR BOOK
2012 – 2013

RAJASTHAN STATE



GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

REGIONAL OFFICE DATA CENTRE
WESTERN REGION
RAJASTHAN

March 2014

GROUND WATER YEAR BOOK
2012 – 2013

RAJASTHAN STATE

Compiled by

Dr. A.K.Jain, Sc 'C'

REGIONAL OFFICE DATA CENTRE
CENTRAL GROUND WATER BOARD
WESTERN REGION
JAIPUR

March 2014

FOREWORD

The limited Ground Water resources of the arid state Rajasthan are increasingly being exploited for Irrigation, Industrial and Domestic uses. The impact of these stresses together with effect of monsoon Rainfall pattern distribution is well reflected in the form of changes in water levels and Groundwater quality changes **Central Ground Water Board** is monitoring the behaviour of ground water system four times a year during a ten days period in May, August, November and January throughout the State. Interpreted results of this activity are being made available to the State authorities and other users for planning purposes. The wealth of data generated by CGWB during the past three decades on the behaviour of ground water system is available to ground water planning and management organizations. **Ground Water Year Book 2012-2013, Rajasthan** is a compilation of the interpreted and basic data on the behaviour of ground water levels and water quality prevailing during 2012-2013 as observed from the network of monitoring stations and elucidates the changes that are observed in comparison with the situation prevailing in 2011-2012 and during the past decade.

Under present scenario, there is immense need to adopt water conservation practices in agriculture, domestic and industrial sectors. Artificial recharge to ground water by rain water harvesting should be the policy directive in all areas of the state where stage of ground water development has exceeded the assessed replenish-able component of the resource.

In the preparation of this valuable document, the efforts made by **Dr A K Jain Scientist "B"** is commendable. Shri S. K. Jain, Officer Surveyor did appreciable work of data compilation. The hydrochemical analysis and its presentation by **Shri Yeshveer Singh Asstt. Chemist and his team** is also appreciated.

I hope this Ground Water Year Book 2012-2013 will be of immense use to various user agencies and the concerned departments of State Government of Rajasthan for planning ground water management programmes on scientific consideration in different areas of Rajasthan State.

Jaipur,
March, 2014.

(P. K. Parchure)
Regional Director

CENTRAL GROUND WATER BOARD
WESTERN REGION

GROUND WATER YEAR BOOK 2012-13
RAJASTHAN

C O N T E N T S

GROUND WATER YEAR BOOK 2012-2013
RAJASTHAN

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EXECUTIVE SUMMARY

1. Central Ground Water Board has set up a network of 1,206 stations called the National Hydrograph Network Stations (NHS). During 2012-2013, measurements of water level, temperature, water quality and other parameters for monitoring the behaviour of ground water system and changes in quality regime over time and space was done on 1,206 stations which comprises of 745 dug wells and 461 piezometers.

2. Water levels and other parameters at site are monitored four times a year. Water samples for ground water quality (inorganic constituents) are collected once in a year during May when the concentration of the chemical constituents is expected to be at the peak level.

3. Major part of the recharge to ground water in the entire State is through infiltration from rainfall.

4. About 30% of the recharge to ground water in the areas falling under the irrigated commands of Indira Gandhi Nahar Pariyojna, Chambal and Mahi Canal systems is estimated as the seepage contribution from conveyance systems and return flow from irrigation.

5. Rajasthan State has an area of 3,42,239 Sq.Km. The density of stations monitored during 2012-13 works out to one station for every 284sq.km. which is considered to be rather low keeping in view the emerging problems and the ground water scenario in the state.

6. The normal annual rainfall of Rajasthan is 541 mm. However, during 2007-08, 2008-09, 2009-10, 2010-11 and 2011-12 rainfall received was

669.9,567.1, 389.3, 687.40 and 727.46 mm. In 2011-12, the rainfall was 34.4.0 % above normal.

7. Rajasthan receives much lower rainfall compared to the other parts of the country. Out of the total rainfall, a sizable portion is in the beginning of the rainy season is used for building the soil moisture and is also lost to evaporation because of its arid conditions. The amount infilterating through the soil mass to contribute to ground water storage is of the order of 5% to 7% in areas underlain by hard rocks and 10% to 15% in alluvial areas.

8. During all the four recordings of water levels in May, August and November, 2012 and January, 2013, the depth to ground water was within 20m in more then 60% of the stations.

The summarized details are given in the following table :

Depth to water(mbgl)	**May, 12**	**August, 12**	**November, 12**	**January, 13**
	<======== **Percentage of Stations**==========>			
> 40	17.81	18.55	17.04	17.89
20 - 40	21.54	18.11	16.81	17.33
10 - 20	26.78	18.11	17.40	22.08
5 - 10	23.40	16.68	20.50	20.95
2 - 5	8.61	14.60	19.67	16.08
> 2	1.86	13.94	8.58	5.66

9. The analysis of water level data brings out the following:

a) Compared to the average water level in the month of May during the decade 2002 to 2011, 54 % of the station recorded a rise in water levels in May 2012.
b) Compared to the average water level in the month of August during the decade 2002 to 2011, 65% of the station recorded a rise in water levels in August, 2012.
c) Compared to the average water level in the month of November during the decade 2002 to 2011, 64 % of the station recorded a rise in water levels in November, 2012.
d) Compared to the average water level in the month of January during the decade 2003 to 2012, 60 % of the station recorded a rise in water levels in January, 2013.

e) In August, 2012 as compared to May, 2012 rise in water levels was recorded in 73% of the stations and fall in the remaining 27% stations.

f) In November, 2012, rise and fall over May, 2012 in water levels was recorded in 69% and 31 % stations respectively.

g) In January, 2013, rise and fall over May, 2012 in water levels was recorded in 69 % & 31 % respectively.

10. Water level have registered rise in 4 to 18% less monitoring station in 2012-2013 as compared to 2011-12 .

Comparison of water level fluctuation

Period	2011-2012		2012-2013		Variation in rise of water level %
	Rise (%)	Fall (%)	Rise (%)	Fall (%)	
May-Aug	80	20	73	27	-7
May-Nov	79	21	69	31	-10
May-Jan	73	27	69	31	-4
May-May	60	40	55	45	-5
Aug-Aug	65	35	47	53	-18
Nov-Nov	60	40	47	53	-13
Jan -Jan	56	44	46	54	-10

11. The state receives 34% more rainfall then normal rainfall during (2011-12), so about 54 % of monitoring stations a rise in water levels (Mean May Vs May,2012) has been observed.

12. The hard rocks occupy more than 50% of the area of the state in the west-central, south-eastern and southern parts. The storage of ground water in hard rocks is in the weathered mantle, joints and fractures which provide only limited storage space. Therefore, only a part of the rainfall is available as ground water storage in many areas. This situation warrants full consideration in the planning process.

13. The chemical quality of the ground water has been evaluated by analysing 684 samples collected from National Hydrograph Stations and nearby wells. The broad details are given in the following table :

Constituents	Percentage of Samples falling within		
	Desirable limits	Maximum Permissible limits	Beyond Permissible limits
Total Dissolvd Solids	11.4	63.60	25.29
Fluorides (F)	53.65	16.52	29.97

Limits of the various constituents in parts Per Million for Potable Category

	Constituents	Desirable limits	Maximum Permissible limits
1.	TDS	500	2,000
2.	F	1.0	1.5

14. The manner of deposition of geological formations and arid climatic condition has led to high salinity in ground water at variable depths. Keeping in view of the national standard of 500ppm TDS in drinking water, 11.40 % samples fall within this limit. In addition, 63.60% of the samples recorded TDS within 2000ppm i.e the maximum permissible limit for drinking water. Alternative arrangements for assuring water for drinking and domestic uses within the prescribed national standards therefore, need to be made in the remaining areas represented by 25.29% of the samples. The situation is worsening in some areas because of human interference.

15. Districts of Bhilwara, Churu, Dausa, Ganganagar, Hanumangarh, Jaisalmer, Nagaur, Pali Sirohi and Tonk are worst affected districts with fluoride contamination where more than 40% of stations have fluoride value greater than 1.5 mg/L.

16. During 2012-13 a Workshop on “Groundwater Scenario of Jaipur Urban Area” has been organized at State Institute of Health & Family Welfare, Jhalana Institutional area, Jaipur by Central Ground Water Board, Western Region, Jaipur. Two no. of State level training (Tier II) on “ Aquifer Information System & Aquifer Management Plan” have been orgainsed at Jodhpur & Jaipur for the duration of one week. Six no. of Block/Village level training (Tier III) program on “ Aquifer Information System & Aquifer Management Plan” have been conducted in the districts of Ajmer, Bansara, Dausa, Jodhpur, Jaisalmer & Sikar. In addition to this

State Level Painting competition on water conservation has been organized by Ministry of Water Resources, Government of India, Central Ground Water Board in the premises of office of CGWB, WR, Jaipur.

CONCLUSIONS AND RECOMMENDATIONS

1. There is progressive increase in ground water draft due to increasing population, urbanization and industralisation. In as many as 166 blocks the draft has exceeded the estimated replenishable resource. In 25 blocks, the stage of development has reached Critical levels (Ground water resource estimation 2009). Any further increase in the draft will aggravate the already worsened situation of declining water levels and/or degrading water quality in some areas.

2. Planning for the development and management of ground water in any area in the state must address the factors like low rainfall, limited ground water storage availability, ground water salinity in many areas, deep water levels in most of western parts of state and desertic conditions in nearly 50% of the state's area. These aspects should be taken as a core consideration for planning and implementing ground water development and management programmes. A holistic approach taking all aspects into consideration shall therefore, need to be adopted.

3. Artificial recharge of ground water by arresting storm water run-off during monsoon seasons should be the policy directive in all areas with ground water draft more than 90% of the assessed replenishable resource or areas where decline either in the pre- or post-monsoon water levels is observed or the areas where adequate storage capacity is available. The following specific measures will improve the situation and help lessen the stress on the system :

a: In areas where the situations of over-draft are manifested in declining water levels, action to reduce the draft by atleast 20% must be taken as an immediate measure. The impact of reduced draft be monitored over 2-3 years to enable development of a scientifically based long-term management strategy.

b: In areas where depth to water in May is more than 10 metres, adequate storage capacity is available in the aquifer systems. Storage of additional water underground shall not only ensure availability of water at places of requirement during dry season but also result in huge savings in evaporation losses.

c: Paving of surface for providing civic amenities in the towns & cities has led to reduced infiltration and increased run-off during the rainy season. Rainwater harvesting structures should therefore be constructed to intrercept and recharge the roof-top run-off from individual house-holds in feasible areas. Such a provision should be encoursed by local municipal bodies.

d: Concurrent with the above measures should proceed the work of impounding & recharging the storm water run-off from other sources. The storm water drains, where filled up or where the concept itself stands abandoned, must be revived. Suitable locations in nalas & gullies should be utilised for the construction of check-dams, sub-surface dams, ponds etc. for ensuring stagnation of water & thus its infiltration underground for augmenting ground water storage. Such structures must be located & designed keeping in full view the geology, Geomorphology and hydrogeological set-up prevailing in the area .

e: Under the programme of artificial recharge Studies, CGWB has also constructed 13 Roof-top rain water harvesting stuctures in Jaipur at Governor's House, Secretariat, MREC, Chief Minister's Residence, GWD office, Vitta Bhawan, High court and CGWB office, etc. One such recharge stucture has been complted in Udaipur urban area. CGWB has also constructed a sub-surface barrier at Mainpura on Kantli river in Jhunjhunu district and three sub- surface barrirres in Sikar district to augument ground water resources locally. Besides technical guidance is rendered to individuals, socities, NGO's, group housing socities for rainwater harvesting.

4. Re-use & recycling of urban waste water should receive added attention of muncipal bodies. The liquid urban wastes can be recycled through aquifers to improve their quality and pumped out for reuse particularly for irrigation. It shall however, be essential to ensure that urban & industrial wastes are not inter-mixed. Where such a situation exists, the industrial wastes must be treated before disposal to remove the toxic elements. Liquid urban wastes can also be used for direct irrigation in suitable areas after atleast primary treatment. Recycling of urban wastes shall reduce dependance on ground water to some extent and shall also ensure conservation and use of the waste water which is other-wise lost to evaporation.

5. To reduce dependance of ground water, measures aimed at affecting economy in water use be implemented. These could include inastallation of new small capacity cisterns in toilets and other house-hold means of saving water, use of improved irrigation systems - sprinkler and drip. Where feasible, metering

of water and charging of economic costs, relocating high water-use industries to surplus water available areas etc. be undertaken.

6. Whereas declines in ground water levels are noticed in many areas, in the canal command areas of IGNP, Chambal, Mahi and other surface irrigation systems the menace of water-logging is becoming increasingly visible/ pronounced. Improved irrigation practices and cropping pattren and controlled water supplies from canals coupled with mandatory development of ground water for meeting atleast 50% of the water requirements are urgently called for in such areas. For promoting ground water development, subsidies should be provided. Any further delay in executing preventive and remedial measures aimed at mitigating water-logging conditions will result in large areas going out of agriculture and / or reduction in farm output besides degradation of the environment and eco-system of the area.

7. Instances of growing levels of nitrates in ground water are noticed due to haphazard disposal of wastes, particularly faecal disposals in urban areas. Educating of public in the maintenance of hygiene and installation of organized sewerage system will go a long way in reducing this hazard.

8. Disposal of solid wastes in natural or man-made depressions without adequate scientific considerations is bound to pollute ground water in due course. As a measure of precaution, it is therefore, essential that solid wastes from major cities and towns are disposed off in scientifically located and designed sites and structures for recycling and reuse. Detailed investigations to locate such sites must be initiated urgently.

9. Impact of the release of industrial wastes in an unsystematic manner and without pre-disposal treatment is causing deterioration in ground water quality. To cite an instance, the liquid waste from the cloth printing and dyeing industry near Jaipur is leading to an increase in fluoride content in ground water. High fluoride content in the effluent is derived from a dye. The effluent is also being disposed off without being decolourized. Urgent measures including awareness and if need be, punitive action may have to be taken to contain further degradation in the quality. Ground water pollution is of serious proporation due to dyeing & printing industry in Balotra, texturing etc. in Pali and dyeing and processing industry in Bhilwara areas. Central Ground Water Authority and Pollution Control Boards may consider suitable actions, both preventive and remedial, and drawing up of long-term plans in this regard.

10. Since ground water abstraction structures are individually owned, operated and managed, it is difficult to have an account of ground water abstraction by volume. Voluntary registration of structures needs to be encouraged so as to obviate the requirement for enactment and enforcement of any legal measures.

11. Whereas restrictions must be laid on the construction and energization of individually owned structures for drinking and domestic use with a view to avoid wastage of water, adequate supply from municipal water supply system shall have to be ensured in such areas. Ground water markets, where these are developing will have to be regulated.

12. Ground water development is a 'People's programme'. Therefore, education and involvement of people in its management- development, conservation, protection and augmentation projects will be the prime requisite to protect resource against quality degradation and guarantee quality assurance. Mass awareness programmes aimed at educating the users of the adverse effects of over-exploitation of ground water on its quality and quantity and environment; economic and efficient use of water, voluntary regulation of abstraction, etc. will ensure utilisastion of the resource at optimal levels.

13. The National Hydrograph Monitoring Network was designed by CGWB more than 30 years back. It has been progressively strengthened during the period. However, most of the stations set up are dugwells which are going in disuse and are therefore neither representative nor ideal for getting the full and dependable information on resource behaviour and regime monitoring. Even though some 396 purpose-built stations have been established, the number is rather too meagre keeping in view the size of the state and the changing ground water levels and quality regime scenario. The network thus need to be strengthened with construction of purpose built stations for monitoring of water level and water quality in vulnerable areas like the industrial zones, mining and smelting complexes and urban agglomerates.

14. With the aim of regulation and management of ground water in Over-Exploited areas 34 no. of blocks of the state have been notified by Central Ground Water Authority. Registration of existing ground water structures has been done through state agencies.

15. A holistic and integrated approach in relation to ground water development, protection, conservation and augmentation involving a combination of two or more aspects must be adopted for all areas in the state to ensure sustainability of the ground water development programmes.

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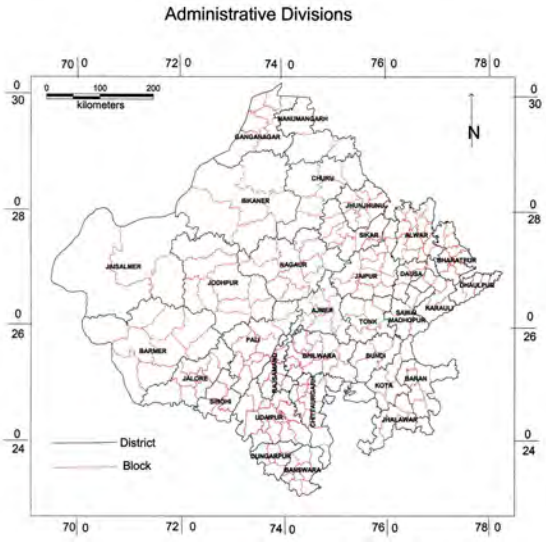
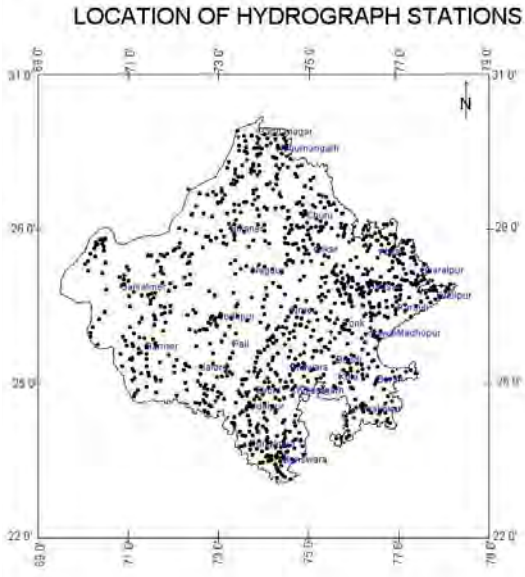
1.0 INTRODUCTION

The state of Rajasthan comprising 33 districts has a geographical area of 3,42,239 square kilometre (sq km) and is the largest state in the country . It is situated between north latitudes 23^0 03' and 30^0 12' and east longitudes 69^0 30' and 78^0 17'. The ground water monitoring is being carried out through a network of observation wells - the National Hydrograph Network Stations (NHS).



The National Hydrograph Network Stations set-up is a system of spatially distributed observation points at which periodic monitoring of ground water and regime behaviour viz. recording of water levels and temperature and collection of water samples for water (chemical) quality analysis are done. The main objectives of monitoring of water levels and water quality are to observe the rise and fall of ground water levels and to study changes in quality of water in space and time consequent to changes in the inputs and outputs. Database on ground water levels and quality created through this effort forms an important tool in the evaluation of optimum development and decision making on the various aspects of water resources management. Presently



1206 NHS in the state are being monitored. The district-wise distribution is given in Table -1 and water level data of monitoring stations is in Annexure-I.

Table 1: AREA OF DISTRICT AND NUMBER OF NHS AS ON 31.3.2013

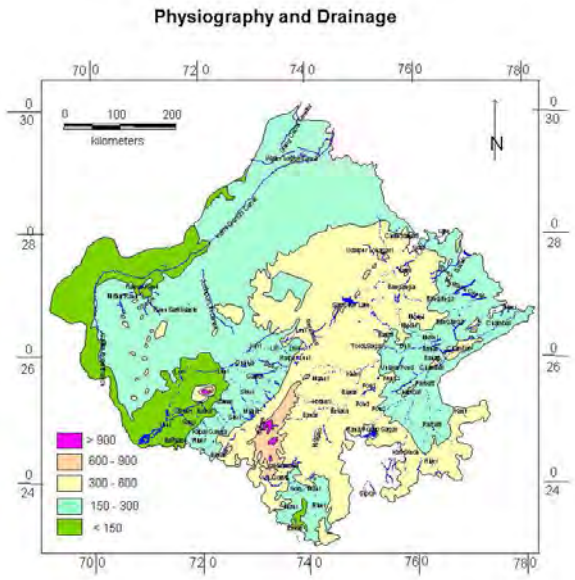
S.No.	District	Geographical area (sq km)	Number of NHS monitored		
			Dug well	Piezometer	Total
1	Ajmer	8,481	25	10	35
2	Alwar	8,380	15	29	44
3	Banswara	4536.08	28	16	44
4	Baran	6,955	21	1	22
5	Barmer	28,387	39	12	51
6	Bharatpur	5,100	27	23	50
7	Bhilwara	10,455	33	4	37
8	Bikaner	27,244	35	46	81
9	Bundi	5,550	14	0	14
10	Chittorgarh	7880.00	16	4	20
11	Churu	16,830	33	11	44
12	Dausa	3,470	7	29	36
13	Dhaulpur	3,000	10	7	17
14	Dungarpur	3,770	19	6	25
15	Ganganagar	10,978	38	7	45
16	Hanumangarh	9,656	35	23	58
17	Jaipur	11,066	15	50	65
18	Jaisalmer	38,401	33	28	61
19	Jalore	10,640	7	13	20
20	Jhalawar	6,219	27	6	33
21	Jhunjhunu	5,928	6	32	38
22	Jodhpur	22,850	38	34	72
23	Karauli	5,016	17	3	20
24	Kota	5,481	18	0	18
25	Nagaur	17,718	26	6	32
26	Pali	12,387	23	2	25
27	Pratapgarh*	4359.80	21	2	23
28	Rajsamand	4,768	29	03	32
29	Sawai Madhopur	5,043	17	2	19
30	Sikar	7,732	5	31	36
31	Sirohi	5,136	12	4	16
32	Tonk	7,194	18	10	28
33	Udaipur	11760.60	38	07	45
RAJASTHAN		**342,239**	**745**	**461**	**1206**

*Newly created district

2.0 PHYSIOGRAPHIC FEATURES

2.1 Topography

The state has a fairly mature topography developed during the long period of denudation and erosion. The present physiography and landforms are greatly determined by geological formations and structures and is the product of the past fluvial cycle of erosion and the recent & continuing desert cycle of erosion.



Physiographically the state can be divided into four units:

(a) Aravalli hill ranges
(b) Eastern plains
(c) Western Sandy Plain and Sand Dunes and

(d) Vindhyan Scarpland and Deccan Lava Plateau

2.1.1 Aravalli Hill Ranges

The Aravalli ranges trending NE -SW are the oldest mountain chain in India. The elevation of these hill ranges varies from about 600 metres to over 900 metres above mean sea level (m amsl). They are composed of Bhilwara, Aravalli and Delhi Supergroup of rocks ranging in age from Archaean {2500 million year (my)} to Proterozoic (740 my). These ranges form a series of rugged hills with rounded surfaces. The quartzites however, stand out as scarps. Near Ajmer, these separate out southwestwards into a number of parallel ridges. At Mount Abu , the clusters of granite peaks reach a maximum height of 1722 m amsl at Guru Sikhar.

2.1.2 The Eastern Plains

In the plains, east of the Aravalli ranges, the altitude varies from 150 m to 450m amsl. The general trend of the slope varies from place to place. In Dungarpur and Banswara districts it is mainly from north to south, in Alwar district it is from south to north and in the remaining districts, forming the central and north eastern Rajasthan, it is from west to east. The south - eastern limit is marked by the Vindhyan plateau.

2.1.3 The Western Sandy Plains and Sand Dunes

The sandy plains in western Rajasthan, forming a part of Thar Desert, are mainly occupied by alluvium and blown sands. These plains are further sub-divided into three units :

i) Sandy Arid Plain (Marusthali)
ii) Semi-arid Transitional Plain
iii) Ghaggar Plain

The Sandy Arid Plain is a typical desert terrain. It includes the western most districts of Jaisalmer, Bikaner and part of Barmer, Jodhpur, Nagaur, Churu and Ganganagar. The line dividing the Sandy Arid Plain and the Semi-arid Transitional Plain as well as Ghaggar Plain is based on climatic parameters and water resource availability.

The eastern boundary of the Semi-arid Transitional Plain are the foot-hills and their extension on the western side of Aravalli ranges. Sand dunes are prominent and the terrain is punctuated with isolated hills of granites and rhyolites. The altitude varies from 30m to 300m amsl. The general slope is from northeast to southwest.

The Ghaggar Plain consists mainly of former flood plains and aeolian deposits. A network of canals cover the entire area. The southern and southeastern part is occupied by medium to high dunes. Nineteen of these interdunal depressions are being utilised for storing the diverted Ghaggar flood waters. The central part of the Ghaggar Plain is drained by the regulated flood waters of Ghaggar river.

2.1.4 Vindhyan Scarpland and Deccan Lava Plateau

The southeastern plains are locally characterised by plateau, scarpland and ravines. The Vindhyan scarpland are seen all along the Great Boundary Fault from Chittorgarh to the trijunction of Bharatpur, Dholpur and Sawai Madhopur districts. They have an average elevation of 300m to 580m amsl.

The Deccan Lava Plateau is mainly confined to parts of Kota, Jhalawar, Banswara and Chittorgarh districts. The elevation ranges from 300m to over 500m amsl.

The ravines, locally impassable, are confined to the alluvium overlying the Vindhyans in Dholpur, Sawaì Madhopur, Jhalawar and Kota districts along the Chambal river and its tributaries.

2.2 Drainage

The Aravalli Hill Ranges form the main water divide in Rajasthan. Luni is the only river west of Aravallis. In the remaining area of western Rajasthan

comprising about 60% of the geographical area of the state, the drainage is internal, and the streams are lost in the desert sands after flowing for a short distance from the point of origin. Luni itself essentially is an ephemeral stream with flood cycle of 16 years. Drainage in western Rajasthan is towards west and south - west.

In the east of Aravalli ranges the main drainage is towards north - east. The Chambal catchment occupies 23% (78630 sq km) of the total geographical area of the state (Table 2).

Table 2: DISTRIBUTION AND DENSITY OF NHS IN RIVER BASINS

Sr. No.	BASIN	Area in sq. km	Area %	NHS No.	NHS %	Density in sq. km/Station
1	Chambal	78630.83	22.92	319	26.45	246
2	Draining into Gulf of Kutch	2722.53	0.79	13	1.08	209
3	Jaiselmer-Bikaner-Churu	69875.57	20.37	173	14.34	404
4	Luni and other drainage into Great Rann of Kutch	62315.84	18.16	147	12.19	424
5	Luni-Barmer-Jaiselmer	58899.97	17.17	140	11.61	421
6	Mahi	16140	4.70	104	8.62	155
7	Rohtali to Ambala on east and Ganganagar on West	14992.14	4.37	85	7.05	176
8	Sabarmati	4196.27	1.22	11	0.91	381
9	Sutlej	4511.64	1.32	20	1.66	226
10	Yamuna	30791.06	8.98	194	16.09	159
	Grand Total	343075.9	100.00	1206	100.00	284

The other important catchments include Yamuna-Ganga in the north east, and Mahi and Sabarmati in the south west with flow towards south. The former three catchments support perennial rivers. In the northern and north-eastern parts of eastern Rajasthan, the Banganga, Barah, Sota, Sahib and Kantli rivers are of inland nature. The drainage in the whole of Rajasthan is generally dendritic.

In the desert area a few salt lakes and depressions exist, prominent among them being the Sambhar lake, Didwana lake, Bap, Pachpadra and Rann of Jaisalmer and Pokran.

3.0 CLIMATE

3.1 Climate

Climatically, the year in Rajasthan can be divided into three major conventional seasons as follows :

- The Hot- Weather Season (March to end of June)
- Monsoon Season (End of June to September)
- The Cold- Weather Season (October to February)

The India Meteorological Department has further sub-divided the cold season into two divisions, i.e.

a) The Season of retreating monsoon (October to December)
b) The cold season (January to February)

These seasonal variations have been broadly based on temperature and rainfall conditions in different months.

3.2 Rainfall

Rainfall is the major source of ground water recharge in the state. The state receives 90 % rainfall from southwest monsoon from June to September. The winter rainfall is meagre.

There are 292 Raingauge stations in the state. The annual rainfall data (June to May) of four years 2007-08 to 2011-12 have been analysed to calculate average rainfall of each district in the respective years. The average annual rainfall of the state during the period 2011-12 works out to be 727.46 mm.The percentage departures of average annual rainfall from normal (1901-70) have been computed for the last five years and tabulated in Table 3. It is observed that the average annual rainfall in the state, during the year 2011-12, is 34.4.0% more than the normal annual rainfall. The average annual rainfall in the state during the preceding year i.e. 2010-11 was less than 27.0 % to normal annual rainfall.

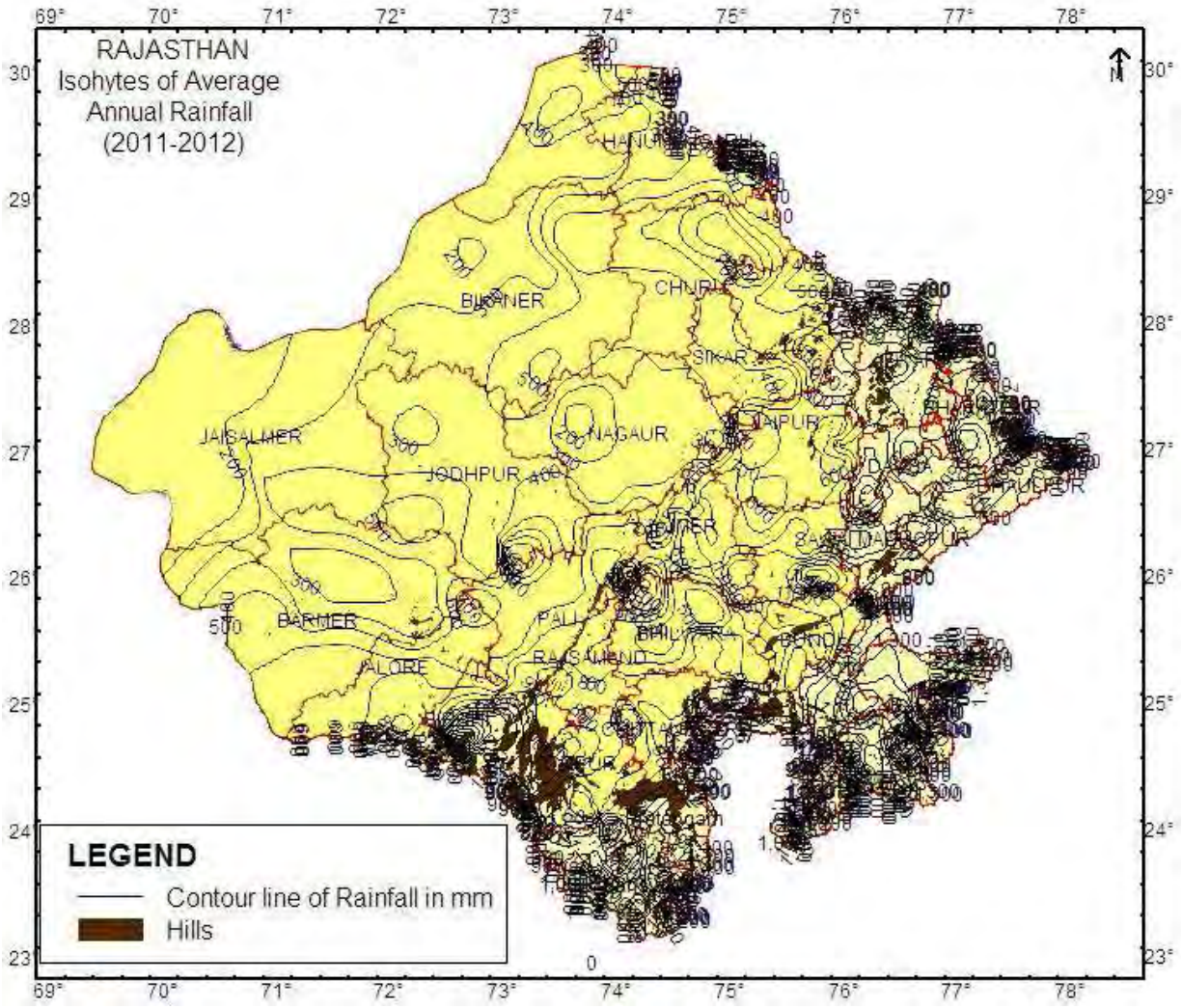
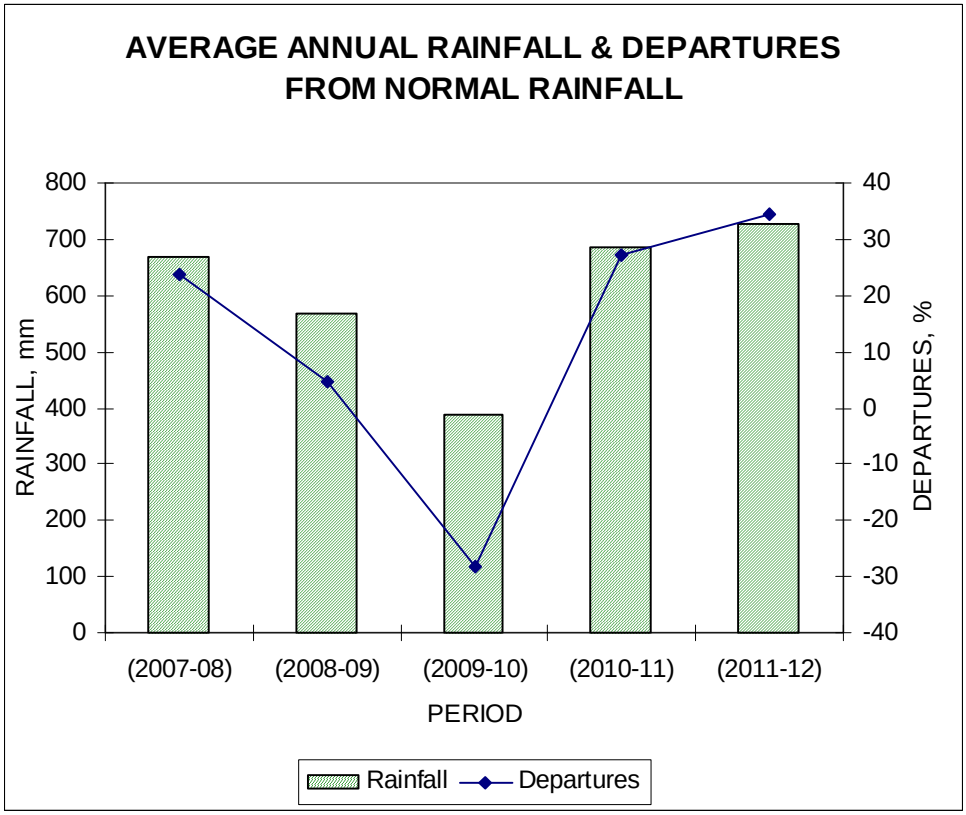

RAJASTHAN
Isohytes of Average
Annual Rainfall
(2011-2012)
69°
70°
71°
72°
73°
74°
75°
76°
77°
78°
30°
29°
28°
27°
26°
25°
24°
23°
BIKANER
CHURU
SIKAR
JAISALMER
NAGAUR
JAIPUR
JODHPUR
DAUSA
BARMER
PALI
RAJSAMAND
ALORE
LEGEND
Contour line of Rainfall in mm
Hills

TABLE 3: AVERAGE ANNUAL RAINFALL AND DEPARTURE FROM NORMAL RAINFALL

Sr. No.	District	Rainfall in mm						Departure form normal rainfall				
		Normal (1901-70)	Annual (2007-08)	Annual (2008-09)	Annual (2009-10)	Annual (2010-11)	Annual (2011-12)	(07-08) %	(08-09) %	(09-10) %	(10 - 11) %	(11-12) %
1	Ajmer	437	444.8	435.5	257.4	693.16	655.05	1.8	-0.3	-41.1	58.6	49.9
2	Alwar	626	579.8	854.3	524.7	783.59	599.59	-7.4	36.5	-16.2	25.2	-4.2
3	Banswara	870	808.2	557.3	723.8	622.13	1030.21	-7.1	-35.6	-16.8	-28.5	18.4
4	Baran	895.3	1270.7	949.5	701.6	612.19	1528.38	41.9	6.1	-21.6	-31.6	70.7
5	Barmer	260	659.9	278.9	153.8	554.38	430.25	153.8	7.3	-40.8	113.2	65.5
6	Bharatpur	675.1	381.5	771.3	573.8	820.70	781.34	-43.5	14.2	-15	21.6	15.7
7	Bhilwara	603.3	834	564.5	375.4	709.75	602.00	38.2	-6.4	-37.8	17.6	-0.2
8	Bikaner	249.8	246	294.1	173.6	433.50	354.06	-1.5	17.7	-30.5	73.5	41.7
9	Bundi	715.8	656.5	626.9	428.2	649.37	883.62	-8.3	-12.4	-40.2	-9.3	23.4
10	Chittorgarh	772.3	1256.7	797.2	640.7	794.21	870.96	62.7	3.2	-17	2.8	12.8
11	Churu	337.9	318.7	466.8	216.5	688.67	582.00	-5.7	38.1	-35.9	103.8	72.2
12	Dausa	625.7	488.3	808.4	433	757.60	776.80	-22	29.2	-30.8	21.1	24.1
13	Dhaulpur	717.5	479.3	1007.8	489.6	738.83	632.67	-33.2	40.5	-31.8	3.0	-11.8
14	Dungarpur	610.4	1420.3	460.3	721.4	599.25	961.33	132.7	-24.6	18.2	-1.8	57.5
15	Ganganagar	171.6	282.2	287.2	212.3	370.44	336.11	64.5	67.4	23.7	115.9	95.9
16	Hanumangarh	237.5	308.9	339.4	199.6	438.29	369.24	30.1	42.9	-16	84.5	55.5
17	Jaipur	526.8	419.1	625.6	314.1	826.45	628.14	-20.4	18.8	-40.4	56.9	19.2
18	Jaisalmer	158.6	300.9	206.3	99	396.67	309.17	89.7	30.1	-37.6	150.1	94.9
19	Jalore	400.6	871.9	353.5	167	834.97	681.22	117.6	-11.8	-58.3	108.4	70.0
20	Jhalawar	884.8	1323.1	685.6	657.4	625.78	1190.97	49.5	-22.5	-25.7	-29.3	34.6
21	Jhunjhunu	459.5	462	543.7	262.6	831.57	629.71	0.5	18.3	-42.9	81.0	37.0
22	Jodhpur	296.7	298.6	329	143.1	481.29	403.96	0.6	10.9	-51.8	62.2	36.2
23	Karauli	616.2	466.6	986.3	535.2	768.92	734.80	-24.3	60.1	-13.1	24.8	19.2
24	Kota	808.7	952.5	780.4	578.3	595.65	1268.27	17.8	-3.5	-28.5	-26.3	56.8
25	Nagaur	363.1	315.5	427.8	161.9	554.34	325.05	-13.1	17.8	-55.4	52.7	-10.5
26	Pali	484.5	667.3	348	260	652.78	661.67	37.7	-28.2	-46.3	34.7	36.6
27	Rajsamand	556.1	818	393.8	408.4	842.29	772.57	47.1	-29.2	-26.6	51.5	38.9
28	Sawai Madhopur	655.8	492.1	740.9	478.6	666.29	839.43	-25	13	-27	1.6	28.0
29	Sikar	459.8	387.5	508.1	226.6	868.71	600.57	-15.7	10.5	-50.7	88.9	30.6
30	Sirohi	606.3	1533.9	498.4	437.6	942.15	1079.40	153	-17.8	-27.8	55.4	78.0
31	Tonk	598.2	416.5	599.2	308.3	790.74	866.88	-30.4	0.2	-48.5	32.2	44.9
32	Udaipur	632.7	1274.7	622.4	593	895.89	893.33	101.5	-1.6	-6.27	41.6	41.2
RAJASTHAN		**541.1**	**669.9**	**567.1**	**389.3**	**687.40**	**727.46**	**23.8**	**4.81**	**-28.1**	**27.0**	**34.4**

A perusal of Table 3 reveals that during year 2011-12, 28 districts received rainfall above annual normal rainfall and among which Ganganagar district received 95.9% above normal annual rainfall. But four districts received below normal annual rainfall.

The isohytes of annual rainfall (2011-12) indicates that the rainfall in the east of Aravalli is significantly higher as compared to the western part.



3.3 Temprature

The hot weather season commences in the month of March and continues through April to June. In the month of May the diurnal range of temperature increases more and the day become hotter. During June the mean maximum temperature reaches as high as 48^0 C.

January is the coldest month.The normal minimum temperature for the month of January range from 2^0 C in the north to 7.8^0 C in the south west in the western Rajasthan. At Mount Abu (1195 mamsl), temperature dips to freezing point during the month of December /January. In eastern Rajasthan the range of normal minimum temperature (January) in and around the Aravalli hill ranges is 7^0 C to 8^0 C which increases towards the east and attains a high of more than 10^0 C in the districts of Kota and Bundi.

4.0 GEOLOGY

Diverse rock types ranging from the oldest Archaean rocks to sub- Recent alluvium and wind blown sand are exposed in Rajasthan. In a major portion of the area, particularly in western Rajasthan, the oldest rocks are concealed below a thick cover of alluvium and wind blown sands. A generalised stratigraphic succession of various formations and rock types is given in Table-4. Distribution of NHS in relation to various litho-units is given in Table-5

4.1 Archaeans

The Archaeans in Rajasthan are represented by Bhilwara Supergroup and comprise Banded Gneissic Complex representing the oldest metasedimentary sequence alongwith Berach Granite.

4.2 Proterozoics

Aravallis: Aravalli Supergroup unconformably overlies the Archaeans and consists of phyllites, greywackes, quartzites and dolomites intruded by granites and mafic rocks.

Delhis: These are exposed over a large part of central and north eastern Rajasthan and consist dominantly of quartzites, biotite-schist, calc-schist and marble.

Vindhyans: Vindhyans unconformably overlie Delhis and have been deposited in two separate basins on either side of the Aravallis. In the eastern part these comprise unmetamorphosed, relatively undisturbed, sandstones, limestones and shales. Great Boundary Fault separates them from Aravallis and Archeans.

Intrusives and extrusives: Nepheline syenites are exposed around Kishangarh and are post-Delhi in age. Erinpura Granite is the principal intrusive into the Delhis and are exposed around Ajmer and Mount Abu. Malani Suit of Igneous rocks consisting of rhyolites and pyroclastic material are exposed around Jodhpur and are post-Delhi in age.

Table 4: GEOLOGICAL SUCCESSION

GEOLOGICAL TIME UNIT		LITHOSTRATIGRAPHIC TIME UNIT		LITHOLOGY
ERA	PERIOD	SUPERGROUP / GROUP		
RECENT				Alluvium and blown sand
CAINOZOIC (TERTIARY)	Eocene	Mandai/ Akli/ Kapurdih/ Jogira/ Banda/ Khuiala / Palana		Sandstone, bentonitic clay & fuller's earth
DECCAN TRAPS				Basalt
MESOZOIC	Cretaceous	Abur / Fatehgarh		Sandstone, limestone, caly and lignite
	Jurasic	Paruhar/ Bhadesar/ Baisakhi/ Jaisalmer/ Lathi		Limetstone, sandstone & shale
PALAEOZOIC	Permo- Carboniferous		Bhadura	Sandstone & boulders
		Marwar	Nagaur/ Bilara/ Jodhpur	Sandstone, gypsum, siltstone, limestone, dolomite & shale
UPPER PROTEROZOIC		Vindhyan	Bhander/ Rewa/ Kaimur/ Semri	Sandstone, shale, limestone, conglomerate & basic flows
		Acid,Basic and Ultrabasic Intrusives and Extrusives Malani Volcanics / Plutonics Kishangarh Syenite		
LOWER PROTEROZOIC		Delhi	Ajabgarh/ Alwar/ Sirohi/ Punagarh/ Raialo	Quartzite, schist, gneiss, marble, shale, slate, phyllite & basic flows
		Granite, Basic & Ultrabasic Intrusives		
		Aravalli	Jharol/ Bari/ Udaipur/ Debari	Quartzite, schist, phyllite, conglomerate, greywacke, metavolcanics & marble
		Granite & Basic Intrusives		
ARACHAEAN		Bhilwara	Ranthamobre/ Rajpura-Dariba /Hindoli	Phyllite, slates, schist, gneiss, granite gneiss & migmatites

4.3 Palaeozoics

In the western part of the state, Marwar Super Group of Lower Palaeozoic age consists of three groups namely Jodhpur group (mainly sandstone & shale), Bilara Group (mainly limestones and dolomite) and Nagaur group (sandstone, siltstone and gypsum). Overlying the Marwar Super Group are the Badhura Formation of Permo-Carboniferous age comprising sandstones and boulders.

4.4 Mesozoics

Mesozoics are exposed mainly in Jaisalmer and Barmer districts. These comprise sandstones and limestones.

4.5 Deccan Traps

Deccan Traps occupy a part of southeastern segment of the state covering parts of Banswara, Baran, Jhalawar and Chittorgarh districts. These overlie pre-Aravallis, Aravallis and Vindhyans. These are basaltic to doleritic in composition and are uniform over a large area.

4.6 Tertiaries

Sandstones, bentonitic clay and Fuller's earth are the main litho-units and are exposed in Barmer, Bikaner and Jaisalmer districts.

4.7 Recent

This group consists of alluvium, blown sands, kankar and evaporites and are widely spread in the state.

5.0 HYDROGEOLOGY

The principal source of recharge to ground water in Rajasthan is rainfall. In canal irrigated areas, a part of canal water through seepage from conveyance system and part of water i.e. utilised for irrigation also returns to ground water and contributes to storage.

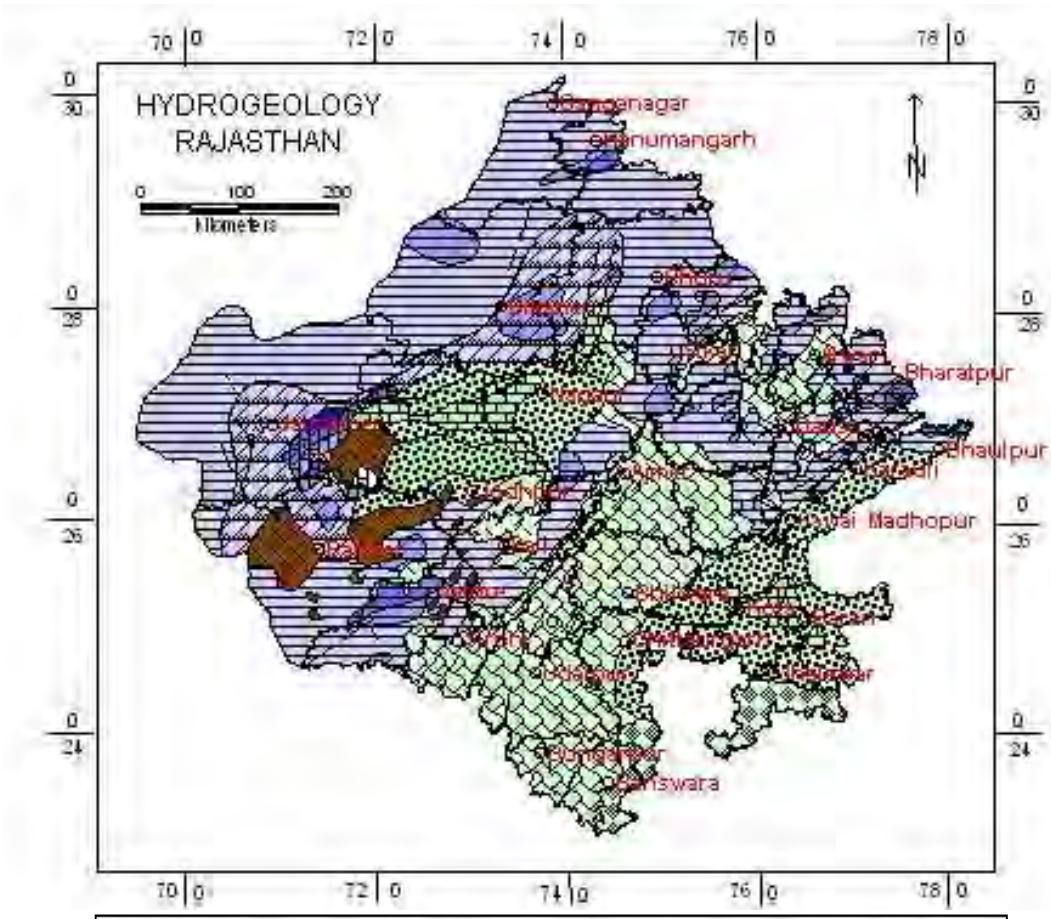
For broadly grouping geological formations from ground water occurrence & movement considerations, the various lithological units have been classified into two groups on the basis of their degree of consolidation and related parametres These are:

I Porous formations

(a) Unconsolidated formations
(b) Semi- consolidated formations

II Fissured fromations

(a) Consolidated sedimentary rocks
(b) Igneous and metamorphic rocks
(c) Volcanic rocks
(d) Carbonate rocks



Alluvium, sand, silt clay, unconfined to confined aquifers down to 330 mbgl

Sandstone, shale & siltstone, unconfined to confined aquifers down to 390 mbgl

Lathi Sandstone, unconfined to confined aquifers down to 440 mbgl

Basalt with or without intrertrappean, unconfined to confined aquifers down to 150 mbgl restricted to fractures, vesicular zones and weathered mental

Sandstone and shale, unconfined to confined aquifers down to 375 mbgl

Limestone & dolomite, unconfined to semiconfined aquifers down to284 mbgl restricted to caverns, fractures and weathered mantle

Granite & rhyolite, unconfined aquifers down to 80 mbgl restricted to weathered mantle and fractures

Quartzite, slate, phyllite, schist & gneiss, unconfined to semiconfined aquifers down to 150 mbgl restricted to fractures and weathered mantle

Ground Water Potential (Yield in liters/sec)

1 - 10 | 10 - 25 | 25 - 40 | > 40 — Aquifers with primary intergranular porosity

1 - 5 | 5 - 25 — Aquifers with secondary intergranular porosity & fracture

< 1 — Regions with limited groundwater, compact formations with less intergranular porosity & fracture

Lineament

5.1 Porous Formations

The Quaternary sediments comprising younger as well as older alluvium are the most important unconsolidated formations due to their wide-spread occurrence. The sediments are composed of clay, silt, sand, gravel and mixture of concretions etc. Sand, gravel and admixture of these form the potential aquifers in northern, eastern, north-eastern, western and south-western parts of the state. The maximum drilled thickness of alluvium is 543.51 metre below ground level (m bgl) at Anupgarh in Ganganagar district.

The semi-consolidated formations belonging to Palaeozoic, Mesozoic and Cainozoic Groups are composed of siltstone, claystone, sandstone, shale, conglomerate and limestone. Sandstones and limestones form the main aquifers in Jaisalmer, Jodhpur, Barmer and Bikaner districts. Sandstones of Lathi formation are the most potential aquifers in the districts of Jaisalmer, Jodhpur and Barmer.

5. 2 Fissured Formations

Fissured formations, as hydrogeological unit, occupy 32 % area of the state and can be broadly classified into four units.

Consolidated sedimentary rocks, excluding carbonate rocks, include sandstones and shales. In eastern and south-eastern part of the state these belong to Vindhyan Supergroup whereas in western Rajasthan these belong to the Marwar Supergroup.

Igneous and metamorphic rocks of lower Proterozoic age comprise slate, quartzite, phyllite, schist, gneiss and various crystallines of Bhilwara Supergroup. These are mostly found in the districts of Banswara, Dungarpur, Udaipur, Chittorgarh, Bhilwara, Tonk, Jaipur, Alwar and Jhunjhunu in eastern Rajasthan and Nagaur, Churu, Barmer, Jaisalmer, Pali, Jalore, Sirohi and Jodhpur districts in western Rajasthan.

Volcanic rocks include Deccan Trap Lava Flows and occur in parts of Barmer, Jhalawar, Chittorgarh and Banswara districts. These are basaltic to doleritic in composition. Occurrence and movement of ground water in these fromations is controlled by the presence of vesicles, extent of weathering, jointing and fracture pattern.

Carbonate rocks include limestone, marble and dolomite of Proterozoic and Upper Palaeozoic to Mesozoic age and occupy parts of Kota, Bundi, Jaipur, Sawai Madhopur and Alwar districts on the eastern side of Aravallis and parts of Nagaur, Bikaner, Jaisalmer and Jodhpur districts in western Rajasthan.

6.0 GROUND WATER REGIME MONITORING

Ground water monitoring is carried out mostly through a network of observation open wells all over the state. A few purpose-built stations (piezometers) have also been installed. These wells serve as permanent hydrograph network stations. The network of observation station is being improved by construction of new purpose-built piezometers. This will provide a better scientific environ, represent the true state of water levels and an even distribution of observation stations in the state.

At present the National Hydrograph Network Stations are being monitored four times a year simultaneously throughout the state on the under-mentioned dates:

May : 20th to 30th of the month - Represent water level of Premonsoon period

August : 20th to 30th of the month - Represent peak water level of monsoon period

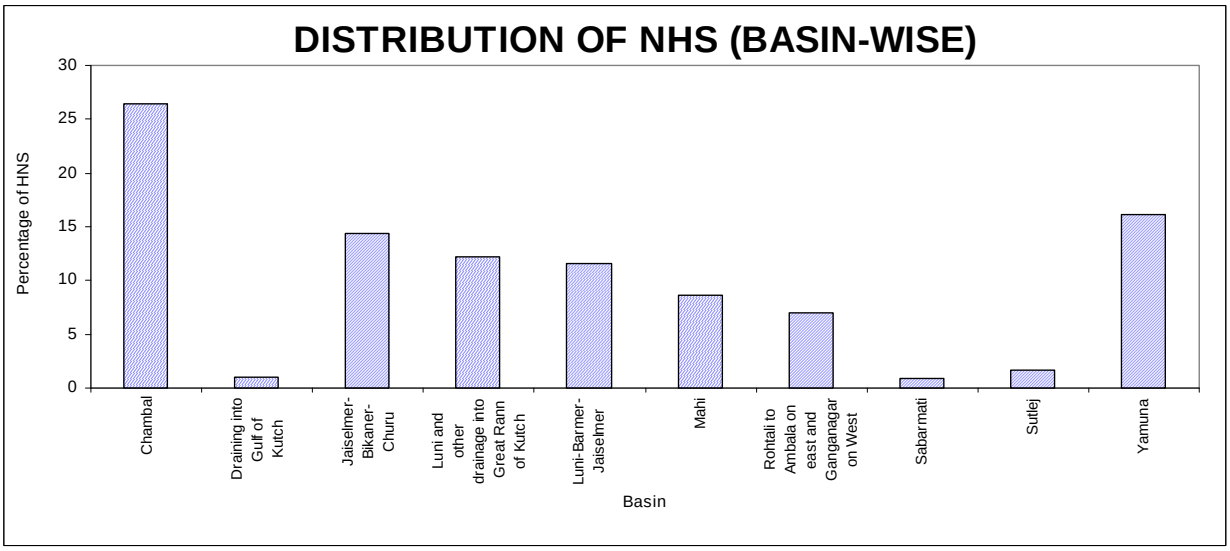
November: 1st to 10th of the month - Represent water level of Post-monsoon period

January : 1st to 10th of the month - Represent water level during irrigation period

Water sample are collected from each of the network station during May (Premonsoon) every year to evaluate the changes in quality regime of ground water.

6.1 Distribution of the National Hydrograph Stations:

A total of 1206 stations were monitored in the entire state. Arrangements for selection of alternative sites in place of dried up dug wells and cleaning & rehabilitation of piezometres that have been damaged due to tempering by ignorance are being made. Out of 1206 NHS, open dug-wells were 745 and piezometers 461. The district-wise distribution of hydrograph stations is in Table - 1. For computation of unit area per NHS, the effective area is arrived at by subtracting the forest and hill area from total geographical area. Thus on an average one NHS represents 284 sq km. The density of the stations is considered to be low. The net-work is therefore under redesigning and alternative new stations shall be set-up within few year timeframe to bring the net-work to a near optimal level.



In all there are 10 main river basins in the state. The break up of NHS and basin area of each river basin is given in the Table -2. The correlation between percentage geographical area of river basin and percentage of NHS in each basin closely match except in the zone of inland drainage. This is because of the fact that the districts of western Rajasthan viz. Barmer, Bikaner, Jaisalmer, Nagaur and Churu occupying 35 % of the total geographical area of the state are thinly populated. Hence the population of ground water structures is also less as compared to other parts.

The distribution of NHS in the state in major hydrogeological units is given in Table-5.

Table5: DISTRIBUTION OF HYDROGRAPH NETWORK STATIONS IN DIFFERENT HYDROGEOLOGICAL UNITS

AGE	FORMATION	TYPE	Area		NHS		Density
			Sq. km	%	No.	%	Sq. km/Station
Quarternary	Blown Sand, Recent older alluvium	Unconsolidated	145954	42.55	550	45.61	265
Tertiary-Upper Palaozoic	Sandstone, Siltstonme, Shale, Limestone	Semi Consolidated	36468	10.63	74	6.14	493
Mesozoic	Basalt, Intrertrapeans	Effusive	9092	2.65	43	3.57	211
Proterozoic	Limestone, Dolomite	Sedimentaries	10189	2.97	23	1.91	443
	Sandstone, Shale	Sedimentaries	51116	14.90	156	12.94	328
Lower Proterozoic	Quartzite, Phyllite,Schist, Gneiss,Marble	Meta-sediments	73493	21.42	323	26.78	228
Archaeon	Granite, Metamorphics	Basal Crystallines	16741	4.88	37	3.07	452
RAJASTHAN TOTAL			343053	100.00	1206	100.00	284

Out of 1,206 NHS, 42.55 % are in unconsolidated formation of Quaternary age and 10.63 % in semi-consolidated formations of Tertiary and Upper Palaozoic age. The consolidated formations have 46.82 % of the total NHS.

6.2 Analysis of data

The water levels reflect the cumulative effect on ground water regime as a consequence of natural recharge - discharge conditions and artificial draft. Where the draft exceeds the recharge, its manifestation is reflected in the decline of water levels. The hydrograph clearly shows the period of recharge and discharge.

Water level data, collected four times a year, is subjected to analysis for bringing out changes in water levels i.e. rise / fall and trend in the water levels.

6.2.1 Hydrograph analysis

(i) Comparison of hydrograph with rainfall and draft

6.2.2 Water level analysis

(i) Depth to water level

(ii) General range of water level fluctuation as compared with previous measurement

(iii) Water level data of specific period as compared with corresponding water level data in the previous year

(iv) Comparison of water level data with the mean water level data of the preceding decade

7.0 ANALYSIS OF COMPOSIT HYDROGRAPH SHOWING INTER-RELATIONSHIPS OF GROUND WATER LEVELS, RAINFALL AND GROUND WATER DRAFT

Ground water system in the state of Rajasthan has become extremely vulnerable to the overuse and water quality degradation. Since the volume of ground water instorage varies both in space and time in accordance with the hydrometeorological and hydrogeological domain conditions together with the external stress loaded on it as per the ground water requirements of various sectors like agriculture, drinking water needs and industrial uses, therefore the net impact imparted on the ground water system need to be studied closely and critically by analysing the behavioural pattern of ground water levels in the light of rainfall as input and extraction of ground water as output.

A composit well-hydrograph has been prepared which incorporates trends of water level during premonsson (May each year) and post monsoon (November each year) from 1989 to 2012 and rainfall histrograms for the corresponding year,

the data of ground water draft for the same periods have also been introduced. Regressions trend in respect of premonsoon and postmonsoon water levels over the period 1989-2012 has been worked out to predict the water level at certain interval of time, given the depth of water level at the stage of calculation. A few stations are presented in Fig. 7.1 to 7.8.

The behavioural pattern of the hydrographs can be grouped into three categories:

- Hydrographs of wells falling in hard rock areas
- Hydrographs of wells falling in alluvial area
- Hydrograph of wells falling in canal - irrigated command area

In the first category, the composit hydrograph reveals falling trend in the water levels of premonsoon period as well as post monsoon period over long span from 1989 to 2012 with increasing trend of the ground water draft. In the premosoon period at Kalsera **(Fig. 7.1)**, Pisangan block, district Ajmer that there has been long-term marginal declining trend in post monsoon period.

There has been marginal decline in pre-monsoon as well as post-monsoon period at Arthuna **(Fig. 7.2)**, block Garhi in district Banswara though there was many times increase in draft from 0.8 mcm in 1995 to 18.4 mcm in 2009.

The aquifers tapping sandstone have revealed that there has been significant decline of premonsoon and post monsoon water levels, caused due to increasing ground water draft. For example well located at Kalyansar **(Fig. 7.3)**, Block Bikaner, district Bikaner , the ground water draft of 14.1 mcm had gone up to 96.08 mcm (Six and a half times) during 2009. This will give sharp decline trend both pre - post monsoon water levels.

In the second category of hydrographs i.e. hydrographs of wells tapping alluvial aquifers, the decline of pre-monsoon as well as post-monsoon water levels are caused due to increasing ground water draft.

A typical case is reflected from the composit hydrograph of Jhotwara **(Fig. 7.4)** well (Jhotwara block of Jaipur district) . The ground water draft curve is hyperbolic as the withdrawal rate of ground water was stepped up from 93.53 mcm to 181.43 mcm during 2009. The result is reflected in the decline of both the post – monsoon and pre-monsoon water levels.

The wells located at Kotputli **(Fig. 7.5)**, Jaipur district the steepening in the declining water level trend from 1995 to 2012 in respect of pre-monsoon and post-

monsoon are mainly caused by accentuated withdrawal of ground water from 40.99 mcm during 1995 to 95.59 mcm during 2009.

Fig. 7.1

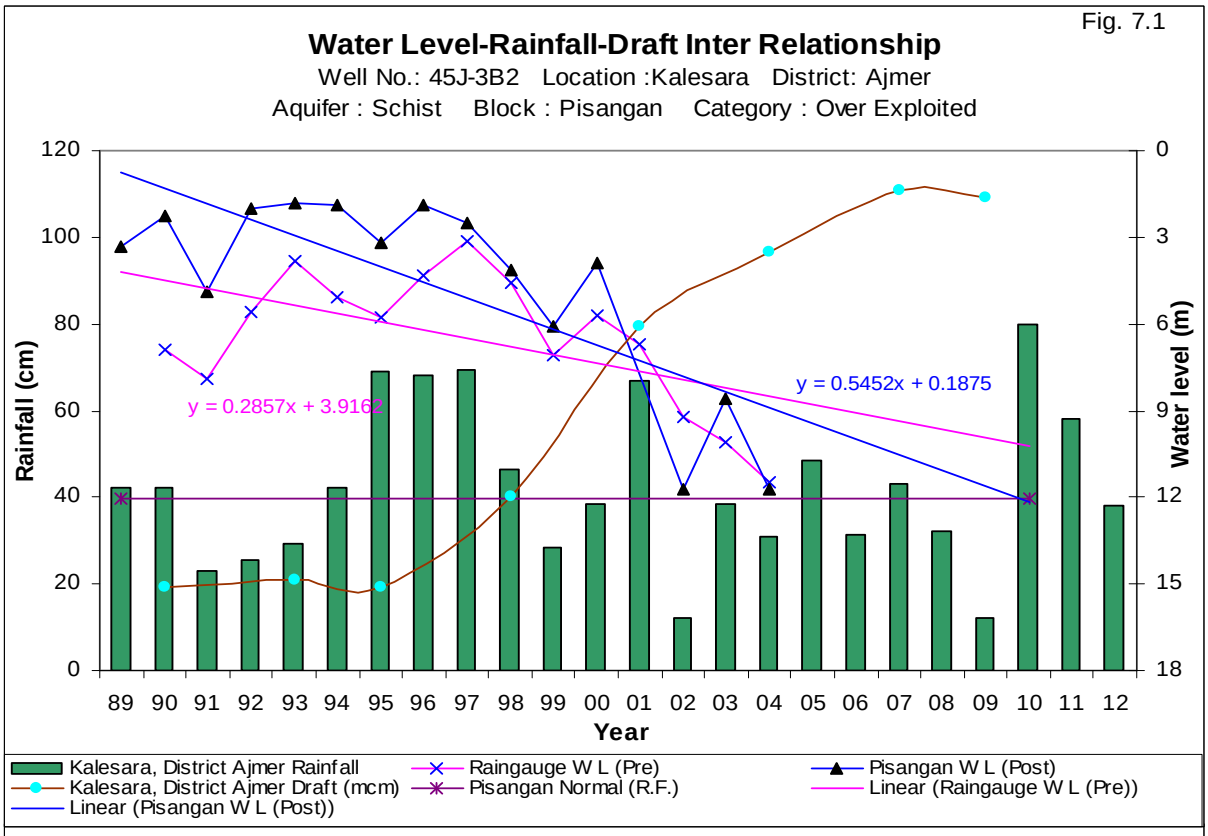


Fig. 7.2

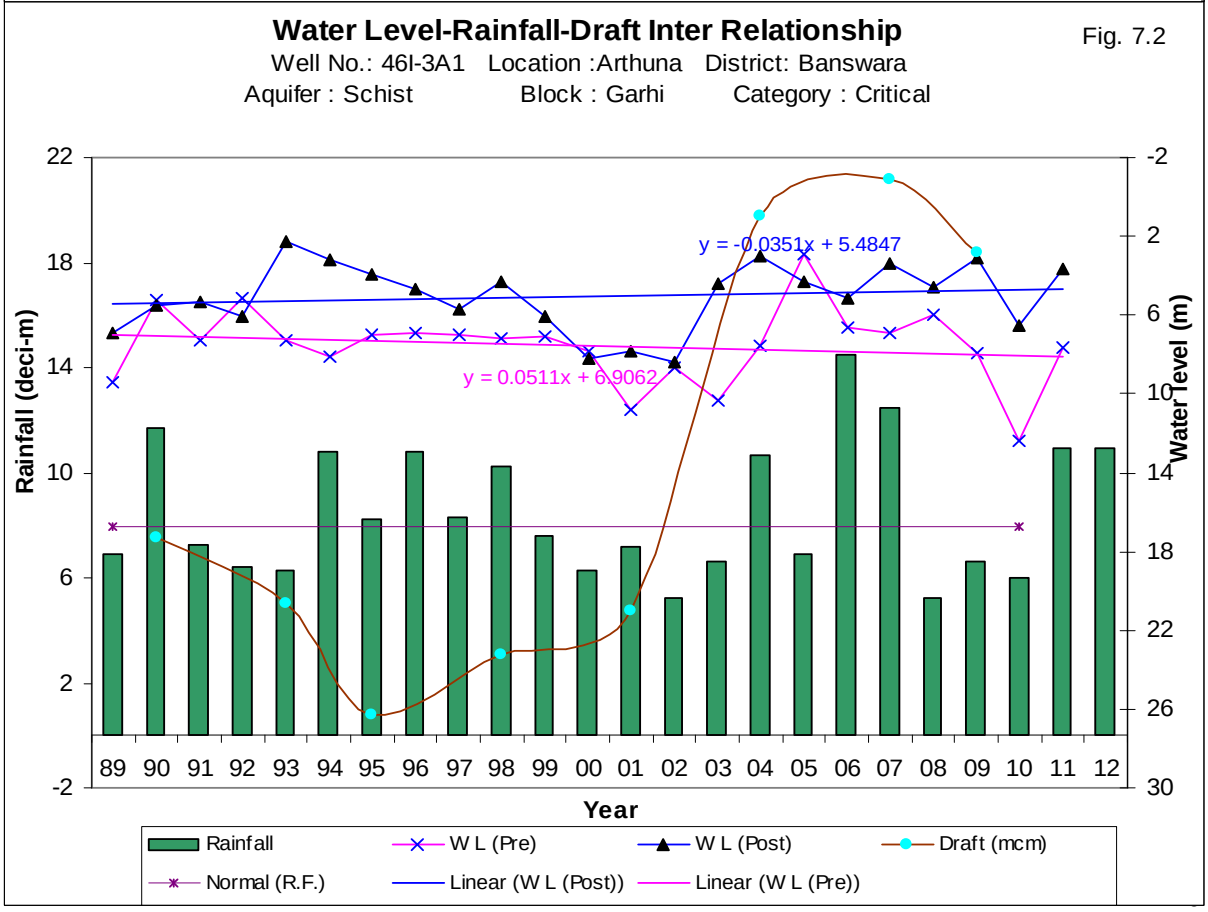


Fig. 7.3

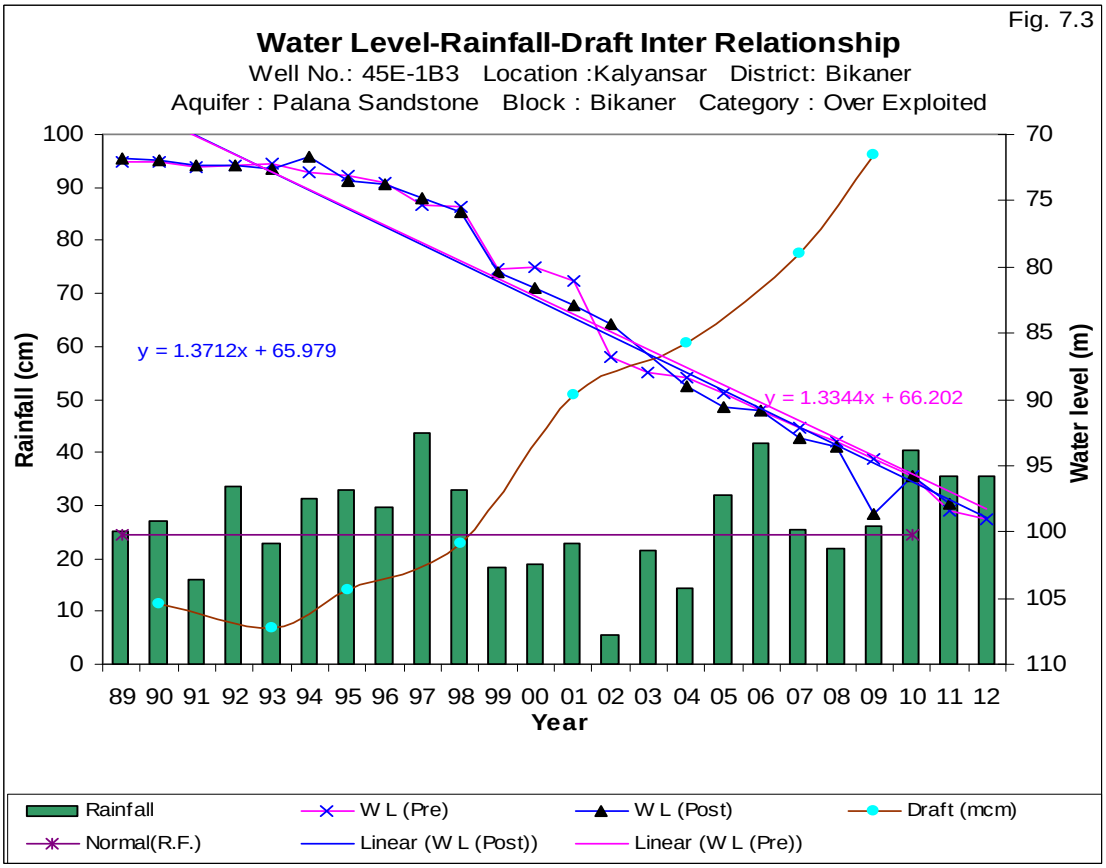
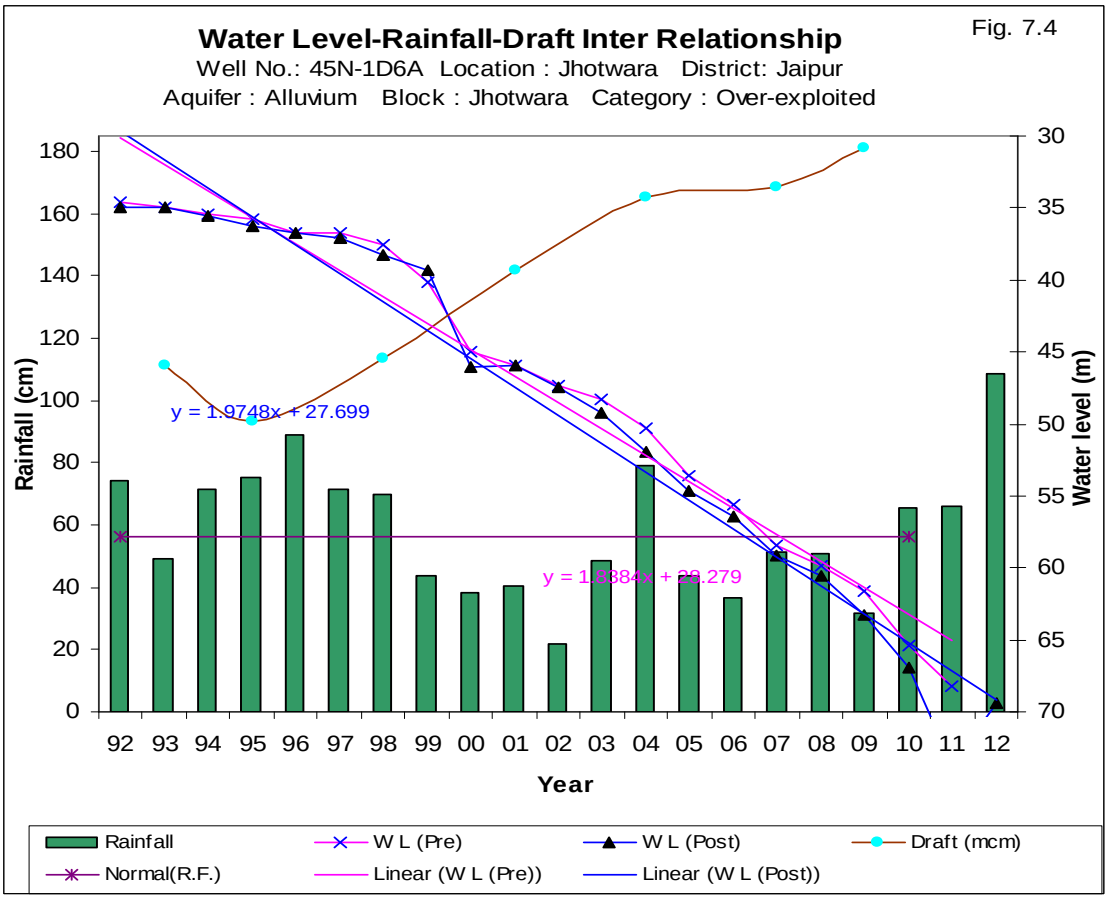

Water Level-Rainfall-Draft Inter Relationship
Well No.: 45E-1B3 Location :Kalyansar District: Bikaner
Aquifer : Palana Sandstone Block : Bikaner Category : Over Exploited
Rainfall (cm)
Water level (m)
Year
y = 1.3712x + 65.979
y = 1.3344x + 66.202
89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12
Rainfall
W L (Pre)
W L (Post)
Draft (mcm)
Normal(R.F.)
Linear (W L (Post))
Linear (W L (Pre))

Fig. 7.4


Water Level-Rainfall-Draft Inter Relationship
Well No.: 45N-1D6A Location : Jhotwara District: Jaipur
Aquifer : Alluvium Block : Jhotwara Category : Over-exploited
Rainfall (cm)
Water level (m)
Year
y = 1.9748x + 27.699
92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12
Rainfall
W L (Pre)
W L (Post)
Draft (mcm)
Normal(R.F.)
Linear (W L (Pre))
Linear (W L (Post))

The rainfall histogram between this period indicates rainfall precipitation in excess of normals. Identical situations and restulting scenario are observed in alluvial aquifer at Dhod **(Fig. 7.6)**, Sikar district.

Fig. 7.5

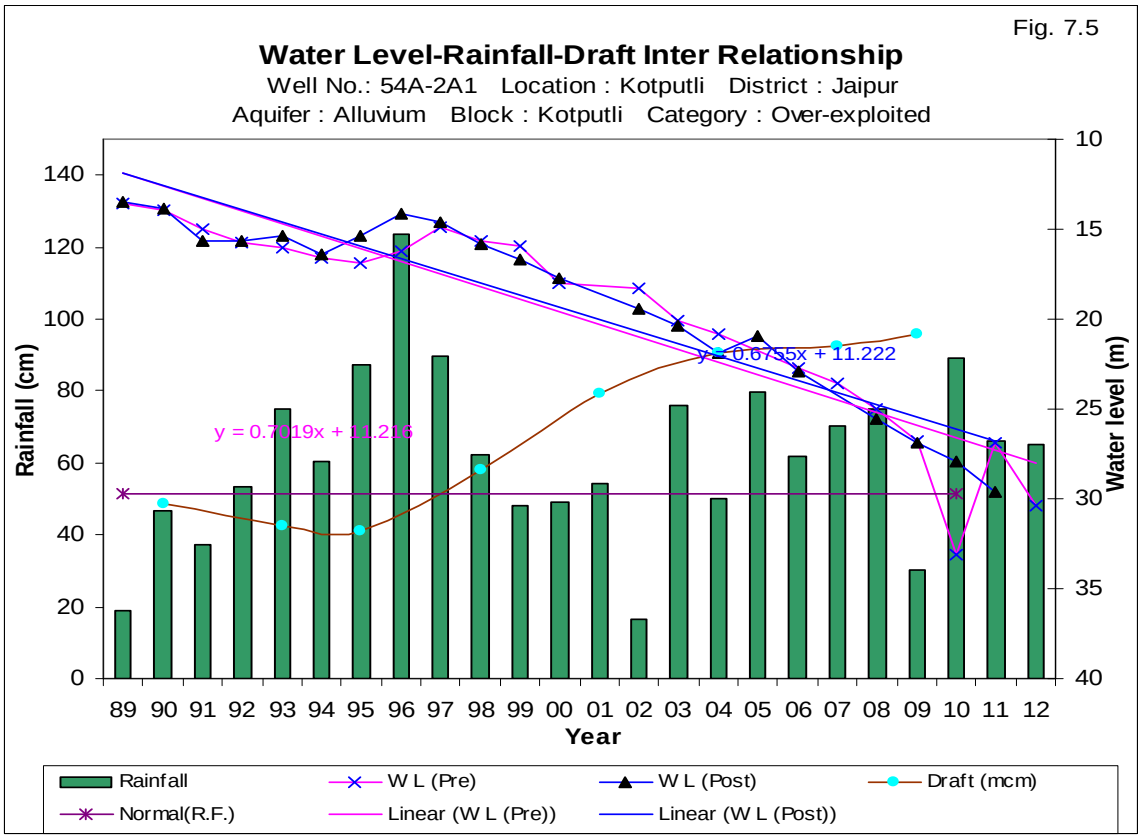
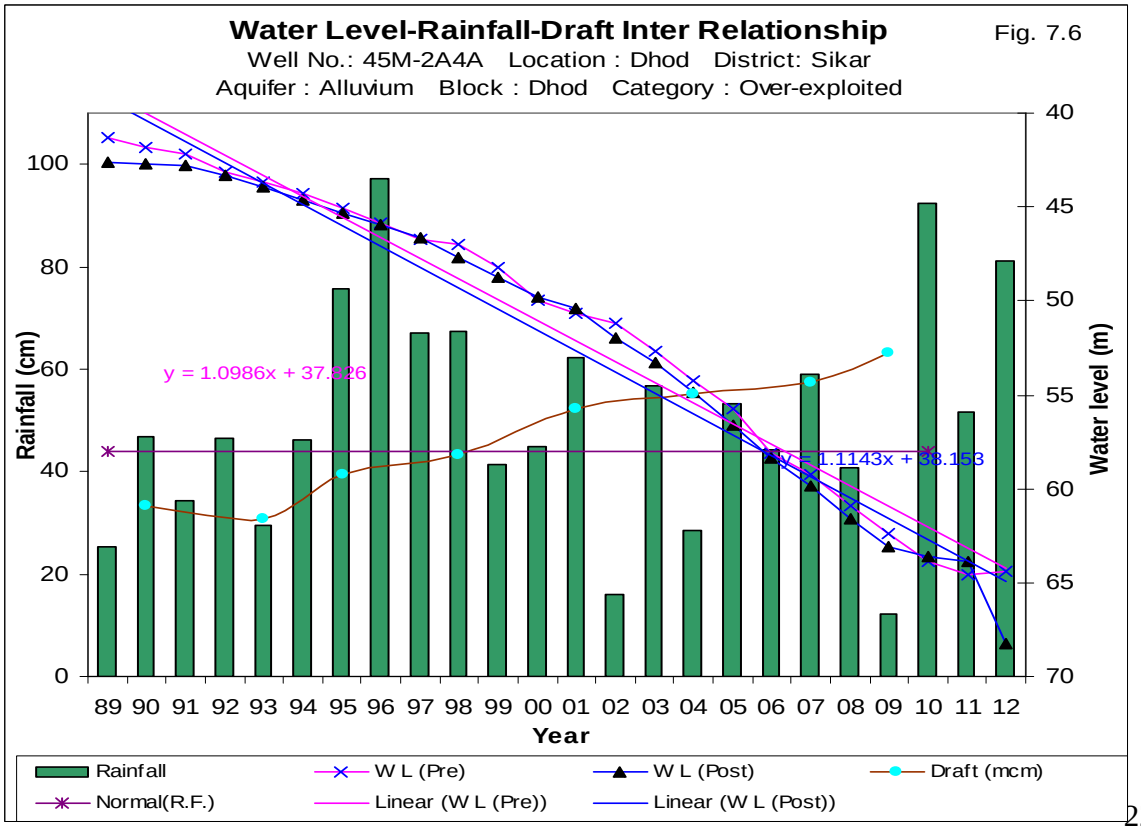
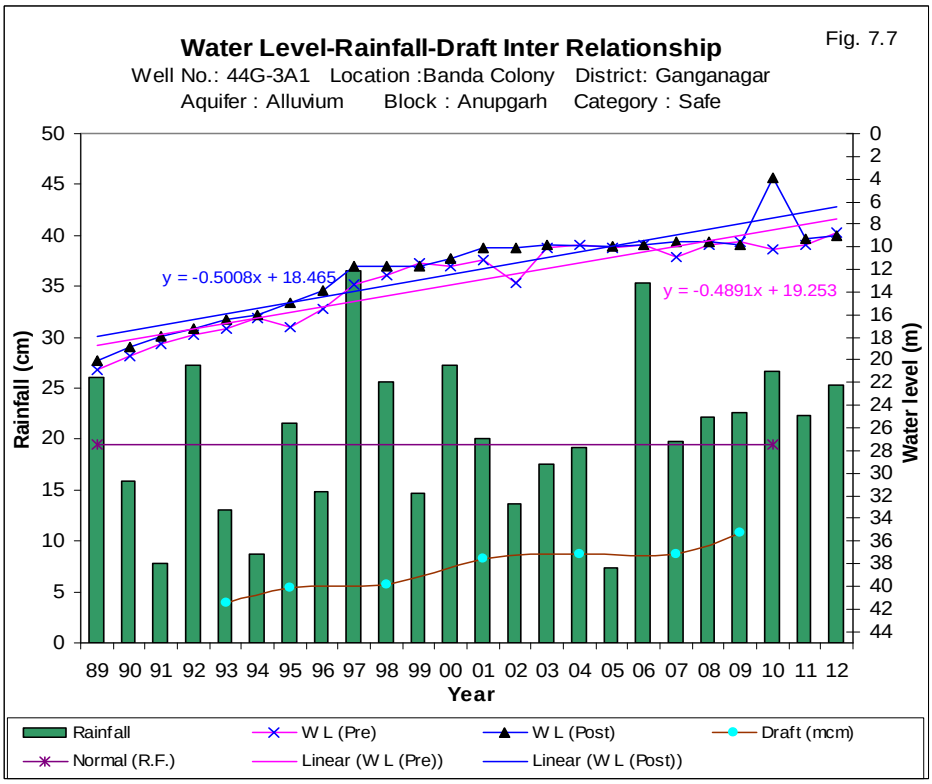
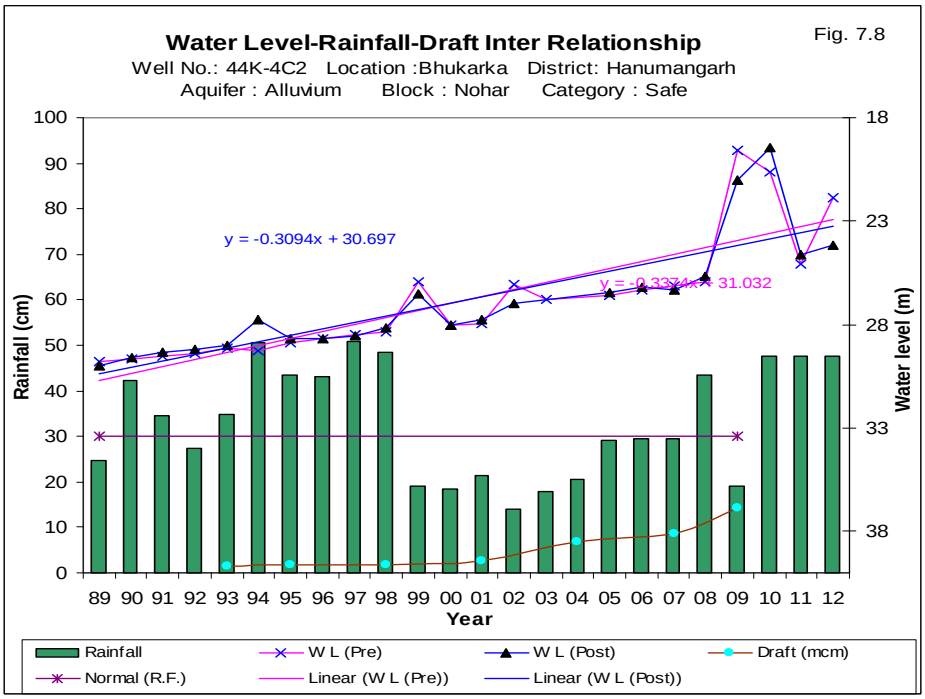


Fig. 7.6



The third category of well hydrographs reflect influence of canal irrigation and resultant increase in ground water level despite substantial over draft of ground water which has been increasing gradually over the time. Such locations for instance are at Banda Colony (**Fig. 7.7,** Block Anupgarh, district Ganganagar) and Bhukarka (**Fig. 7.8,** block, Nohar, district Hnumangarh).





8.0 GROUND WATER SCENARIO

Systematic and regular monitoring of ground water levels brings out the changes taking place in the groundwater regime. The maps so generated are of immense help for regional groundwater flow modelling which serves as a groundwater management tool to provide the necessary advance information to the user agencies to prepare contingency plans in case of unfavorable groundwater recharge situation. The data also has immense utility in deciding the legal issues arising out of conflicting interests of groundwater users.

Water level data of the NHS collected during the year 2012 – 2013 has been utilized to prepare various maps showing depth to water level and fluctuation of water level. Depth to water level maps are useful in dealing with problems of water logging and artificial recharge, where the relative position of water level with reference to the ground surface is of critical importance. Water level fluctuation maps (rise or fall) are indispensable for estimation of change in storage in the aquifer.

The water level data of open wells and piezometers are presented in the Annexure-I.

The data is analysed for each set of measurement, and report prepared which include following maps to understand the groundwater regime in the state.

Depth to water level maps

Seasonal fluctuation maps- water level fluctuation in comparison to pre- monsoon.

Annul fluctuation maps - water level fluctuation in comparison to same month in the previous year.

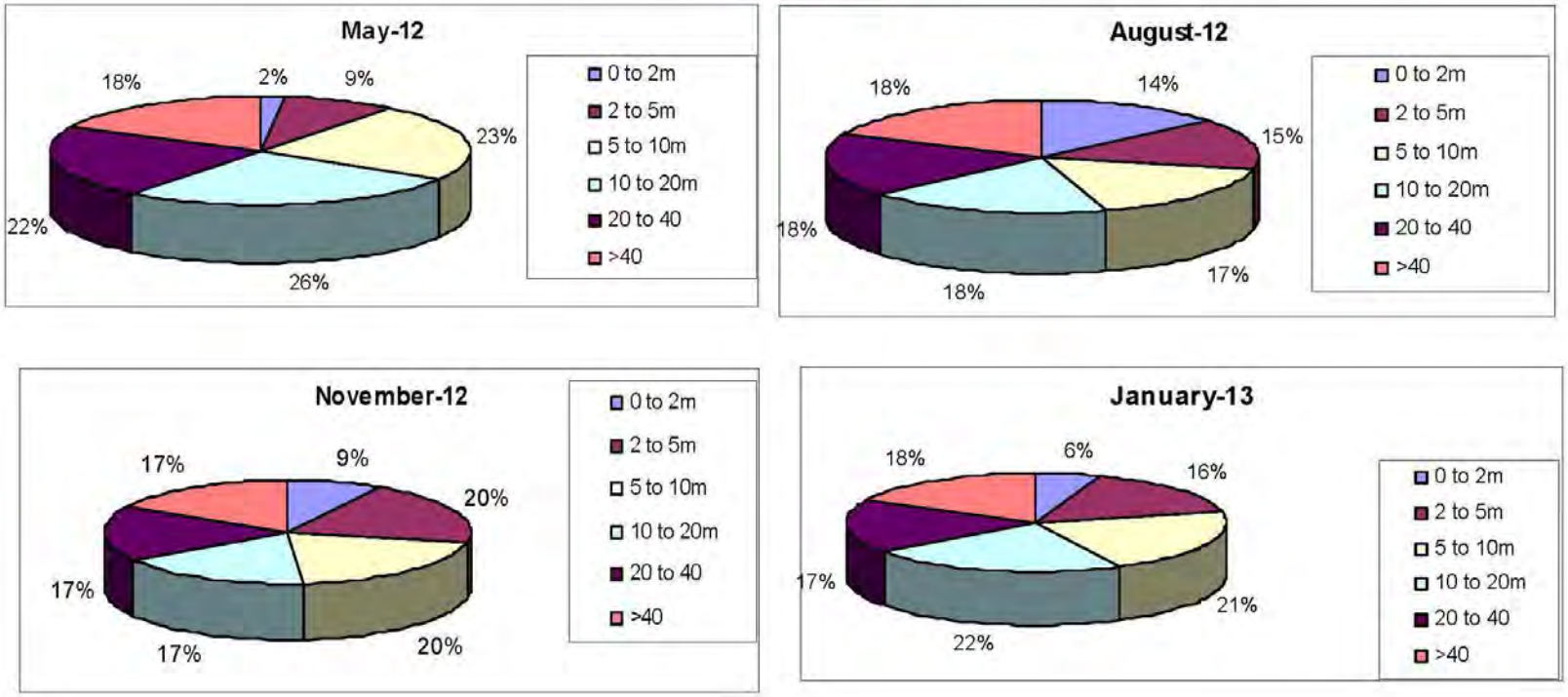
Decadal fluctuation maps - water level fluctuation in the month of measurement with reference to the decadal average for the same month.

8.1 Depth to Water Level (Unconfined Aquifer)

A graphical analysis was done to understand the water level behaviours of the NHS stations in the different categories of the water levels during every monitoring period and the same is depicted in **Fig. 8.1**. Shallow water level 0 to 2 m

Fig. 8.1

DISTRIBUTION OF WELLS IN DIFFERENT CATEGORIES OF WATER LEVELS (2012-2013)



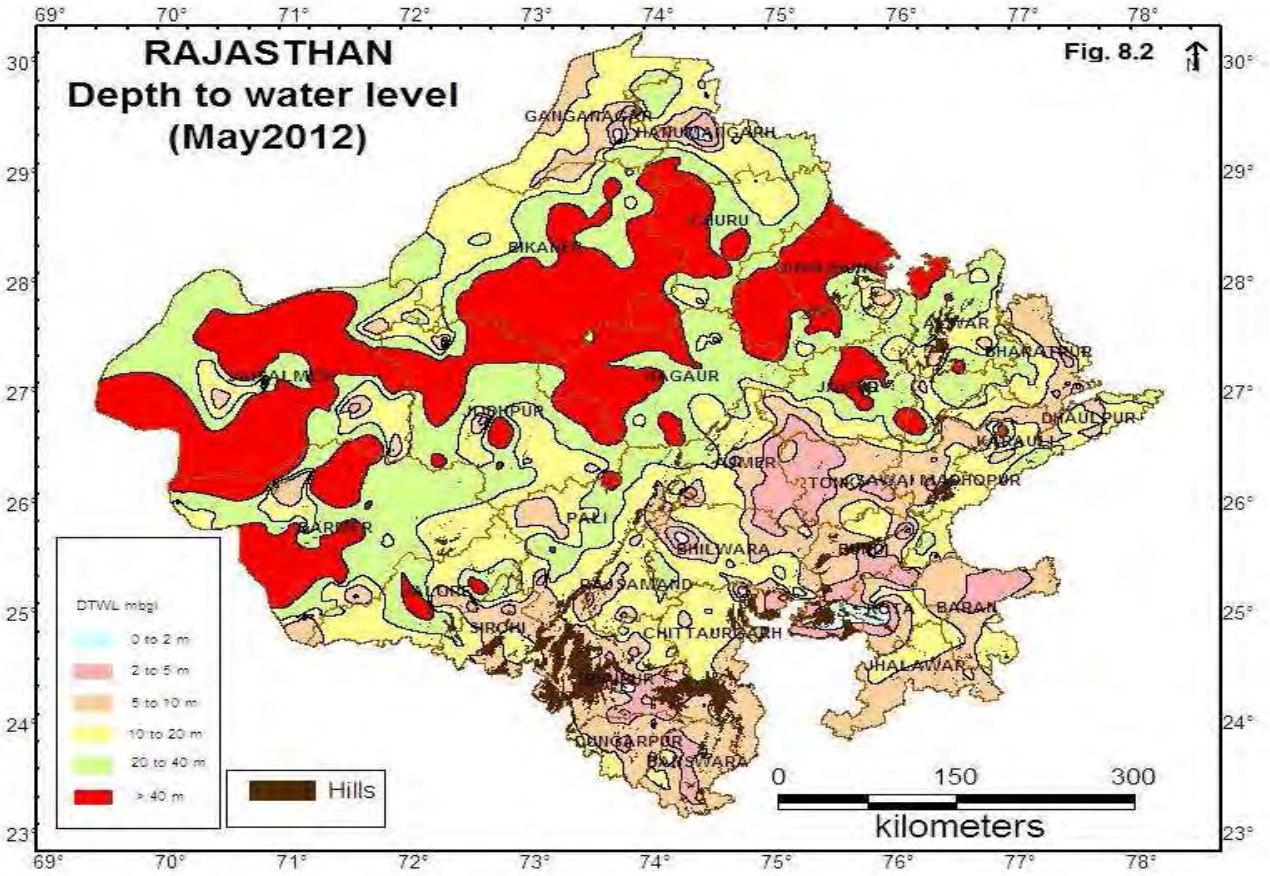
bgl observed in 2% to 14% of the majority of the stations whereas deeper water level recorded in 17% to 18% of the stations in the year 2012-13.

8.1.1 May 2012

A perusal of the map (**Fig. 8.2**) and **Table 8.1** reveals that large patches of water levels of more than 40 m bgl exist in the north western parts of the state extending from north east to south west direction. Water level deeper than 40 m bgl have been recorded in 18% of stations falling mostly in the districts of Jaisalmer, Barmer, Jodhpur, Bikaner, Jhunjhunu , Jaipur, Nagaur, Sikar and Churu. South Eastern half of the State exhibit water level generally less than 20 m bgl. Water level less than 2 m bgl have been observed in isolated patches and scattered mostly in the south Eastern parts of the State. About 72% of stations recorded water level between 5 to 40 mbgl. The deepest water level 120.85 m bgl has been recorded at Deshnokh in Bikaner district.

8.1.2 August 2012

A perusal of the map (**Fig. 8.3**) and **Table 8.2** reveals that large patches of water levels of more than 40 m bgl exist in the north western parts of the state extending from north east to south west direction. Water level deeper than 40 m bgl have been recorded in 19% of stations falling mostly in the districts of Jaisalmer, Barmer, Jodhpur, Bikaner, Jhunjhunu , Jaipur, Nagaur, Sikar and Churu. South Eastern half of the State exhibit water level generally less than 20 m bgl. Water level less than 2 m bgl have been observed in isolated patches and scattered mostly in the south Eastern parts of the State. Water level in the range of 10 to 20m, 20 to 40 m and more than 40m are recorded in almost in equal percentage of stations(App. 18%). The deepest water level 117.65 m bgl has been recorded at Darwar in Jaisalmer district.


RAJASTHAN
Depth to water level
(May2012)
Fig. 8.2
DTWL mbgl
0 to 2 m
2 to 5 m
5 to 10 m
10 to 20 m
20 to 40 m
> 40 m
Hills
0
150
300
kilometers

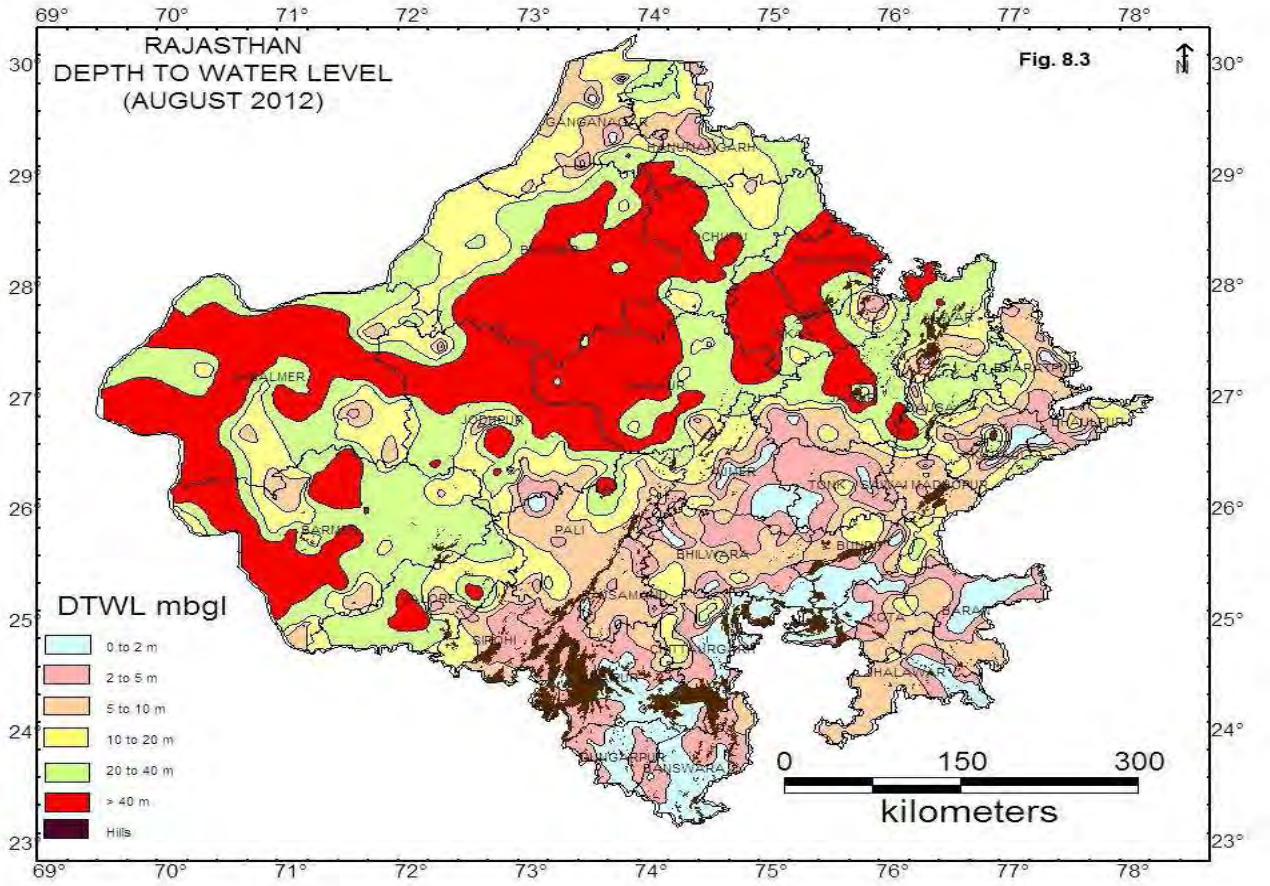

RAJASTHAN
DEPTH TO WATER LEVEL
(AUGUST 2012)
Fig. 8.3
DTWL mbgl
0 to 2 m
2 to 5 m
5 to 10 m
10 to 20 m
20 to 40 m
> 40 m
Hills
0
150
300
kilometers

Table 8.1

WELL WISE CATEGORISATION OF DEPTH TO WATER LEVEL - MAY 2012

District	No of well analysed	DTWL mbgl		No of well in different Ranges					
		Min	Max	0 to 2 (m)	2 to 5(m)	5 to 10(m)	10 to 20(m)	20 to 40(m)	>40(m)
AJMER	26	2	28.8	1 3.85%	6 23.08%	8 30.77%	9 34.62%	2 7.69%	0 0.00%
ALWAR	30	5.1	81.05	0 0.00%	0 0.00%	3 10.00%	6 20.00%	16 53.33%	5 16.67%
BANSWARA	26	2.64	16.65	0 0.0%	9 34.6%	13 50.0%	4 15.4%	0 0.0%	0 0.0%
BARAN	15	2.99	15.15	0 0.00%	3 20.00%	11 73.33%	1 6.67%	0 0.00%	0 0.00%
BARMER	47	4.1	102.39	0 0.0%	3 6.4%	7 14.9%	9 19.1%	13 27.7%	15 31.9%
BHARATPUR	36	1.2	32.25	1 2.78%	3 8.33%	19 52.78%	9 25.00%	4 11.11%	0 0.00%
BHILWARA	33	1.25	29.75	1 3.03%	3 9.09%	10 30.30%	13 39.39%	6 18.18%	0 0.00%
BIKANER	50	8.49	120.85	0 0.00%	0 0.00%	1 2.00%	10 20.00%	16 32.00%	23 46.00%
BUNDI	11	1.68	17.31	1 9.09%	5 45.45%	2 18.18%	3 27.27%	0 0.00%	0 0.00%
CHITTAURGARH	25	0.14	20.86	2 8.00%	2 8.00%	6 24.00%	14 56.00%	1 4.00%	0 0.00%
CHURU	34	9.2	63.82	**0** **0.00%**	**0** **0.00%**	**2** **5.88%**	**5** **14.71%**	**14** **41.18%**	**13** **38.24%**
DAUSA	13	8.37	56.95	0 0.00%	0 0.00%	2 15.38%	3 23.08%	6 46.15%	2 15.38%
DHAULPUR	17	4.94	34.7	0 0.00%	1 5.88%	5 29.41%	7 41.18%	4 23.53%	0 0.00%
DUNGARPUR	21	3.32	14.8	0 0.00%	3 14.29%	13 61.90%	5 23.81%	0 0.00%	0 0.00%
GANGANAGAR	35	0.15	39.2	3 8.57%	0 0.00%	13 37.14%	13 37.14%	6 17.14%	0 0.00%
HANUMANGARH	37	0.72	48.06	2 5.41%	1 2.70%	4 10.81%	15 40.54%	11 29.73%	4 10.81%
JAIPUR	40	3.63	87.5	0 0.00%	1 2.50%	4 10.00%	9 22.50%	11 27.50%	15 37.50%
JAISALMER	55	3.6	119.6	0 0.00%	3 5.45%	5 9.09%	9 16.36%	18 32.73%	20 36.36%
JALORE	12	3.54	55.05	**0** **0.00%**	**1** **8.33%**	**2** **16.67%**	**3** **25.00%**	**4** **33.33%**	**2** **16.67%**
JHALAWAR	8	5.05	15.46	0 0.00%	0 0.00%	3 37.50%	5 62.50%	0 0.00%	0 0.00%
JHUNJHUNU	16	16.19	81.15	0 0.00%	0 0.00%	0 0.00%	1 6.25%	1 6.25%	14 87.50%
JODHPUR	39	0.9	101.85	1 2.56%	1 2.56%	4 10.26%	10 25.64%	13 33.33%	10 25.64%
KARAULI	15	5.78	34.06	0 0.00%	0 0.00%	4 26.67%	8 53.33%	3 20.00%	0 0.00%
KOTA	16	0.57	25.36	2 12.50%	4 25.00%	2 12.50%	7 43.75%	1 6.25%	0 0.00%
NAGAUR	35	6.12	71.24	0 0.00%	0 0.00%	1 2.86%	5 14.29%	18 51.43%	11 31.43%
PALI	25	2.49	41.96	0 0.00%	2 8.00%	5 20.00%	11 44.00%	6 24.00%	1 4.00%
RAJSAMAND	26	4.29	20.12	**0** **0.00%**	**2** **7.69%**	**9** **34.62%**	**14** **53.85%**	**1** **3.85%**	**0** **0.00%**
SAWAI MADHOPUR	18	3.63	51.9	0 **0.00%**	2 **11.11%**	9 **50.00%**	6 **33.33%**	0 **0.00%**	1 **5.56%**
SIKAR	25	6	70	0 0.00%	0 0.00%	1 4.00%	1 4.00%	6 24.00%	17 68.00%
SIROHI	16	2.83	20.56	0 0.00%	1 6.25%	9 56.25%	4 25.00%	2 12.50%	0 0.00%
TONK	13	2.49	16.04	0 0.00%	7 53.85%	4 30.77%	2 15.38%	0 0.00%	0 0.00%
UDAIPUR	44	1.16	23.5	2 15.38%	11 84.62%	20 153.85%	9 69.23%	2 15.38%	0 0.00%
Grand Total	**859**	**0.14**	**120.85**	**16** **1.86%**	**74** **8.61%**	**201** **23.40%**	**230** **26.78%**	**185** **21.54%**	**153** **17.81%**

Table-8.2

WELL WISE CATEGORISATION OF DEPTH TO WATER LEVEL - AUGUST 2012

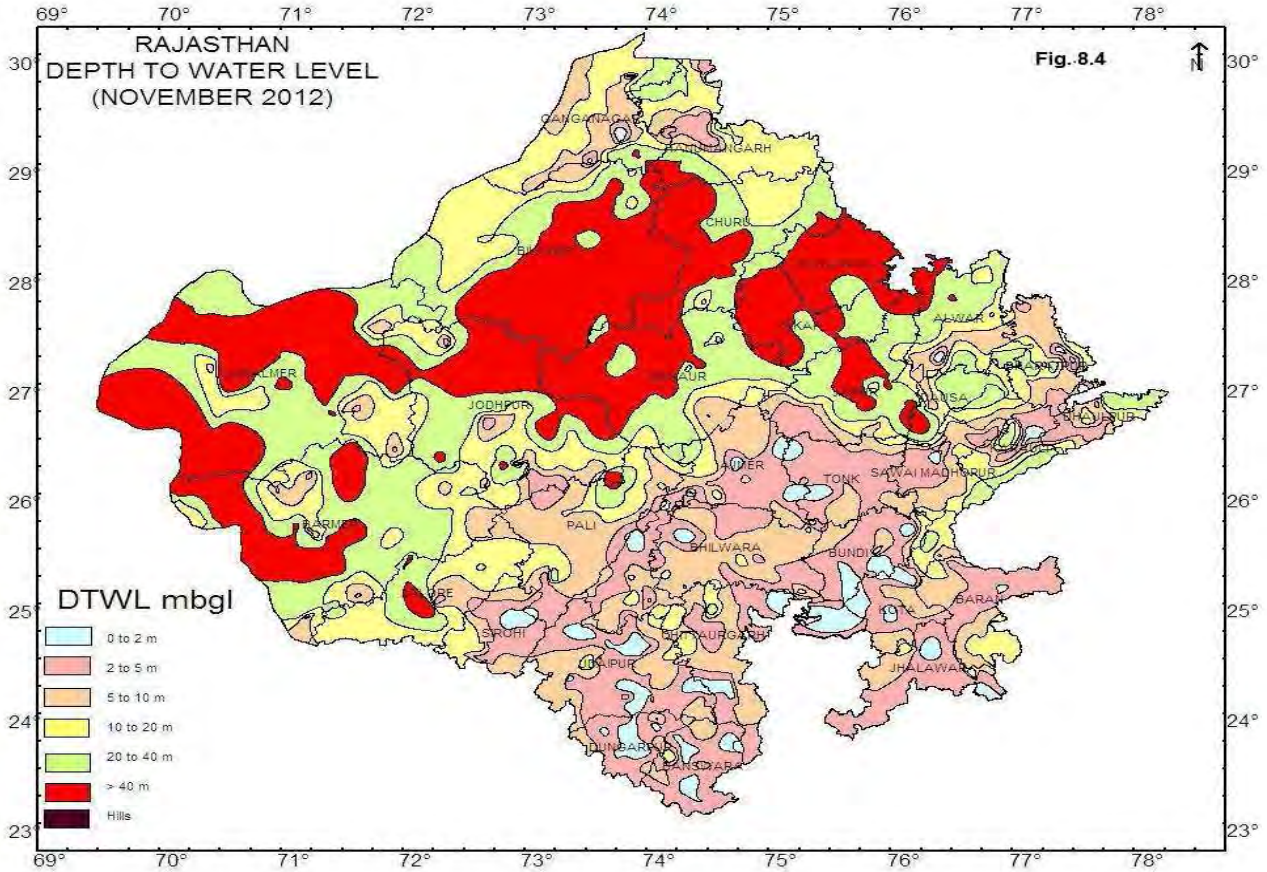
District	No of well analysed	DTWL mbgl		No of well in different Ranges					
		Min	Max	0 to 2 (m)	2 to 5(m)	5 to 10(m)	10 to 20(m)	20 to 40(m)	>40(m)
AJMER	28	0.01	15.89	11 39.29%	7 25.00%	5 17.86%	5 17.86%	0 0.00%	0 0.00%
ALWAR	32	1.39	83.7	1 3.13%	0 0.00%	5 15.63%	4 12.50%	17 53.13%	5 15.63%
BANSWARA	23	0.01	4.6	17 73.9%	6 26.1%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
BARAN	15	0.04	9.8	6 40.00%	5 33.33%	4 26.67%	0 0.00%	0 0.00%	0 0.00%
BARMER	60	4.2	102.39	0 0.0%	3 5.0%	10 16.7%	12 20.0%	17 28.3%	18 30.0%
BHARATPUR	34	0.36	28.75	3 8.82%	6 17.65%	14 41.18%	8 23.53%	3 8.82%	0 0.00%
BHILWARA	36	0.81	16.33	7 19.44%	9 25.00%	13 36.11%	7 19.44%	0 0.00%	0 0.00%
BIKANER	51	8.07	117.3	0 0.00%	0 0.00%	1 1.96%	12 23.53%	12 23.53%	26 50.98%
BUNDI	11	0.18	18.92	5 45.45%	2 18.18%	1 9.09%	3 27.27%	0 0.00%	0 0.00%
CHITTAURGARH	29	0.01	29.51	11 37.93%	8 27.59%	4 13.79%	4 13.79%	2 6.90%	0 0.00%
CHURU	35	7.9	63.6	**0 0.00%**	**0 0.00%**	**2 5.71%**	**4 11.43%**	**17 48.57%**	**12 34.29%**
DAUSA	14	2.84	56.1	0 0.00%	1 7.14%	3 21.43%	2 14.29%	7 50.00%	1 7.14%
DHAULPUR	16	1.04	33.95	3 18.75%	2 12.50%	2 12.50%	6 37.50%	3 18.75%	0 0.00%
DUNGARPUR	23	0.22	4.89	11 47.83%	12 52.17%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
GANGANAGAR	40	0.3	40.8	5 12.50%	2 5.00%	11 27.50%	15 37.50%	6 15.00%	1 2.50%
HANUMANGARH	37	1.15	47.75	1 2.70%	3 8.11%	6 16.22%	13 35.14%	10 27.03%	4 10.81%
JAIPUR	44	0.86	88.39	1 2.27%	3 6.82%	5 11.36%	5 11.36%	12 27.27%	18 40.91%
JAISALMER	61	3.6	117.65	0 0.00%	2 3.28%	6 9.84%	13 21.31%	17 27.87%	23 37.70%
JALORE	14	3.39	59.35	**0 0.00%**	**3 21.43%**	**0 0.00%**	**3 21.43%**	**6 42.86%**	**2 14.29%**
JHALAWAR	6	0.45	10.69	3 50.00%	0 0.00%	2 33.33%	1 16.67%	0 0.00%	0 0.00%
JHUNJHUNU	16	15.85	69.77	0 0.00%	0 0.00%	0 0.00%	1 6.25%	2 12.50%	13 81.25%
JODHPUR	47	0.9	85.5	1 2.13%	4 8.51%	6 12.77%	11 23.40%	10 21.28%	15 31.91%
KARAULI	13	0.17	34.06	3 23.08%	1 7.69%	3 23.08%	4 30.77%	2 15.38%	0 0.00%
KOTA	16	0.11	26	5 31.25%	5 31.25%	2 12.50%	3 18.75%	1 6.25%	0 0.00%
NAGAUR	32	4.44	71.24	0 0.00%	2 6.25%	0 0.00%	5 15.63%	14 43.75%	11 34.38%
PALI	30	0.51	36.75	1 3.33%	4 13.33%	11 36.67%	10 33.33%	4 13.33%	0 0.00%
RAJSAMAND	29	0.92	10.92	**5 17.24%**	**9 31.03%**	**14 48.28%**	**1 3.45%**	**0 0.00%**	**0 0.00%**
SAWAI MADHOPUR	19	1.44	47.55	3 **15.79%**	3 **15.79%**	6 **31.58%**	6 **31.58%**	0 **0.00%**	1 **5.26%**
SIKAR	24	2	70.08	1 4.17%	0 0.00%	0 0.00%	1 4.17%	3 12.50%	19 79.17%
SIROHI	16	2.03	18.09	0 0.00%	7 43.75%	6 37.50%	3 18.75%	0 0.00%	0 0.00%
TONK	14	0.56	18.81	3 21.43%	5 35.71%	4 28.57%	2 14.29%	0 0.00%	0 0.00%
UDAIPUR	46	0.01	14.81	20 142.86%	19 135.71%	6 42.86%	1 7.14%	0 0.00%	0 0.00%
Grand Total	**911**	**0.01**	**117.65**	**127 13.94%**	**133 14.60%**	**152 16.68%**	**165 18.11%**	**165 18.11%**	**169 18.55%**

8.1.3 November 2012

A perusal of the map (**Fig 8.4**) and **Table 8.3** reveals that large patches of water levels of more than 40 m bgl are exist in the north western parts of the state and extending from north east to south west direction and covering mostly in the districts of Barmer, Bikaner, Churu, Jaipur, Jaisalmer, , Jodhpur, Jhunjhunu' and Sikar. South Eastern half of the State exhibit water level generally less than 20 m bgl. Water level less than 2 m bgl are shown in isolated patches and scattered mostly in the south western parts of the State. Water level in the range of 2 to 5 m , 5 to 10 m, 10 to 20 m, 20 to 40 m and > 40 are observed in almost equal proportions of the monitoring stations i.e. 17 to 20% of stations analysed. The deepest water level 113.53 m bgl is recorded at Bholasar in Bikaner district.

8.1.4 January 2013

A perusal of the map (**Fig 8.5**) and **Table 8.4** reveals that large patches of water levels of more than 40 m bgl are exist in the north western parts of the state and extending from north east to south west direction and recorded in 18% of stations falling mostly in the districts of Jaisalmer, Barmer, Jodhpur, Bikaner, Jhunjhunu , Jaipur, Nagaur, Sikar and Churu. South Eastern half of the State exhibit water level generally less than 20 m bgl. Water level less than 2 m bgl are shown in isolated patches and scattered mostly in the south Eastern parts of the State. Water level in the range of 2 to 5 m, 20 to 40 m and > 40 are observed in almost equal proportions of the monitoring stations i.e. 16 to 18% of stations analysed whereas water level in the range of 5 to 10m and 10 to 20 m are observed in 21 to 22 % of the monitoring stations. The deepest water level 117.36 m bgl is recorded at Deshnokh in Bikaner district.


RAJASTHAN
DEPTH TO WATER LEVEL
(NOVEMBER 2012)
Fig. 8.4
DTWL mbgl
0 to 2 m
2 to 5 m
5 to 10 m
10 to 20 m
20 to 40 m
> 40 m
Hills

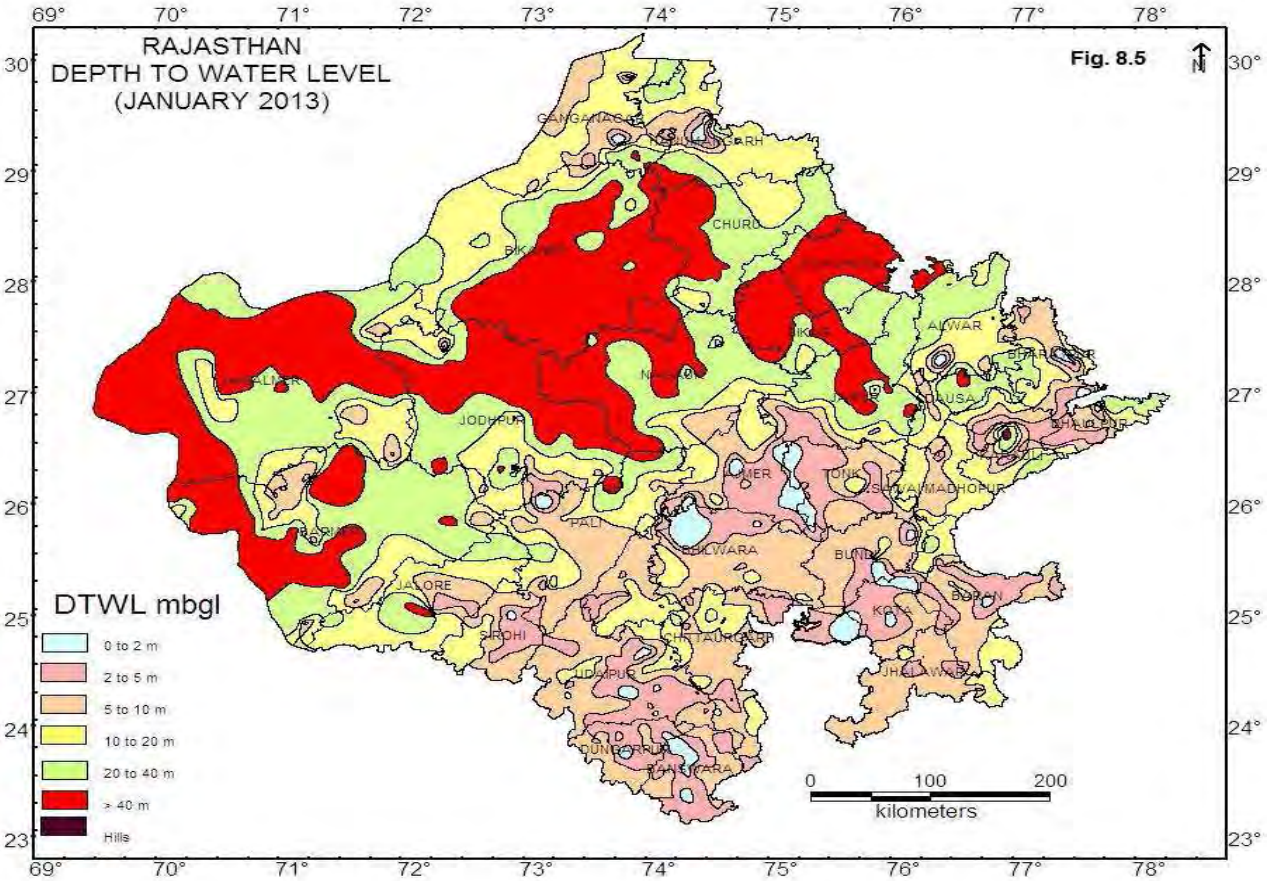

RAJASTHAN
DEPTH TO WATER LEVEL
(JANUARY 2013)
Fig. 8.5
DTWL mbgl
0 to 2 m
2 to 5 m
5 to 10 m
10 to 20 m
20 to 40 m
> 40 m
Hills
0
100
200
kilometers

Table-8.3

WELL WISE CATEGORISATION OF DEPTH TO WATER LEVEL - NOVEMBER 2012

District	No of well analysed	DTWL mbgl		No of well in different Ranges					
		Min	Max	0 to 2 (m)	2 to 5(m)	5 to 10(m)	10 to 20(m)	20 to 40(m)	>40(m)
AJMER	25	0.01	13.77	6 24.00%	12 48.00%	5 20.00%	2 8.00%	0 0.00%	0 0.00%
ALWAR	26	0.46	66.07	1 3.85%	1 3.85%	3 11.54%	6 23.08%	12 46.15%	3 11.54%
BANSWARA	25	0.95	16.65	7 28.0%	14 56.0%	3 12.0%	1 4.0%	0 0.0%	0 0.0%
BARAN	15	1.76	15.15	1 6.67%	7 46.67%	5 33.33%	2 13.33%	0 0.00%	0 0.00%
BARMER	50	4.45	89.05	0 0.0%	4 8.0%	8 16.0%	10 20.0%	16 32.0%	12 24.0%
BHARATPUR	34	0.01	34.47	3 8.82%	3 8.82%	20 58.82%	5 14.71%	3 8.82%	0 0.00%
BHILWARA	30	0.68	11.79	2 6.67%	10 33.33%	13 43.33%	5 16.67%	0 0.00%	0 0.00%
BIKANER	43	7.73	113.53	0 0.00%	0 0.00%	1 2.33%	9 20.93%	9 20.93%	24 55.81%
BUNDI	12	0.16	13.64	3 25.00%	6 50.00%	2 16.67%	1 8.33%	0 0.00%	0 0.00%
CHITTAURGARH	24	0.15	28.85	4 16.67%	8 33.33%	8 33.33%	3 12.50%	1 4.17%	0 0.00%
CHURU	31	9.06	61.52	**0** **0.00%**	**0** **0.00%**	**1** **3.23%**	**5** **16.13%**	**12** **38.71%**	**13** **41.94%**
DAUSA	13	6.86	56.84	0 0.00%	0 0.00%	4 30.77%	2 15.38%	6 46.15%	1 7.69%
DHAULPUR	15	2.53	34.48	0 0.00%	5 33.33%	1 6.67%	4 26.67%	5 33.33%	0 0.00%
DUNGARPUR	22	0.58	10.2	8 36.36%	9 40.91%	4 18.18%	1 4.55%	0 0.00%	0 0.00%
GANGANAGAR	37	0.29	41.55	4 10.81%	2 5.41%	11 29.73%	13 35.14%	6 16.22%	1 2.70%
HANUMANGARH	35	2.1	47.7	0 0.00%	5 14.29%	3 8.57%	15 42.86%	8 22.86%	4 11.43%
JAIPUR	36	2.46	86.74	0 0.00%	4 11.11%	4 11.11%	6 16.67%	8 22.22%	14 38.89%
JAISALMER	58	4.45	111.7	0 0.00%	2 3.45%	5 8.62%	11 18.97%	16 27.59%	24 41.38%
JALORE	11	2.74	56.55	**0** **0.00%**	**2** **18.18%**	**1** **9.09%**	**2** **18.18%**	**4** **36.36%**	**2** **18.18%**
JHALAWAR	20	1.13	13.89	2 10.00%	8 40.00%	7 35.00%	3 15.00%	0 0.00%	0 0.00%
JHUNJHUNU	14	33.77	84.9	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 7.14%	13 92.86%
JODHPUR	41	2.4	77.86	0 0.00%	5 12.20%	6 14.63%	10 24.39%	11 26.83%	9 21.95%
KARAULI	13	1.16	34.06	2 15.38%	2 15.38%	3 23.08%	3 23.08%	3 23.08%	0 0.00%
KOTA	18	0.52	26.06	5 27.78%	6 33.33%	4 22.22%	2 11.11%	1 5.56%	0 0.00%
NAGAUR	24	4.99	73.11	0 0.00%	1 4.17%	1 4.17%	4 16.67%	11 45.83%	7 29.17%
PALI	30	2.08	34.7	0 0.00%	5 16.67%	13 43.33%	8 26.67%	4 13.33%	0 0.00%
RAJSAMAND	27	0.98	14.72	**5** **18.52%**	**10** **37.04%**	**9** **33.33%**	**3** **11.11%**	**0** **0.00%**	**0** **0.00%**
SAWAI MADHOPUR	16	0.99	23.39	2 **12.50%**	5 **31.25%**	5 **31.25%**	3 **18.75%**	1 **6.25%**	0 **0.00%**
SIKAR	19	21.46	71.06	0 0.00%	0 0.00%	0 0.00%	0 0.00%	3 15.79%	16 84.21%
SIROHI	17	0.51	16.4	3 17.65%	7 41.18%	3 17.65%	4 23.53%	0 0.00%	0 0.00%
TONK	13	1.7	12.5	2 15.38%	6 46.15%	4 30.77%	1 7.69%	0 0.00%	0 0.00%
UDAIPUR	45	0.49	16.3	12 92.31%	16 123.08%	15 115.38%	2 15.38%	0 0.00%	0 0.00%
Grand Total	**839**	**0.01**	**113.53**	**72** **8.58%**	**165** **19.67%**	**172** **20.50%**	**146** **17.40%**	**141** **16.81%**	**143** **17.04%**

Table-8.4

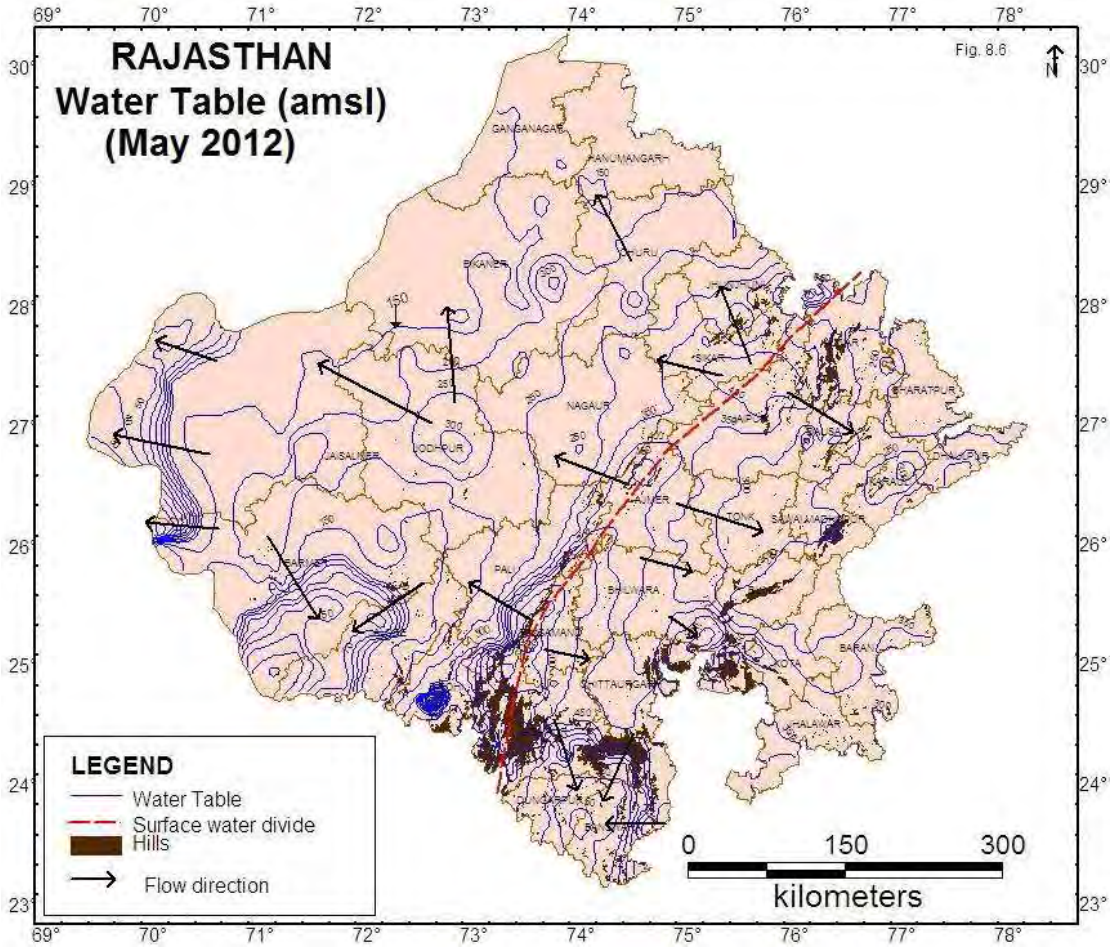
WELL WISE CATEGORISATION OF DEPTH TO WATER LEVEL - JANUARY 2013

District	No of well analysed	DTWL mbgl		No of well in different Ranges					
		Min	Max	0 to 2 (m)	2 to 5(m)	5 to 10(m)	10 to 20(m)	20 to 40(m)	>40(m)
AJMER	27	0.01	17.72	6 22.22%	11 40.74%	6 22.22%	4 14.81%	0 0.00%	0 0.00%
ALWAR	28	0.01	90.95	1 3.57%	0 0.00%	2 7.14%	11 39.29%	12 42.86%	2 7.14%
BANSWARA	23	0.47	9.5	5 21.7%	12 52.2%	6 26.1%	0 0.0%	0 0.0%	0 0.0%
BARAN	21	0.86	15.15	1 4.76%	9 42.86%	8 38.10%	3 14.29%	0 0.00%	0 0.00%
BARMER	55	4.3	102.39	0 0.0%	3 5.5%	9 16.4%	12 21.8%	14 25.5%	17 30.9%
BHARATPUR	34	0.01	32.75	3 8.82%	8 23.53%	12 35.29%	7 20.59%	4 11.76%	0 0.00%
BHILWARA	29	0.01	13.99	5 17.24%	4 13.79%	14 48.28%	6 20.69%	0 0.00%	0 0.00%
BIKANER	52	8.04	117.35	0 0.00%	0 0.00%	1 1.92%	12 23.08%	11 21.15%	28 53.85%
BUNDI	12	0.7	12.22	3 25.00%	2 16.67%	5 41.67%	2 16.67%	0 0.00%	0 0.00%
CHITTAURGARH	28	0.87	29.54	2 7.14%	7 25.00%	9 32.14%	8 28.57%	2 7.14%	0 0.00%
CHURU	36	9.74	63.9	**0** **0.00%**	**0** **0.00%**	**1** **2.78%**	**6** **16.67%**	**17** **47.22%**	**12** **33.33%**
DAUSA	12	6.6	43.56	0 0.00%	0 0.00%	4 33.33%	0 0.00%	7 58.33%	1 8.33%
DHAULPUR	15	1.14	39.3	1 6.67%	3 20.00%	3 20.00%	4 26.67%	4 26.67%	0 0.00%
DUNGARPUR	23	0.77	7.92	2 8.70%	10 43.48%	11 47.83%	0 0.00%	0 0.00%	0 0.00%
GANGANAGAR	36	0.01	42.3	2 5.56%	2 5.56%	11 30.56%	16 44.44%	4 11.11%	1 2.78%
HANUMANGARH	39	0.55	45.25	2 5.13%	1 2.56%	5 12.82%	18 46.15%	10 25.64%	3 7.69%
JAIPUR	39	2.33	90.11	0 0.00%	4 10.26%	4 10.26%	5 12.82%	11 28.21%	15 38.46%
JAISALMER	52	4.79	112.45	0 0.00%	1 1.92%	5 9.62%	11 21.15%	11 21.15%	24 46.15%
JALORE	8	3.34	56.65	**0** **0.00%**	**3** **37.50%**	**0** **0.00%**	**2** **25.00%**	**2** **25.00%**	**1** **12.50%**
JHALAWAR	19	4.22	13.51	0 0.00%	6 31.58%	9 47.37%	4 21.05%	0 0.00%	0 0.00%
JHUNJHUNU	13	31.85	79.82	0 0.00%	0 0.00%	0 0.00%	0 0.00%	2 15.38%	11 84.62%
JODHPUR	49	1.95	102.85	1 2.04%	3 6.12%	4 8.16%	11 22.45%	16 32.65%	14 28.57%
KARAULI	14	2.43	34.06	0 0.00%	6 42.86%	0 0.00%	5 35.71%	3 21.43%	0 0.00%
KOTA	18	0.86	26.06	5 27.78%	7 38.89%	3 16.67%	2 11.11%	1 5.56%	0 0.00%
NAGAUR	25	4.97	73.46	0 0.00%	1 4.00%	1 4.00%	4 16.00%	12 48.00%	7 28.00%
PALI	27	0.18	34.7	1 3.70%	3 11.11%	9 33.33%	9 33.33%	5 18.52%	0 0.00%
RAJSAMAND	27	2.08	20.12	**0** **0.00%**	**8** **29.63%**	**9** **33.33%**	**9** **33.33%**	**1** **3.70%**	**0** **0.00%**
SAWAI MADHOPUR	18	3.05	47.95	0 **0.00%**	2 **11.11%**	7 **38.89%**	8 **44.44%**	0 **0.00%**	1 **5.56%**
SIKAR	25	16	70.1	0 0.00%	0 0.00%	0 0.00%	1 4.00%	3 12.00%	21 84.00%
SIROHI	16	1.43	16.5	1 6.25%	5 31.25%	5 31.25%	5 31.25%	0 0.00%	0 0.00%
TONK	17	0.27	19.54	3 17.65%	7 41.18%	4 23.53%	3 17.65%	0 0.00%	0 0.00%
UDAIPUR	46	0.44	20.35	6 35.29%	14 82.35%	18 105.88%	7 41.18%	1 5.88%	0 0.00%
Grand Total	**883**	**0.01**	**117.35**	**50** **5.66%**	**142** **16.08%**	**185** **20.95%**	**195** **22.08%**	**153** **17.33%**	**158** **17.89%**

8.2 Water Table Scenario

The water table contour map for pre-monsoon (May 2012) period reveals that the Water table contours in general follow the regional topographic configuration **(Fig. 8.6)**. The Aravalli hill ranges act as principal ground water divide. The boundary separating the Luni river basin from the areas of misfit streams also act as conspicuous groundwater divide in western Rajasthan. The highest elevation of water table is over 1176.6 m above m.s.l. at Mount Abu in Aravalli hills and lowest about 7.29 m above m.s.l. at Panchla along the Luni river before meets the Rann of Kutch.

In the eastern side of Aravallis, the flow of ground water is easterly in major part, northern in the district of Kota, Jhalawar and Alwar and towards south and southwest in the districts of Dungarpur, Banswara and Udaipur. The altitude of water table is highest in the Aravalli region and lowest i.e. below 150 m above m.s.l. along the Mahi and Chambal river bordering Gujarat and U. Pradesh respectively. The Hydraulic gradient varies from 0.8 to 4.5 metres per kilometre. In the misfit stream area in the districts of Ganganagar, Bikaner, Churu, Sikar, Jhunjhunu, Nagur, Jaisalmer and Jodhpur, the water table slope is mainly in north western direction. The altitude of water table varies from less than 40 m. a.m.s.l. to 469 m. amsl. And the hydraulic gradient ranges from 1.23 to 3.12 m/km.

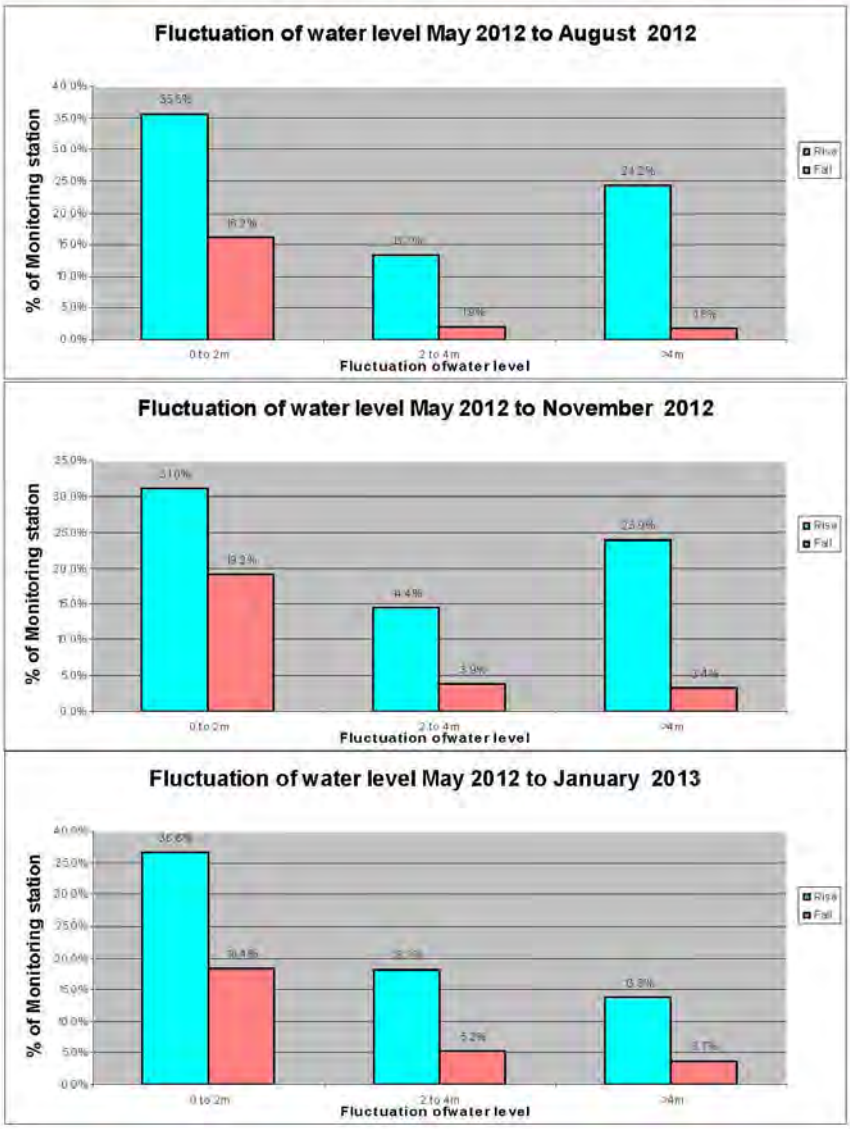


8.3 Seasonal Water Level Fluctuation

To study effect of monsoon on the groundwater regime and subsequent utilisation of groundwater for various needs like agriculture, irrigation, Domestic etc., changes in depth to water levels with respect to May data are studied. The change in groundwater in the region over different periods is presented graphically in **Fig. 8.7** and a summary of each observation is discussed below.

Fig. 8.7

SEASONAL FLUCTUATION OF WATER LEVEL DURING 2012-2013

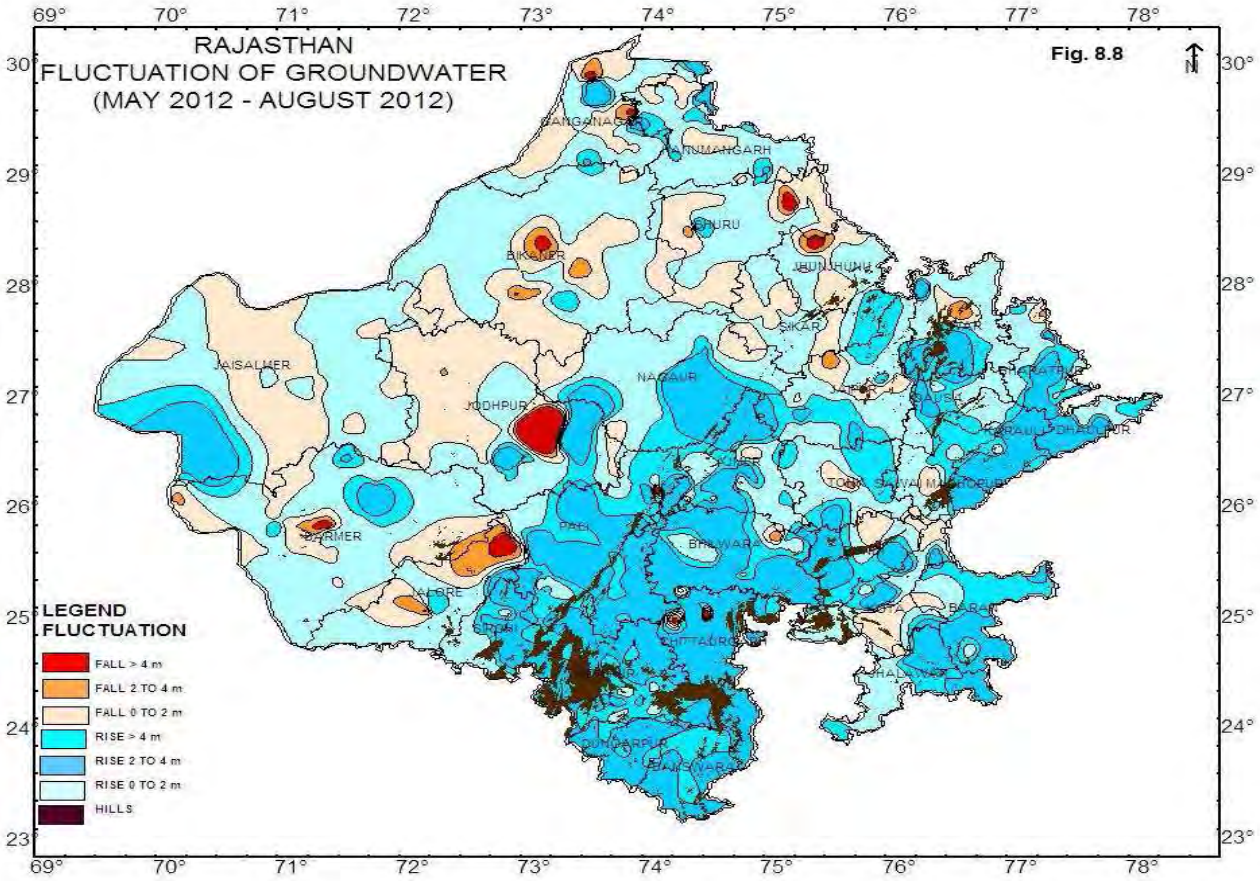


8.3.1 May 2012 to August 2012

Water level fluctuation data during May 2012 to August 2012 is presented in Table IV and has been depicted in Plate 4. A perusal of Map (**Fig. 8.8**) and **Tables 8.5** indicates that about 73% of the stations have registered rise on water levels, out of which 36% stations have recorded rise in the range of 0 to 2m (In the Southern parts of the State mostly covered by hills and mountains) Rise of more than 4m has been observed in about 24% of the stations falling mostly in Ajmer, Banswara, Baran, Bhatarpur, Bhilwara, Chittourgarh, Dungarpur, Pali, Rajsamad and Udaipur districts. About 16% of the stations have show fall of 0 to 2m mostly in the western sandy plain and cover parts of the districts of Jaisalmer, Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jaipur Jaisalmer, Jhunjhunu, Jodhpur and Sikar. Fall of more than 4 m has been registered in isolated patches and scattered in north western half of the State. A maximum rise of 28.48 m has been recorded at Salawatia in Bhilwada district and maximum fall of 8.65 m has been recorded at Purohitokasavat in Chittourgarh district.

8.3.2 May 2012 to November 2012

Map (**Fig. 8.9**) and **Tables 8.6** shows about 69% of the stations observed rise of water level between the period of May 2012 and November 2012. Southern parts mostly covered by hills and mountain experienced the rise of more than 4m. Rise of more than 4 m observed in about 24% of the stations falling mostly in Banswara, Bharatpur, Dugarpur, Jaipur, Jhalawar, Pali, Rajsamad, and Udaipur districts. About 19.5% of the stations shows fall of 0 to 2m mostly in the western sandy plain and covered in parts of the districts of Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jaisalmer, Jhunjhunu, Jodhpura and Sikar. Fall of more than 4 m occurs in the isolated patches and scattered in north western half of the State. A maximum rise of 36.85 m is recorded at Kakra and maximum fall of 14.48 m is recorded at Kalyansar in Bikaner district.


RAJASTHAN
FLUCTUATION OF GROUNDWATER
(MAY 2012 - AUGUST 2012)
Fig. 8.8
N
LEGEND
FLUCTUATION
FALL > 4 m
FALL 2 TO 4 m
FALL 0 TO 2 m
RISE > 4 m
RISE 2 TO 4 m
RISE 0 TO 2 m
HILLS
69°
70°
71°
72°
73°
74°
75°
76°
77°
78°
30°
29°
28°
27°
26°
25°
24°
23°

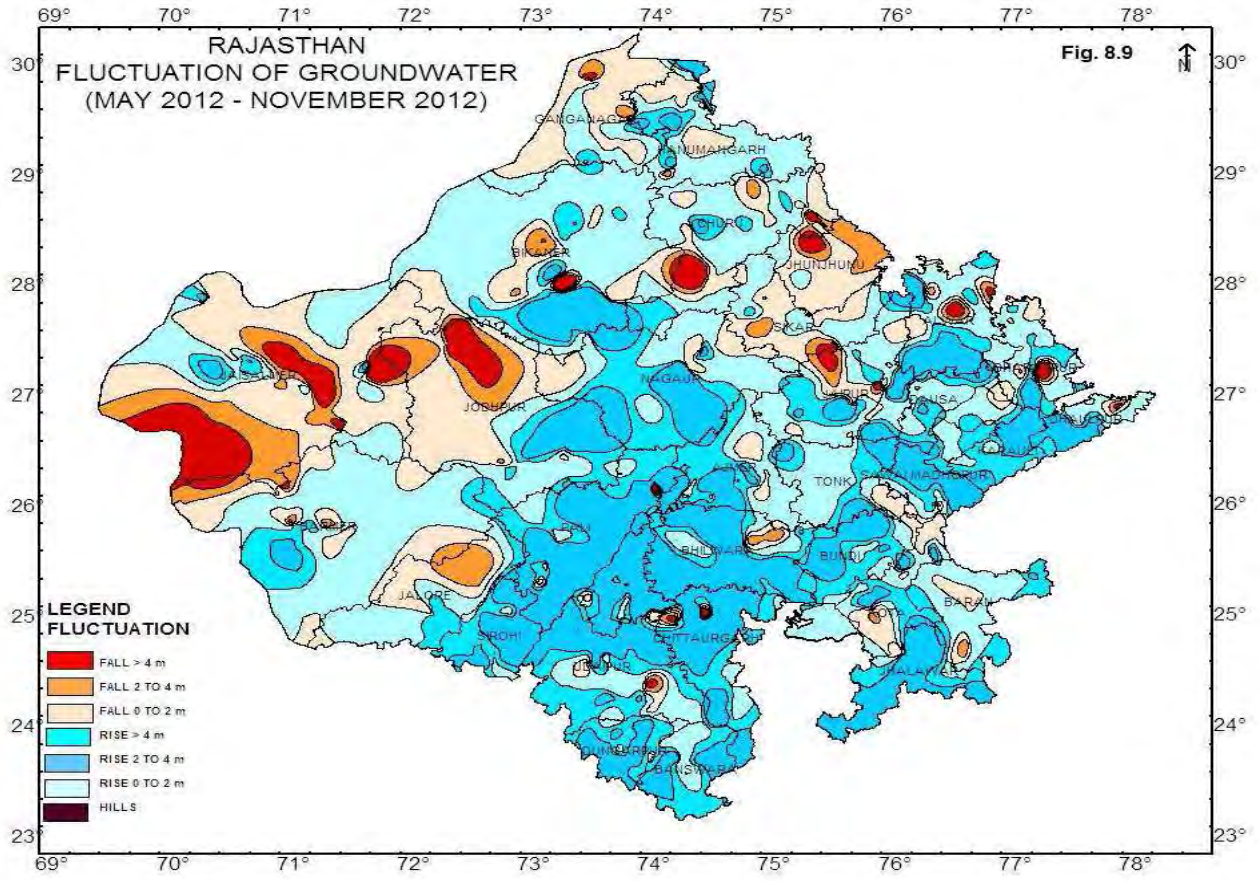

RAJASTHAN
FLUCTUATION OF GROUNDWATER
(MAY 2012 - NOVEMBER 2012)
Fig. 8.9
N
LEGEND
FLUCTUATION
FALL > 4 m
FALL 2 TO 4 m
FALL 0 TO 2 m
RISE > 4 m
RISE 2 TO 4 m
RISE 0 TO 2 m
HILLS
69°
70°
71°
72°
73°
74°
75°
76°
77°
78°
30°
29°
28°
27°
26°
25°
24°
23°

Table-8.5

CATEGORISATION OF CHANGES IN WATER LEVEL BETWEEN MAY 2012 TO AUGUST 2012

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	24	0.08	25.04	0.25	1.18	8 33.3%	2 8.3%	12 50.0%	2 8.3%	0 0.0%	0 0.0%	22	2
2	ALWAR	29	0.06	10.06	0.23	4.05	17 58.6%	4 13.8%	3 10.3%	2 6.9%	1 3.4%	1 3.4%	24	4
3	BANSWARA	22	1.96	10	-	-	2 9.1%	9 40.9%	11 50.0%	0 0.0%	0 0.0%	0 0.0%	22	0
4	BARAN	15	0.58	6.47	0.03	0.03	2 13.3%	6 40.0%	6 40.0%	1 6.7%	0 0.0%	0 0.0%	14	1
5	BARMER	47	0.05	6.55	0.05	5.94	18 38.3%	1 2.1%	2 4.3%	16 34.0%	2 4.3%	1 2.1%	21	19
6	BHARATPUR	34	0.18	11.24	2.24	2.24	16 47.1%	6 17.6%	7 20.6%	0 0.0%	1 2.9%	0 0.0%	29	1
7	BHILWARA	32	0.35	28.48	1.34	3.3	6 18.8%	6 18.8%	18 56.3%	1 3.1%	1 3.1%	0 0.0%	30	2
8	BIKANER	46	0.01	3.55	0.01	4.59	30 65.2%	1 2.2%	0 0.0%	10 21.7%	3 6.5%	2 4.3%	31	15
9	BUNDI	10	0.42	6.93	0.2	1.61	3 30.0%	3 30.0%	2 20.0%	2 20.0%	0 0.0%	0 0.0%	8	2
10	CHITTAURGARH	25	0.42	16.08	5.15	8.65	2 8.0%	2 8.0%	18 72.0%	0 0.0%	0 0.0%	2 8.0%	22	2
11	CHURU	33	0.07	4.58	0.06	6.73	15 45.5%	1 3.0%	1 3.0%	11 33.3%	1 3.0%	1 3.0%	17	13
12	DAUSA	12	0.65	8.5	-	-	6 50.0%	2 16.7%	4 33.3%	0 0.0%	0 0.0%	0 0.0%	12	0
13	DHAULPUR	15	0.64	11.91	1.79	1.79	8 53.3%	1 6.7%	4 26.7%	1 6.7%	0 0.0%	0 0.0%	13	1
14	DUNGARPUR	20	1.68	10.57	-	-	1 5.0%	2 10.0%	17 85.0%	0 0.0%	0 0.0%	0 0.0%	20	0
15	GANGANAGAR	35	0.01	10.09	0.03	5.77	17 48.6%	1 2.9%	3 8.6%	11 31.4%	0 0.0%	2 5.7%	21	13
16	HANUMANGARH	35	0.01	14.65	0.04	3.56	16 45.7%	4 11.4%	4 11.4%	9 25.7%	1 2.9%	0 0.0%	24	10
17	JAIPUR	36	0.11	9.08	0.05	2.73	16 44.4%	5 13.9%	4 11.1%	10 27.8%	1 2.8%	0 0.0%	25	11
18	JAISALMER	45	0.2	7.2	0.05	1.85	17 37.8%	0 0.0%	1 2.2%	16 35.6%	0 0.0%	0 0.0%	18	16
19	JALORE	12	0.1	2.8	2.4	5.4	7 58.3%	1 8.3%	0 0.0%	0 0.0%	1 8.3%	2 16.7%	8	3
20	JHALAWAR	6	1.07	12.19	0.24	0.24	1 16.7%	1 16.7%	3 50.0%	1 16.7%	0 0.0%	0 0.0%	5	1
21	JHUNJHUNU	15	0.06	1.89	0.05	5.12	8 53.3%	0 0.0%	0 0.0%	6 40.0%	0 0.0%	1 6.7%	8	7
22	JODHPUR	34	0.2	11.39	0.05	2.03	9 26.5%	3 8.8%	4 11.8%	8 23.5%	1 2.9%	1 2.9%	16	10
23	KARAULI	13	0.03	11.75	-	-	3 23.1%	3 23.1%	5 38.5%	0 0.0%	0 0.0%	0 0.0%	11	0
24	KOTA	16	0.15	12	0.05	1.64	5 31.3%	2 12.5%	4 25.0%	5 31.3%	0 0.0%	0 0.0%	11	5
25	NAGAUR	26	0.3	22.1	0.05	0.93	7 26.9%	3 11.5%	3 11.5%	4 15.4%	0 0.0%	0 0.0%	13	4
26	PALI	24	0.75	25.2	0.15	8.1	7 29.2%	4 16.7%	6 25.0%	2 8.3%	0 0.0%	1 4.2%	17	3
27	RAJSAMAND	26	2.44	18.34	-	-	0 0.0%	10 38.5%	16 61.5%	0 0.0%	0 0.0%	0 0.0%	26	0
28	SAWAI MADHOPUR	17	0.15	8.84	0.23	2.91	3 17.6%	6 35.3%	3 17.6%	3 17.6%	1 5.9%	0 0.0%	12	4
29	SIKAR	23	0.02	4	0.08	1.1	15 65.2%	1 4.3%	0 0.0%	6 26.1%	0 0.0%	0 0.0%	16	6
30	SIROHI	14	0.8	14.6	-	-	7 50.0%	1 7.1%	5 0.0%	0 0.0%	0 0.0%	0 0.0%	13	0
31	TONK	12	0.16	4.94	0.61	2.77	6 50.0%	2 16.7%	1 8.3%	2 16.7%	1 8.3%	0 0.0%	9	3
32	UDAIPUR	43	1.15	20.43	-	-	5 11.6%	12 27.9%	26 60.5%	0 0.0%	0 0.0%	0 0.0%	43	0
	Grand Total	796	0.01	28.48	0.01	8.65	283 35.6%	105 13.2%	193 24.2%	129 16.2%	15 1.9%	14 1.8%	581	158

Table-8.6

CATEGORISATION OF CHANGES IN WATER LEVEL BETWEEN MAY 2012 TO NOVEMBER 2012

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	22	0.52	23.36	0.06	1.28	7 31.8%	2 9.1%	10 45.5%	3 13.6%	0 0.0%	0 0.0%	19	3
2	ALWAR	25	0.24	13.6	1.63	6.03	10 40.0%	4 16.0%	6 24.0%	1 4.0%	1 4.0%	2 8.0%	20	4
3	BANSWARA	24	0.26	8.2	0.04	0.04	7 29.2%	8 33.3%	7 29.2%	1 4.2%	0 0.0%	0 0.0%	22	1
4	BARAN	13	0.66	4.77	0.03	3.57	6 46.2%	1 7.7%	1 7.7%	3 23.1%	1 7.7%	0 0.0%	8	4
5	BARMER	40	0.1	4.85	0.1	4.9	20 50.0%	2 5.0%	1 2.5%	11 27.5%	2 5.0%	2 5.0%	23	15
6	BHARATPUR	34	0.13	7.8	0.12	8	14 41.2%	6 17.6%	4 11.8%	5 14.7%	1 2.9%	1 2.9%	24	7
7	BHILWARA	29	0.44	20.67	2.71	3.12	5 17.2%	3 10.3%	19 65.5%	0 0.0%	2 6.9%	0 0.0%	27	2
8	BIKANER	41	0.06	36.85	0.01	14.48	21 51.2%	5 12.2%	5 12.2%	7 17.1%	1 2.4%	2 4.9%	31	10
9	BUNDI	11	0.81	13.71	0.05	0.05	4 36.4%	3 27.3%	3 27.3%	1 9.1%	0 0.0%	0 0.0%	10	1
10	CHITTAURGARH	20	0.5	13.22	5.15	7.99	4 20.0%	2 10.0%	12 60.0%	0 0.0%	0 0.0%	2 10.0%	18	2
11	CHURU	30	0.1	5.67	0.05	10.03	12 40.0%	3 10.0%	1 3.3%	10 33.3%	1 3.3%	2 6.7%	16	13
12	DAUSA	11	0.11	5.58	0.11	2	6 54.5%	1 9.1%	2 18.2%	2 18.2%	0 0.0%	0 0.0%	9	2
13	DHAULPUR	15	0.22	11.88	1.98	4.63	8 53.3%	1 6.7%	3 20.0%	1 6.7%	0 0.0%	1 6.7%	12	2
14	DUNGARPUR	19	1.45	10.18	-	-	2 10.5%	6 31.6%	11 57.9%	0 0.0%	0 0.0%	0 0.0%	19	0
15	GANGANAGAR	32	0.04	4.08	0.05	5.77	9 28.1%	1 3.1%	1 3.1%	17 53.1%	1 3.1%	1 3.1%	11	19
16	HANUMANGARH	33	0.03	9.03	0.41	3.84	15 45.5%	1 3.0%	6 18.2%	8 24.2%	3 9.1%	0 0.0%	22	11
17	JAIPUR	29	0.08	8.67	0.06	6.39	4 13.8%	5 17.2%	6 20.7%	10 34.5%	1 3.4%	2 6.9%	15	13
18	JAISALMER	44	0.02	7.8	0.05	10.4	8 18.2%	0 0.0%	4 9.1%	19 43.2%	4 9.1%	5 11.4%	12	28
19	JALORE	10	0.2	3.65	0.3	3.8	3 30.0%	2 20.0%	0 0.0%	3 30.0%	1 10.0%	0 0.0%	5	4
20	JHALAWAR	18	1.32	11.51	1.07	3.48	2 11.1%	6 33.3%	7 38.9%	1 5.6%	2 11.1%	0 0.0%	15	3
21	JHUNJHUNU	13	1.08	1.42	0.04	6.92	2 15.4%	0 0.0%	0 0.0%	8 61.5%	2 15.4%	1 7.7%	2	11
22	JODHPUR	31	0.2	7.8	0.05	11.65	8 25.8%	2 6.5%	4 12.9%	9 29.0%	2 6.5%	1 3.2%	14	12
23	KARAULI	13	0.37	11.15	-	-	4 30.8%	3 23.1%	4 30.8%	0 0.0%	0 0.0%	0 0.0%	11	0
24	KOTA	16	0.2	8.29	0.7	2.15	6 37.5%	2 12.5%	4 25.0%	3 18.8%	1 6.3%	0 0.0%	12	4
25	NAGAUR	20	0.08	22.05	0.86	2	9 45.0%	4 20.0%	3 15.0%	4 20.0%	0 0.0%	0 0.0%	16	4
26	PALI	24	0.4	26.1	0.1	8.1	3 12.5%	5 20.8%	9 37.5%	2 8.3%	0 0.0%	1 4.2%	17	3
27	RAJSAMAND	25	1.28	14.7	0.95	1.64	2 8.0%	6 24.0%	15 60.0%	2 8.0%	0 0.0%	0 0.0%	23	2
28	SAWAI MADHOPUR	15	0.66	7.28	2.59	2.59	5 33.3%	4 26.7%	5 33.3%	0 0.0%	1 6.7%	0 0.0%	14	1
29	SIKAR	18	0.01	2.71	0.06	4.99	7 38.9%	1 5.6%	0 0.0%	7 38.9%	2 11.1%	1 5.6%	8	10
30	SIROHI	14	0.8	11.46	-	-	3 21.4%	3 21.4%	8 0.0%	0 0.0%	0 0.0%	0 0.0%	14	0
31	TONK	10	0.54	2.45	0.81	1.62	5 50.0%	3 30.0%	0 0.0%	2 20.0%	0 0.0%	0 0.0%	8	2
32	UDAIPUR	42	0.08	20.89	0.52	5.49	9 21.4%	12 28.6%	16 38.1%	2 4.8%	0 0.0%	1 2.4%	37	3
	Grand Total	741	0.01	36.85	0.01	14.48	230 31.0%	107 14.4%	177 23.9%	142 19.2%	29 3.9%	25 3.4%	514	196

8.3.3 May 2012 to January 2013

Map (**Fig. 8.10**) and **Tables 8.7** shows about 73% of the stations observed rise of water level out of which 35% stations recorded rise in the range of 0 to 2m between the period of May 2012 and January 2013. Southern parts mostly covered by hills and mountain experienced the rise of more than 4m and observed in about 13% of the stations falling mostly in Ajmer, Bhilwara, Chittaurgarh, Nagur, Rajsamad, Sirohi and Udaipur districts. About 17% of the stations shows fall of 0 to 2m mostly in the western sandy plain and covered in parts of the districts of Alwar,

Barmer, Bharatpur, Bikaner, Churu, Ganganagar, Jaipur, Junjhumu, Jaisalmer and Sikar. Fall of more than 4 m occurs in the isolated patches and scattered in north western half of the State. A maximum rise of 38.10 m is recorded at Jasala in Dungarpur district and maximum fall of 18.42 m is recorded at Moolsagar in Jaisalmer district.

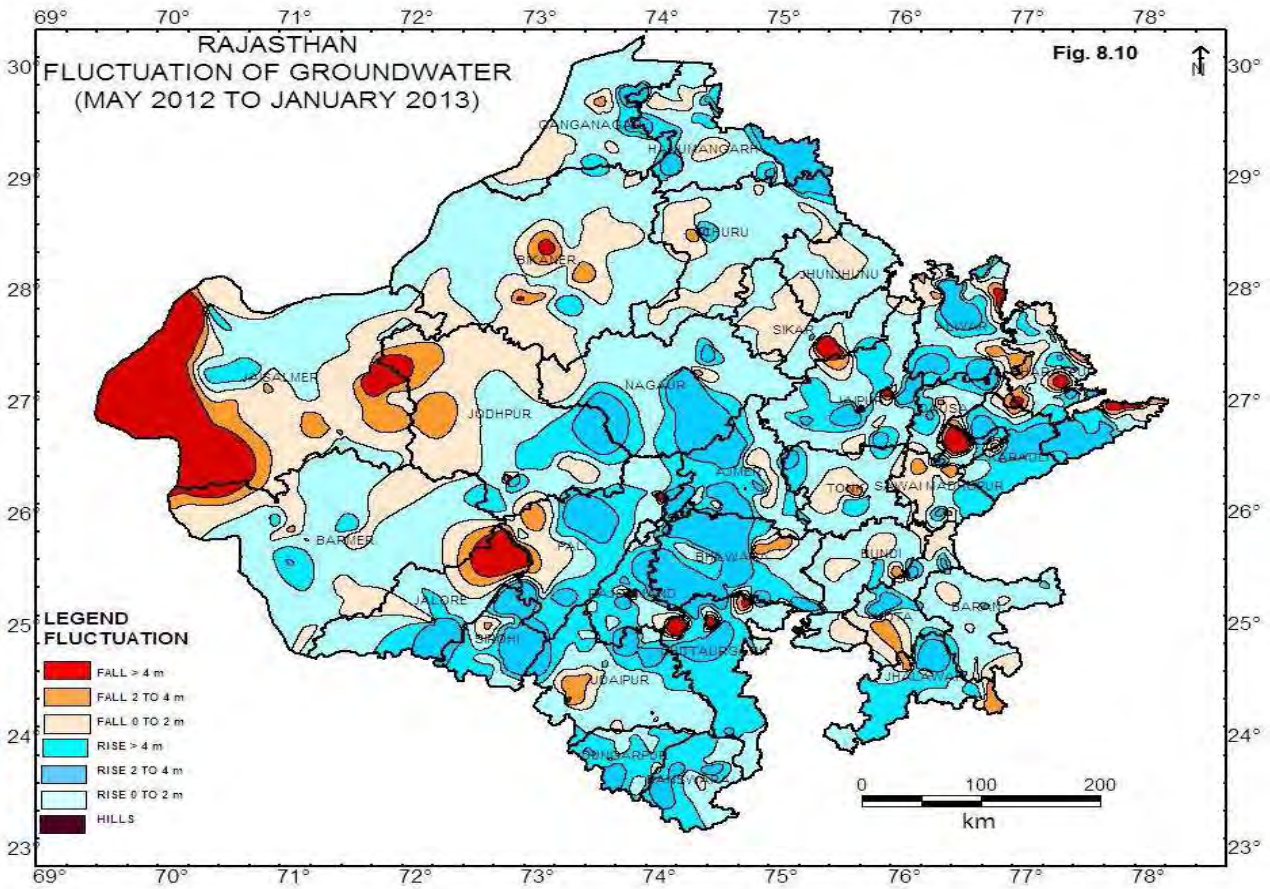


Table-8.7

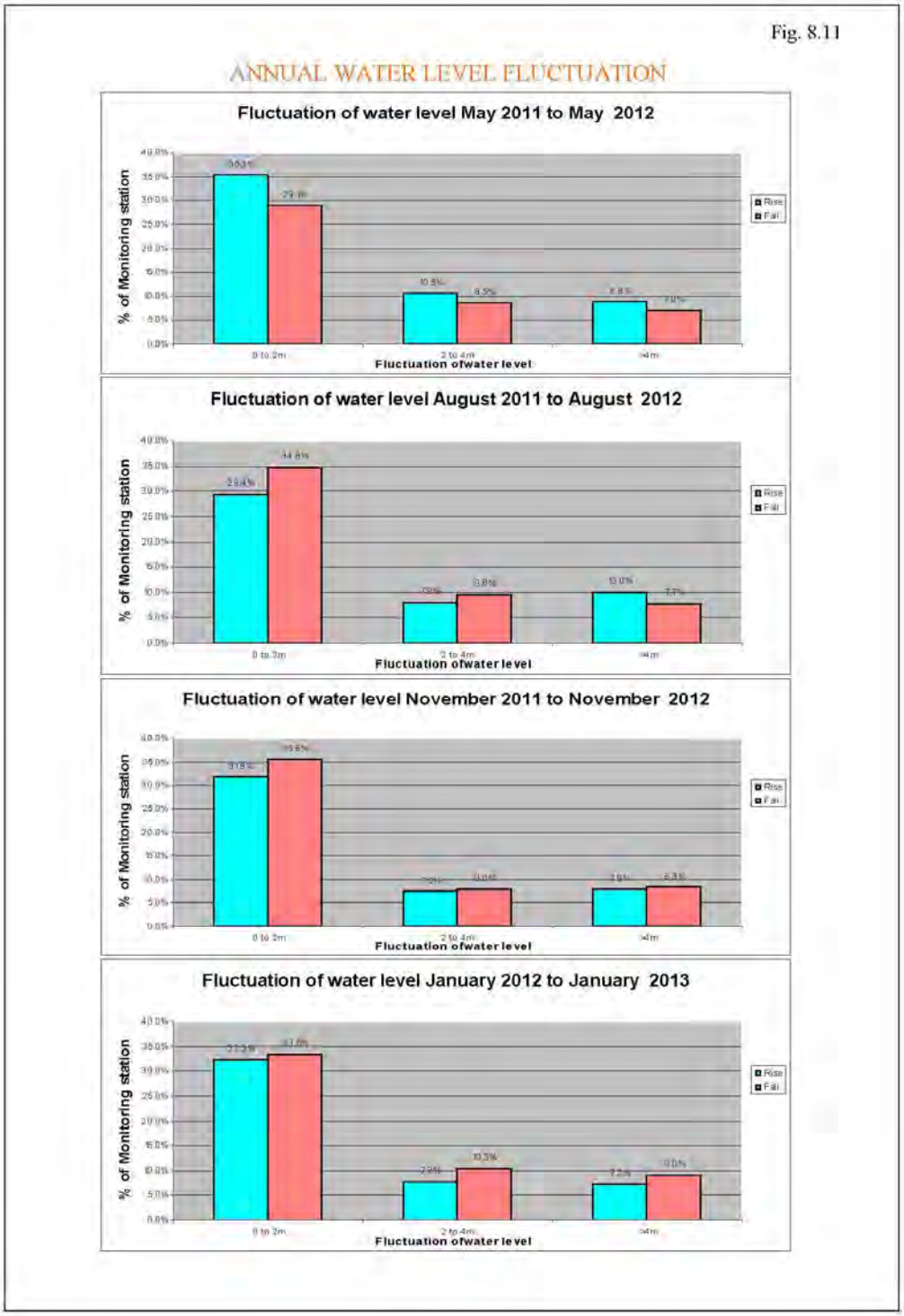
CATEGORISATION OF CHANGES IN WATER LEVEL BETWEEN MAY 2012 TO JANUARY 2013

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	24	0.38	22.9	0.41	1.28	7 29.2%	5 20.8%	8 33.3%	3 12.5%	0 0.0%	0 0.0%	20	3
2	ALWAR	26	0.52	18.75	0.33	14.2	7 26.9%	3 11.5%	7 26.9%	3 11.5%	3 11.5%	3 11.5%	17	9
3	BANSWARA	22	0.38	7.4	0.54	0.54	8 36.4%	8 36.4%	5 22.7%	1 4.5%	0 0.0%	0 0.0%	21	1
4	BARAN	15	0.51	2.32	0.02	0.68	5 33.3%	3 20.0%	0 0.0%	5 33.3%	0 0.0%	0 0.0%	8	5
5	BARMER	42	0.1	34.4	0.1	3.1	17 40.5%	2 4.8%	2 4.8%	13 31.0%	3 7.1%	0 0.0%	21	16
6	BHARATPUR	34	0.25	14.39	0.4	20.8	9 26.5%	10 29.4%	4 11.8%	5 14.7%	2 5.9%	2 5.9%	23	9
7	BHILWARA	28	0.59	16.84	0.02	3.36	4 14.3%	6 21.4%	15 53.6%	1 3.6%	2 7.1%	0 0.0%	25	3
8	BIKANER	45	0.01	3.5	0.01	4.58	28 62.2%	1 2.2%	0 0.0%	10 22.2%	3 6.7%	2 4.4%	29	15
9	BUNDI	10	0.06	4.02	0.16	3.71	5 50.0%	1 10.0%	1 10.0%	2 20.0%	1 10.0%	0 0.0%	7	3
10	CHITTAURGARH	24	0.07	7.39	0.22	12.33	4 16.7%	10 41.7%	6 25.0%	1 4.2%	0 0.0%	3 12.5%	20	4
11	CHURU	33	0.02	4.58	0.03	2.56	15 45.5%	0 0.0%	1 3.0%	13 39.4%	1 3.0%	0 0.0%	16	14
12	DAUSA	10	1.55	4.95	1.1	4.82	3 30.0%	2 20.0%	2 20.0%	1 10.0%	1 10.0%	1 10.0%	7	3
13	DHAULPUR	15	0.87	12.2	0.15	7.94	1 6.7%	4 26.7%	4 26.7%	3 20.0%	1 6.7%	2 13.3%	9	6
14	DUNGARPUR	19	1.03	6.93	-	-	7 36.8%	9 47.4%	3 15.8%	0 0.0%	0 0.0%	0 0.0%	19	0
15	GANGANAGAR	30	0.01	16.45	0.04	2.67	21 70.0%	2 6.7%	1 3.3%	5 16.7%	1 3.3%	0 0.0%	24	6
16	HANUMANGARH	34	0.01	17.52	0.27	1.19	20 58.8%	3 8.8%	5 14.7%	6 17.6%	0 0.0%	0 0.0%	28	6
17	JAIPUR	30	0.06	6.85	0.5	14.8	9 30.0%	9 30.0%	5 16.7%	4 13.3%	0 0.0%	3 10.0%	23	7
18	JAISALMER	36	0.02	3.35	0.2	10.5	8 22.2%	3 8.3%	0 0.0%	16 44.4%	5 13.9%	4 11.1%	11	25
19	JALORE	7	0.2	8.15	1.6	8	3 42.9%	1 14.3%	1 14.3%	1 14.3%	0 0.0%	1 14.3%	5	2
20	JHALAWAR	18	0.76	7.64	2.22	3.86	7 38.9%	7 38.9%	1 5.6%	0 0.0%	3 16.7%	0 0.0%	15	3
21	JHUNJHUNU	12	0.23	1.63	0.18	1.13	5 41.7%	0 0.0%	0 0.0%	6 50.0%	0 0.0%	0 0.0%	5	6
22	JODHPUR	34	0.57	7.9	0.6	4.15	10 29.4%	3 8.8%	2 5.9%	9 26.5%	2 5.9%	1 2.9%	15	12
23	KARAULI	14	1.4	7.71	0.44	0.44	1 7.1%	5 35.7%	5 35.7%	1 7.1%	0 0.0%	0 0.0%	11	1
24	KOTA	16	0.05	7.94	0.05	2.5	5 31.3%	3 18.8%	4 25.0%	3 18.8%	1 6.3%	0 0.0%	12	4
25	NAGAUR	16	0.42	22.04	1.03	2.9	9 56.3%	0 0.0%	4 25.0%	1 6.3%	1 6.3%	0 0.0%	13	2
26	PALI	21	0.65	8	0.35	8.1	4 19.0%	4 19.0%	4 19.0%	3 14.3%	1 4.8%	1 4.8%	12	5
27	RAJSAMAND	25	0.1	6.3	0.47	5.87	7 28.0%	12 48.0%	3 12.0%	1 4.0%	0 0.0%	1 4.0%	22	2
28	SAWAI MADHOPUR	17	0.31	5.38	0.46	10.02	4 23.5%	3 17.6%	2 11.8%	3 17.6%	4 23.5%	1 5.9%	9	8
29	SIKAR	23	0.06	2.31	0.01	16.39	8 34.8%	1 4.3%	0 0.0%	12 52.2%	0 0.0%	2 8.7%	9	14
30	SIROHI	13	0.8	11	2.4	2.4	5 38.5%	3 23.1%	4 0.0%	0 0.0%	1 7.7%	0 0.0%	12	1
31	TONK	13	0.36	3.22	0.81	3.5	5 38.5%	4 30.8%	0 0.0%	3 23.1%	1 7.7%	0 0.0%	9	4
32	UDAIPUR	43	0.28	17.1	0.12	4.2	23 53.5%	9 20.9%	4 9.3%	3 7.0%	2 4.7%	1 2.3%	36	6
	Grand Total	749	0.01	34.40	0.01	20.80	274 36.6%	136 18.2%	103 13.8%	138 18.4%	39 5.2%	28 3.7%	513	205

8.4 Annual Water Level Fluctuation

Annual Fluctuation in the water levels of the NHS stations during different monitoring periods were analysed graphically and depicted in **Fig. 8.11** shows that mostly fall is observed in the range of 0 to 2m fluctuations in most of the stations in all of the annual period.

Fig. 8.11



8.4.1 May 2011 to May 2012

Water level fluctuation data during May 2011 and May 2012 is presented in **Table 8.8** and has been depicted in **Fig. 8.12**. A perusal of the map (**Fig. 8.12**) and **Table 8.8** reveals that about 55% of the wells have registered rise in water level. These wells are mostly concentrated in southern part of the State. Area of State falling in north-west of Aravalli Hills shows predominantly fall in water level. Rise in water level between 0 and 2 m has been observed in 35% of the stations falling mostly in the districts of Ajmer Banswada, Baran, Barmer, Bikaner, Churu, Dungarpur, Ganganagar, Jaipur, Jaisalmer, Jodhpur, Pali, Sikar and Udaipur. Rise of more than 4m has een recorded mostly in Ajmer, Bhilwara, Chittaurgarh, Dungarpur, Jhalawad, Jhunjhunu,, Swai Madhopur, Sirohi, Tonk, and Udaipur districts

Fall in water level is mainly in the range of 0 to 2 m and observed in 29% of the stations in the State. Fall of more than 4 m has been observed in isolated patches scattered in entire State.

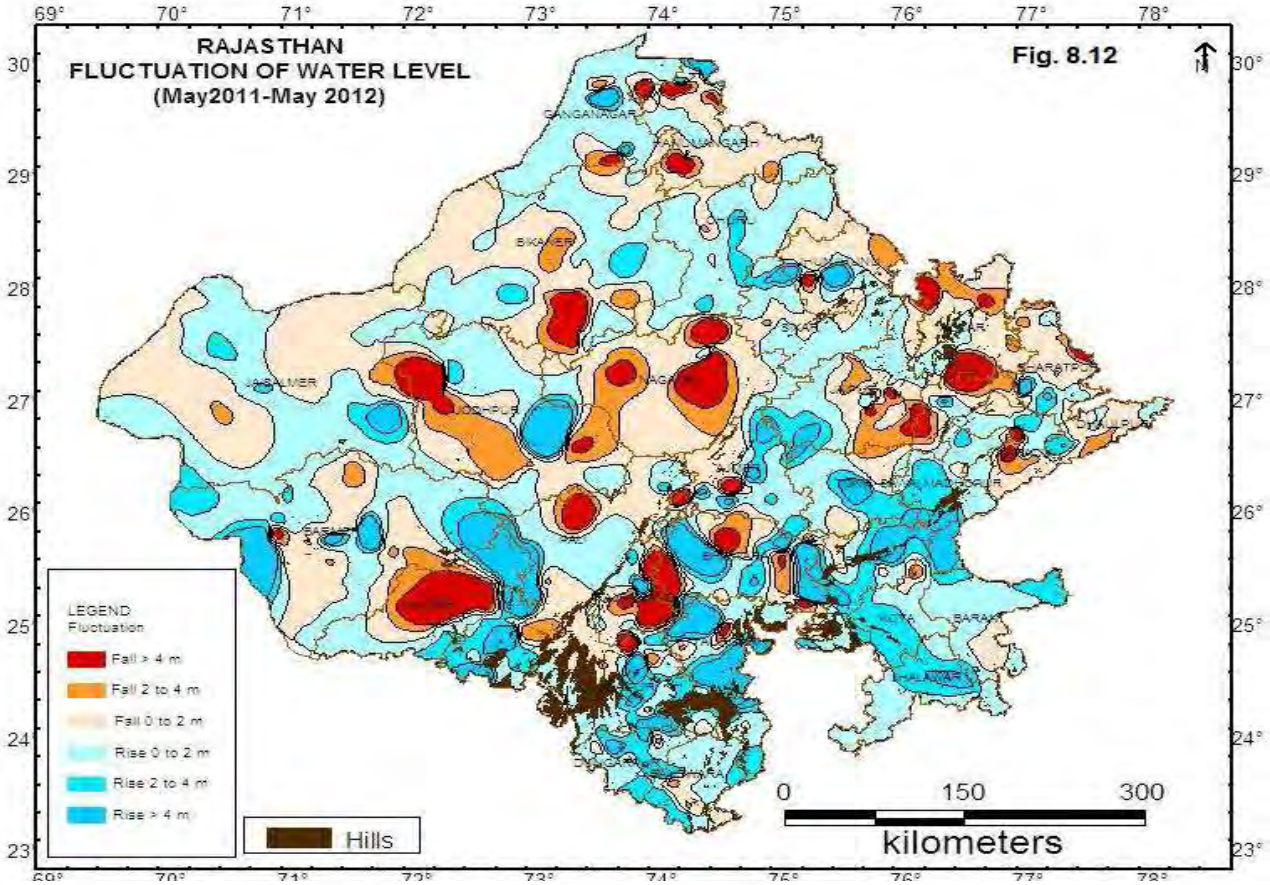
In state, maximum rise of 25.40 m has been recorded at Baori in Jodhpur district, whereas the maximum decline of 21.90 m has been recorded in Baswal in Dausa district.

8.4.2 August 2011 to August 2012

Water level fluctuation data during August 2011 and August 2012 is presented in **Table 8.9** and has been depicted in Plate 3. A perusal of the map (**Fig. 8.13**) and **Table 8.9** reveals that about 52% of the wells have registered fall in water level. These wells are scattered in almost in whole State. Area of State falling in north-west of Aravalli Hills shows predominantly fall in water level. Rise in water level between 0 and 2 m has been observed in 29% of the stations falling mostly in the districts of Ajmer Barmer, Bikaner, Churu, Dhaulpur, Dungarpur, Ganganagar, Hanumangarh, Jaisalmer, Jodhpur and Udaipur. Rise of more than 4m has een recorded mostly in Ajmer, Bharatpur, Bhilwara, and Udaipur districts.

Fall in water level is mainly in the range of 0 to 2 m and observed in 35% of the stations in the State. Fall of more than 4 m has been observed in isolated patches scattered in entire State.

In state, maximum rise of 15.46 m has been recorded at Salawatia in Bhilwada district, whereas the maximum decline of 23.06 m has been recorded in Arniyala in Nagaur district.



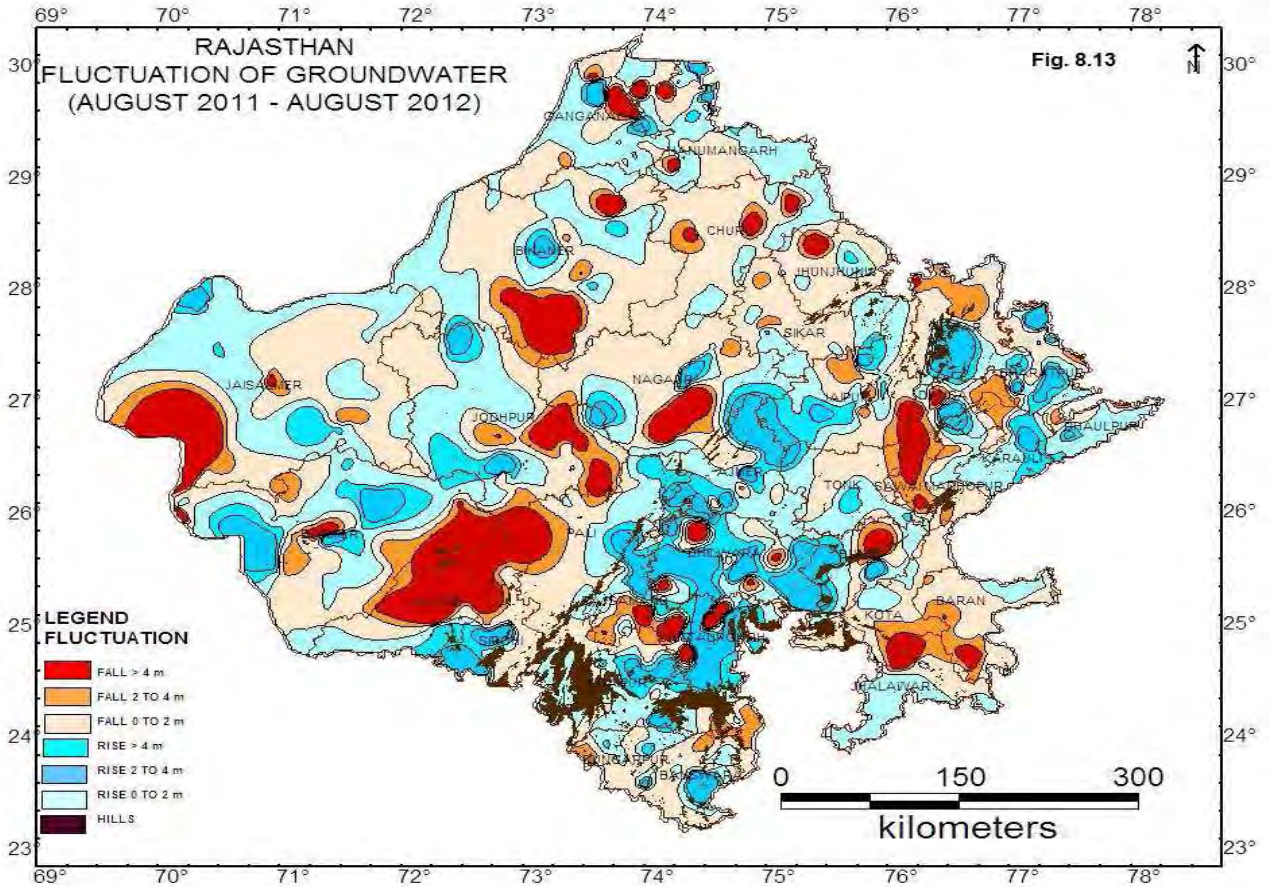


Table 8.8

CATEGORISATION OF CHANGES IN WATER LEVEL BETWEEN MAY 2011 TO MAY 2012

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	22	0.52	5.94	0.29	10.95	7 31.8%	3 13.6%	5 22.7%	5 22.7%	0 0.0%	2 9.1%	15	7
2	ALWAR	27	0.15	1.8	0.03	11.45	4 14.8%	0 0.0%	0 0.0%	13 48.1%	6 22.2%	4 14.8%	4	23
3	BANSWARA	18	0.23	3.31	0.14	2.44	7 38.9%	5 27.8%	0 0.0%	4 22.2%	2 11.1%	0 0.0%	12	6
4	BARAN	8	0.17	4.1	0.9	0.9	3 37.5%	3 37.5%	1 12.5%	1 12.5%	0 0.0%	0 0.0%	7	1
5	BARMER	40	0.1	21.95	0.05	5.3	15 37.5%	3 7.5%	3 7.5%	13 32.5%	4 10.0%	1 2.5%	21	18
6	BHARATPUR	31	0.03	10.43	0.04	12.57	5 16.1%	1 3.2%	2 6.5%	18 58.1%	4 12.9%	1 3.2%	8	23
7	BHILWARA	29	0.35	12.2	0.51	15.3	4 13.8%	3 10.3%	7 24.1%	6 20.7%	3 10.3%	6 20.7%	14	15
8	BIKANER	45	0.05	3.1	0.03	11.05	16 35.6%	3 6.7%	0 0.0%	21 46.7%	3 6.7%	2 4.4%	19	26
9	BUNDI	9	0.42	6.9	0.2	0.55	2 22.2%	4 44.4%	1 11.1%	2 22.2%	0 0.0%	0 0.0%	7	2
10	CHITTAURGARH	18	0.26	12.77	0.13	6.25	5 27.8%	1 5.6%	7 38.9%	1 5.6%	1 5.6%	2 11.1%	13	4
11	CHURU	30	0.02	3.08	0.02	2.35	17 56.7%	4 13.3%	0 0.0%	8 26.7%	1 3.3%	0 0.0%	21	9
12	DAUSA	13	1.22	4.9	0.1	21.9	2 15.4%	0 0.0%	1 7.7%	4 30.8%	3 23.1%	3 23.1%	3	10
13	DHAULPUR	14	0.4	4.11	0.3	2.79	3 21.4%	0 0.0%	1 7.1%	7 50.0%	3 21.4%	0 0.0%	4	10
14	DUNGARPUR	16	0.19	5.4	0.08	3.11	7 43.8%	3 18.8%	3 18.8%	2 12.5%	1 6.3%	0 0.0%	13	3
15	GANGANAGAR	34	0.06	11.58	0.06	16.28	22 64.7%	1 2.9%	2 5.9%	5 14.7%	2 5.9%	2 5.9%	25	9
16	HANUMANGARH	34	0.13	11.87	0.11	14.85	8 23.5%	3 8.8%	1 2.9%	16 47.1%	1 2.9%	4 11.8%	12	21
17	JAIPUR	35	0.16	4.9	0.11	7.4	13 37.1%	1 2.9%	3 8.6%	9 25.7%	7 20.0%	2 5.7%	17	18
18	JAISALMER	36	0.1	7.5	0.01	2.8	15 41.7%	4 11.1%	1 2.8%	13 36.1%	2 5.6%	0 0.0%	20	15
19	JALORE	9	0.3	12.8	2.8	9.14	3 33.3%	0 0.0%	1 11.1%	0 0.0%	2 22.2%	2 22.2%	4	4
20	JHALAWAR	7	0.09	4.5	-	-	4 57.1%	2 28.6%	1 14.3%	0 0.0%	0 0.0%	0 0.0%	7	0
21	JHUNJHUNU	16	0.15	9.69	0.42	11.54	5 31.3%	0 0.0%	2 12.5%	7 43.8%	1 6.3%	1 6.3%	7	9
22	JODHPUR	23	0.1	25.4	0.5	19.34	10 43.5%	1 4.3%	1 4.3%	5 21.7%	3 13.0%	3 13.0%	12	11
23	KARAULI	13	0.7	3.5	0.1	9.7	5 38.5%	1 7.7%	0 0.0%	3 23.1%	2 15.4%	2 15.4%	6	7
24	KOTA	10	0.2	7.1	0.16	4.28	4 40.0%	3 30.0%	1 10.0%	1 10.0%	0 0.0%	1 10.0%	8	2
25	NAGAUR	16	0.1	2.35	0.1	10.7	2 12.5%	1 6.3%	0 0.0%	8 50.0%	1 6.3%	4 25.0%	3	13
26	PALI	16	0.2	2.76	0.3	7.5	7 43.8%	2 12.5%	0 0.0%	4 25.0%	1 6.3%	2 12.5%	9	7
27	RAJSAMAND	25	0.66	6.99	0.05	14.25	9 36.0%	1 4.0%	2 8.0%	8 32.0%	1 4.0%	4 16.0%	12	13
28	SAWAI MADHOPUR	16	0.17	6.45	0.87	3.14	6 37.5%	6 37.5%	2 12.5%	1 6.3%	1 6.3%	0 0.0%	14	2
29	SIKAR	24	0.02	4.43	0.1	2.65	17 70.8%	0 0.0%	1 4.2%	5 20.8%	1 4.2%	0 0.0%	18	6
30	SIROHI	14	0.04	13.7	0.04	3.15	3 21.4%	4 28.6%	4 0.0%	2 14.3%	1 7.1%	0 0.0%	11	3
31	TONK	13	0.13	14.8	0.78	1.91	3 23.1%	4 30.8%	4 30.8%	2 15.4%	0 0.0%	0 0.0%	11	2
32	UDAIPUR	41	0.16	14.8	0.11	17.43	15 36.6%	7 17.1%	5 12.2%	10 24.4%	3 7.3%	1 2.4%	27	14
	Grand Total	702	0.02	25.40	0.01	21.90	248 35.3%	74 10.5%	62 8.8%	204 29.1%	60 8.5%	49 7.0%	384	313

Table-8.9

CATEGORISATION OF CHANGES IN WATER LEVEL BETWEEN AUGUST 2011 TO AUGUST 2012

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	27	0.13	12.19	0.03	2.3	7 25.9%	7 25.9%	7 25.9%	5 18.5%	1 3.7%	0 0.0%	21	6
2	ALWAR	27	0.82	10.9	0.11	6.8	4 14.8%	0 0.0%	2 7.4%	12 44.4%	8 29.6%	1 3.7%	6	21
3	BANSWARA	21	0.14	12.69	0.02	2.84	4 19.0%	0 0.0%	1 4.8%	15 71.4%	1 4.8%	0 0.0%	5	16
4	BARAN	15	0.87	1.93	0.04	7.09	2 13.3%	0 0.0%	0 0.0%	7 46.7%	4 26.7%	2 13.3%	2	13
5	BARMER	47	0.1	13.89	0.1	11	15 31.9%	4 8.5%	4 8.5%	14 29.8%	4 8.5%	5 10.6%	23	23
6	BHARATPUR	32	0.38	7.75	0.18	8.47	6 18.8%	2 6.3%	7 21.9%	12 37.5%	4 12.5%	1 3.1%	15	17
7	BHILWARA	31	0.71	15.46	0.04	8.56	6 19.4%	3 9.7%	13 41.9%	5 16.1%	0 0.0%	4 12.9%	22	9
8	BIKANER	48	0.01	5.24	0.01	17.41	16 33.3%	1 2.1%	2 4.2%	22 45.8%	2 4.2%	5 10.4%	19	29
9	BUNDI	10	0.72	5.35	0.16	8.4	2 20.0%	1 10.0%	2 20.0%	3 30.0%	1 10.0%	1 10.0%	5	5
10	CHITTAURGARH	26	0.48	12.36	0.02	13.7	4 15.4%	4 15.4%	5 19.2%	6 23.1%	2 7.7%	5 19.2%	13	13
11	CHURU	30	0.04	1.18	0.02	7.02	13 43.3%	0 0.0%	0 0.0%	14 46.7%	0 0.0%	3 10.0%	13	17
12	DAUSA	13	1.28	10.5	0.64	9.43	1 7.7%	0 0.0%	2 15.4%	3 23.1%	4 30.8%	3 23.1%	3	10
13	DHAULPUR	15	0.05	4.83	0.13	5.64	9 60.0%	0 0.0%	1 6.7%	4 26.7%	0 0.0%	1 6.7%	10	5
14	DUNGARPUR	21	0.04	5.64	0.23	4.39	7 33.3%	0 0.0%	3 14.3%	8 38.1%	2 9.5%	1 4.8%	10	11
15	GANGANAGAR	40	0.1	9.97	0.09	16.52	22 55.0%	1 2.5%	2 5.0%	9 22.5%	2 5.0%	4 10.0%	25	15
16	HANUMANGARH	36	0.13	9.38	0.33	10.1	16 44.4%	4 11.1%	3 8.3%	9 25.0%	2 5.6%	2 5.6%	23	13
17	JAIPUR	34	0.46	5.72	0.32	3.63	8 23.5%	7 20.6%	2 5.9%	10 29.4%	7 20.6%	0 0.0%	17	17
18	JAISALMER	43	0.15	8.6	0.05	17.45	12 27.9%	3 7.0%	1 2.3%	20 46.5%	4 9.3%	2 4.7%	16	26
19	JALORE	12	2.9	2.9	0.02	13.4	0 0.0%	1 8.3%	0 0.0%	4 33.3%	2 16.7%	4 33.3%	1	10
20	JHALAWAR	6	0.11	1.02	1	10.02	3 50.0%	0 0.0%	0 0.0%	1 16.7%	1 16.7%	1 16.7%	3	3
21	JHUNJHUNU	15	0.02	2.41	0.13	6.81	2 13.3%	1 6.7%	0 0.0%	11 73.3%	0 0.0%	1 6.7%	3	12
22	JODHPUR	30	0.04	11.11	0.04	7.33	10 33.3%	3 10.0%	3 10.0%	8 26.7%	2 6.7%	4 13.3%	16	14
23	KARAULI	10	0.16	6.1	0.56	2.17	5 50.0%	2 20.0%	1 10.0%	1 10.0%	1 10.0%	0 0.0%	8	2
24	KOTA	14	0.4	1.7	0.19	2.09	4 28.6%	0 0.0%	0 0.0%	8 57.1%	1 7.1%	0 0.0%	4	9
25	NAGAUR	25	0.05	9.16	0.2	23.06	6 24.0%	1 4.0%	1 4.0%	9 36.0%	4 16.0%	4 16.0%	8	17
26	PALI	12	0.1	3.7	0.1	2.05	6 50.0%	1 8.3%	0 0.0%	4 33.3%	1 8.3%	0 0.0%	7	5
27	RAJSAMAND	25	1.35	9.02	0.17	8.8	6 24.0%	4 16.0%	5 20.0%	4 16.0%	3 12.0%	3 12.0%	15	10
28	SAWAI MADHOPUR	14	0.07	0.95	0.16	4.8	4 28.6%	0 0.0%	0 0.0%	4 28.6%	4 28.6%	2 14.3%	4	10
29	SIKAR	23	0.09	2.16	0.02	3.96	5 21.7%	1 4.3%	0 0.0%	13 56.5%	3 13.0%	0 0.0%	6	16
30	SIROHI	11	1.7	7	0.25	2.25	1 9.1%	0 0.0%	3 0.0%	6 54.5%	1 9.1%	0 0.0%	4	7
31	TONK	13	0.1	3.43	0.06	0.73	5 38.5%	4 30.8%	0 0.0%	4 30.8%	0 0.0%	0 0.0%	9	4
32	UDAIPUR	44	0.18	8.69	0.21	2.2	15 34.1%	6 13.6%	7 15.9%	13 29.5%	3 6.8%	0 0.0%	28	16
	Grand Total	770	0.01	15.46	0.01	23.06	226 29.4%	61 7.9%	77 10.0%	268 34.8%	74 9.6%	59 7.7%	364	401

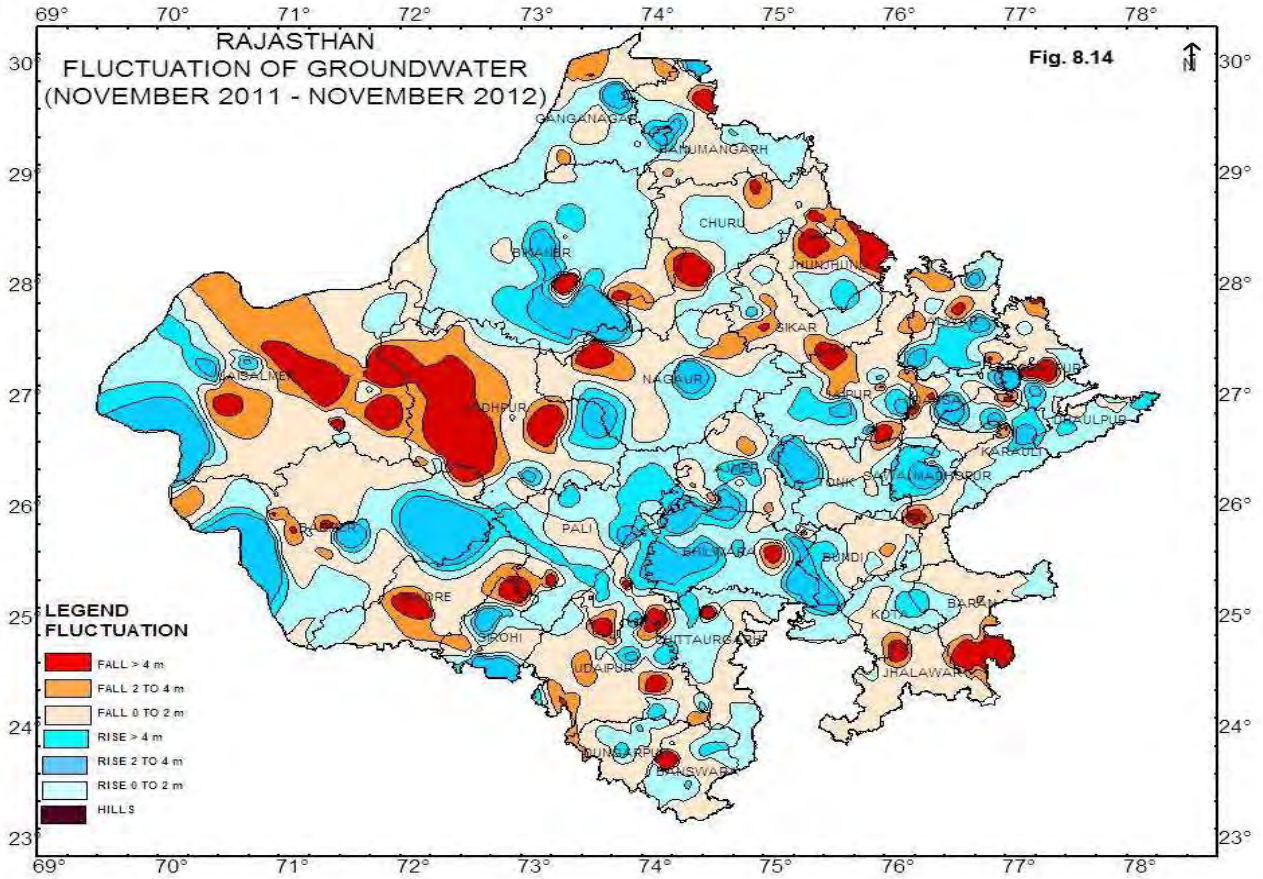
8.4.3 November 2011 to November 2012

A perusal of map (**Fig. 8.14**) and **Table 8.10** reveals that about 52% of the stations shows fall in water level in patches scattered in the whole state. Fall in the fluctuation of water level between 0 and 2 m are observed in 35.2% of the stations. Fall of more than 4m recorded mostly in Baran, Dausa, Jaipur, and Jaisalmer districts. Rise in water level is mainly in the range of 0 to 2 m and observed in 31.7% of the stations in the State. Rise of more than 4 m is shown in isolated patches scattered mostly in Ajmer, Bilwara, Bikaner, and Jaisalmer. In state the maximum rise of 35.87m is recorded at Kakra in Bikaner district, whereas the maximum decline of 19.40 m is recorded in Barani in Nagaur district.

8.4.4 January 2012 to January 2013

A perusal of map (**Fig. 8.15**) and **Table 8.11** reveals that about 55% of the stations shows fall in water level mostly in isolated patches scattered mostly in whole State. South eastern parts of the State have been observed more rise in water level comparatively other parts of the State. Rise and Fall in water level are mainly in the range of 0 to 2 m and observed at 31% to 32% stations. Rise of more than 4 m have been observed at 7% stations mainly in Alwar, Barmer, Bhilwada, Jaipur and Karauli districts. Fall of more than 4m have been recorded at 9% stations mostly in Alwar, Chittaurgarh, Jaipur Jaisalmer, Nagaur, Rajsamand and Sawai Madhopur districts.

In state the maximum rise of 34.30m is recorded at Palri in Barmer district, whereas the maximum decline of 31.35 m is recorded in Ajasar in Jaisalmer district.


RAJASTHAN
FLUCTUATION OF GROUNDWATER
(NOVEMBER 2011 - NOVEMBER 2012)
Fig. 8.14
N
LEGEND
FLUCTUATION
FALL > 4 m
FALL 2 TO 4 m
FALL 0 TO 2 m
RISE > 4 m
RISE 2 TO 4 m
RISE 0 TO 2 m
HILLS
GANGANAGAR
HANUMANGARH
CHURU
BIKANER
JHUNJHUNU
SIKAR
NAGAUR
JODHPUR
JAISALMER
PALI
AJMER
TONK
SAWAI MADHOPUR
KARAULI
DAUSA
BHILWARA
BUNDI
BARAN
KOTA
SIROHI
UDAIPUR
CHITTAURGARH
JHALAWAR
BANSWARA
69°
70°
71°
72°
73°
74°
75°
76°
77°
78°
30°
29°
28°
27°
26°
25°
24°
23°

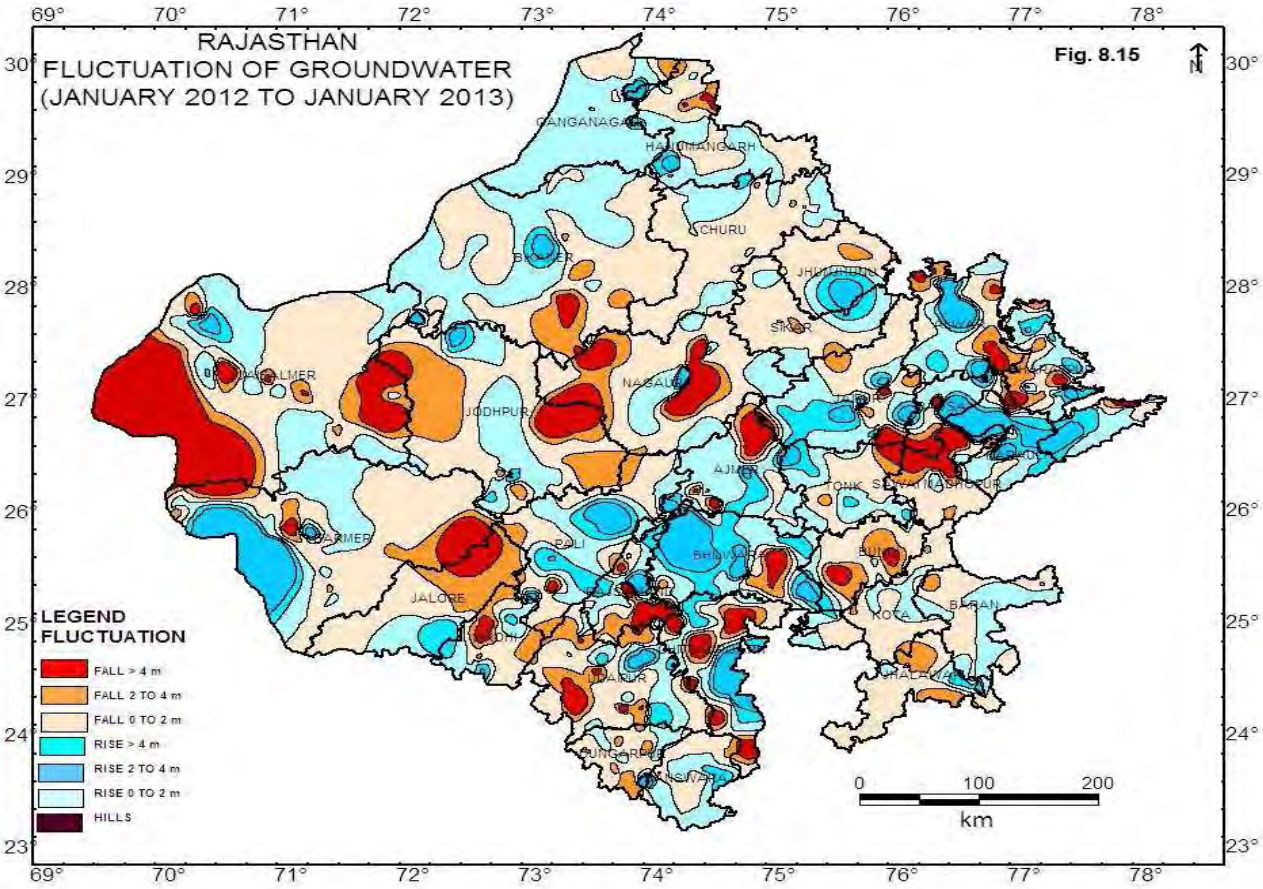

RAJASTHAN
FLUCTUATION OF GROUNDWATER
(JANUARY 2012 TO JANUARY 2013)
Fig. 8.15
N
LEGEND
FLUCTUATION
FALL > 4 m
FALL 2 TO 4 m
FALL 0 TO 2 m
RISE > 4 m
RISE 2 TO 4 m
RISE 0 TO 2 m
HILLS
0
100
200
km
GANGANAGAR
HANUMANGARH
CHURU
BIKANER
JHUNJHUNU
SIKAR
NAGAUR
JODHPUR
JAISALMER
PALI
AJMER
TONK
SAWAI MADHOPUR
BHILWARA
BUNDI
BARAN
KOTA
JALORE
BANSWARA
69°
70°
71°
72°
73°
74°
75°
76°
77°
78°
30°
29°
28°
27°
26°
25°
24°
23°

Table-8.10

CATEGORISATION OF CHANGES IN WATER LEVEL BETWEEN NOVEMBER 2011 TO NOVEMBER 2012

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	22	0.14	8.1	0.54	3.81	7 31.8%	2 9.1%	5 22.7%	4 18.2%	4 18.2%	0 0.0%	14	8
2	ALWAR	23	1.05	7.82	0.06	4.92	5 21.7%	2 8.7%	3 13.0%	8 34.8%	3 13.0%	2 8.7%	10	13
3	BANSWARA	22	0.02	2.97	0.26	15.05	8 36.4%	3 13.6%	0 0.0%	10 45.5%	0 0.0%	1 4.5%	11	11
4	BARAN	15	0.13	1.82	0.01	6.74	3 20.0%	0 0.0%	0 0.0%	7 46.7%	1 6.7%	4 26.7%	3	12
5	BARMER	35	0.2	14.45	0.1	5.2	8 22.9%	1 2.9%	3 8.6%	16 45.7%	4 11.4%	3 8.6%	12	23
6	BHARATPUR	29	0.06	10.81	0.01	9.93	12 41.4%	1 3.4%	2 6.9%	10 34.5%	1 3.4%	3 10.3%	15	14
7	BHILWARA	28	0.37	21.91	0.44	6.2	13 46.4%	3 10.7%	9 32.1%	1 3.6%	0 0.0%	2 7.1%	25	3
8	BIKANER	41	0.01	35.87	0.08	15.68	23 56.1%	4 9.8%	6 14.6%	6 14.6%	0 0.0%	2 4.9%	33	8
9	BUNDI	11	0.02	2.71	0.38	3.52	4 36.4%	1 9.1%	0 0.0%	5 45.5%	1 9.1%	0 0.0%	5	6
10	CHITTAURGARH	23	0.1	7.46	0.05	13.81	11 47.8%	2 8.7%	1 4.3%	6 26.1%	0 0.0%	1 4.3%	14	7
11	CHURU	29	0.01	1.32	0.03	10.22	14 48.3%	0 0.0%	0 0.0%	12 41.4%	0 0.0%	3 10.3%	14	15
12	DAUSA	12	2.1	10.56	0.89	7.89	0 0.0%	1 8.3%	1 8.3%	5 41.7%	1 8.3%	4 33.3%	2	10
13	DHAULPUR	13	0.05	3.81	0.19	0.99	8 61.5%	2 15.4%	0 0.0%	3 23.1%	0 0.0%	0 0.0%	10	3
14	DUNGARPUR	20	0.09	3.61	0.06	2.41	4 20.0%	2 10.0%	0 0.0%	13 65.0%	1 5.0%	0 0.0%	6	14
15	GANGANAGAR	34	0.01	9.44	0.04	4.46	18 52.9%	0 0.0%	2 5.9%	10 29.4%	3 8.8%	1 2.9%	20	14
16	HANUMANGARH	33	0.02	7.64	0.06	8.22	12 36.4%	1 3.0%	2 6.1%	15 45.5%	1 3.0%	2 6.1%	15	18
17	JAIPUR	31	0.07	6.61	0.22	6.24	6 19.4%	6 19.4%	3 9.7%	8 25.8%	4 12.9%	4 12.9%	15	16
18	JAISALMER	45	0.2	11	0.1	12.7	4 8.9%	1 2.2%	4 8.9%	19 42.2%	6 13.3%	9 20.0%	9	34
19	JALORE	9	0.1	0.7	0.4	10.4	2 22.2%	0 0.0%	0 0.0%	5 55.6%	1 11.1%	1 11.1%	2	7
20	JHALAWAR	19	0.04	1.92	0.01	7.43	6 31.6%	0 0.0%	0 0.0%	12 63.2%	0 0.0%	1 5.3%	6	13
21	JHUNJHUNU	13	0.98	2.64	0.08	7.62	1 7.7%	1 7.7%	0 0.0%	5 38.5%	4 30.8%	2 15.4%	2	11
22	JODHPUR	31	0.15	5.5	0.1	14.08	8 25.8%	2 6.5%	2 6.5%	8 25.8%	6 19.4%	3 9.7%	12	17
23	KARAULI	11	0.01	6.39	0.13	4.39	6 54.5%	1 9.1%	2 18.2%	1 9.1%	0 0.0%	1 9.1%	9	2
24	KOTA	15	0.2	3.61	0.35	1.96	7 46.7%	2 13.3%	0 0.0%	6 40.0%	0 0.0%	0 0.0%	9	6
25	NAGAUR	20	0.05	11.75	0.02	19.4	8 40.0%	0 0.0%	1 5.0%	6 30.0%	3 15.0%	2 10.0%	9	11
26	PALI	22	0.45	5.06	0.23	7.32	9 40.9%	5 22.7%	2 9.1%	4 18.2%	1 4.5%	1 4.5%	16	6
27	RAJSAMAND	26	0.25	5.71	0.22	9.52	5 19.2%	3 11.5%	3 11.5%	9 34.6%	3 11.5%	3 11.5%	11	15
28	SAWAI MADHOPUR	15	0.17	7.9	0.07	1.57	3 20.0%	2 13.3%	1 6.7%	9 60.0%	0 0.0%	0 0.0%	6	9
29	SIKAR	19	0.33	3.03	0.12	4.46	3 15.8%	1 5.3%	0 0.0%	11 57.9%	2 10.5%	2 10.5%	4	15
30	SIROHI	13	0.26	10.35	1.25	7.85	4 30.8%	1 7.7%	3 0.0%	2 15.4%	2 15.4%	1 0.0%	8	5
31	TONK	12	0.25	6.6	0.03	6.11	4 33.3%	1 8.3%	1 8.3%	5 41.7%	0 0.0%	1 8.3%	6	6
32	UDAIPUR	43	0.11	6.35	0.01	7.99	8 18.6%	4 9.3%	2 4.7%	20 46.5%	7 16.3%	2 4.7%	14	29
	Grand Total	734	0.01	35.87	0.01	19.40	234 31.9%	55 7.5%	58 7.9%	261 35.6%	59 8.0%	61 8.3%	347	381

Table-8.11

CATEGORISATION OF CHANGES IN WATER LEVEL BETWEEN JANUARY 2012 TO JANUARY 2013

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	25	0.45	7.04	0.16	9.11	10 40.0%	3 12.0%	3 12.0%	5 20.0%	1 4.0%	3 12.0%	16	9
2	ALWAR	25	0.13	13.23	0.1	25.66	5 20.0%	1 4.0%	4 16.0%	10 40.0%	0 0.0%	5 20.0%	10	15
3	BANSWARA	22	0.04	3.2	0.08	2.18	10 45.5%	2 9.1%	0 0.0%	8 36.4%	2 9.1%	0 0.0%	12	10
4	BARAN	17	0.05	2.11	0.01	3.22	5 29.4%	1 5.9%	0 0.0%	7 41.2%	2 11.8%	0 0.0%	6	9
5	BARMER	49	0.1	34.3	0.2	10.2	14 28.6%	0 0.0%	4 8.2%	18 36.7%	6 12.2%	3 6.1%	18	27
6	BHARATPUR	32	0.29	20.57	0.09	20.85	11 34.4%	7 21.9%	3 9.4%	3 9.4%	6 18.8%	2 6.3%	21	11
7	BHILWARA	27	0.1	10.81	0.1	6.66	8 29.6%	6 22.2%	7 25.9%	2 7.4%	2 7.4%	2 7.4%	21	6
8	BIKANER	45	0.02	5.35	0.05	5.79	21 46.7%	0 0.0%	1 2.2%	17 37.8%	4 8.9%	1 2.2%	22	22
9	BUNDI	12	0.12	1.14	0.1	6.06	2 16.7%	0 0.0%	0 0.0%	4 33.3%	3 25.0%	2 16.7%	2	9
10	CHITTAURGARH	24	0.9	9.36	0.1	9.42	4 16.7%	4 16.7%	1 4.2%	8 33.3%	1 4.2%	6 25.0%	9	15
11	CHURU	31	0.01	2.88	0.03	2.3	10 32.3%	1 3.2%	0 0.0%	15 48.4%	2 6.5%	0 0.0%	11	17
12	DAUSA	10	0.24	14.71	1.34	8.15	4 40.0%	1 10.0%	1 10.0%	1 10.0%	1 10.0%	2 20.0%	6	4
13	DHAULPUR	15	0.46	8.72	0.76	8.52	5 33.3%	4 26.7%	2 13.3%	2 13.3%	1 6.7%	1 6.7%	11	4
14	DUNGARPUR	21	0.26	10.12	0.2	3.86	7 33.3%	0 0.0%	1 4.8%	9 42.9%	4 19.0%	0 0.0%	8	13
15	GANGANAGAR	34	0.09	16.45	0.02	3.43	27 79.4%	0 0.0%	1 2.9%	4 11.8%	1 2.9%	0 0.0%	28	5
16	HANUMANGARH	36	0.05	10.35	0.05	5.95	14 38.9%	1 2.8%	1 2.8%	17 47.2%	1 2.8%	2 5.6%	16	20
17	JAIPUR	31	0.1	5.97	0.36	13.92	7 22.6%	5 16.1%	5 16.1%	7 22.6%	2 6.5%	4 12.9%	17	13
18	JAISALMER	44	0.15	13.05	0.1	13.92	12 27.3%	1 2.3%	2 4.5%	18 40.9%	3 6.8%	8 18.2%	15	29
19	JALORE	7	3.7	3.7	0.5	3.8	0 0.0%	1 14.3%	0 0.0%	3 42.9%	3 42.9%	0 0.0%	1	6
20	JHALAWAR	19	0.42	6.83	0.23	3.5	3 15.8%	2 10.5%	1 5.3%	7 36.8%	6 31.6%	0 0.0%	6	13
21	JHUNJHUNU	11	0.04	5.1	0.07	2.47	1 9.1%	0 0.0%	1 9.1%	8 72.7%	1 9.1%	0 0.0%	2	9
22	JODHPUR	42	0.08	26.81	0.11	20.4	12 28.6%	2 4.8%	3 7.1%	7 16.7%	6 14.3%	2 4.8%	17	15
23	KARAULI	14	0.27	9.8	0.69	0.98	2 14.3%	2 14.3%	5 35.7%	3 21.4%	0 0.0%	0 0.0%	9	3
24	KOTA	18	0.1	0.63	0.11	2.11	8 44.4%	0 0.0%	0 0.0%	8 44.4%	2 11.1%	0 0.0%	8	10
25	NAGAUR	24	0.18	12.23	0.38	19.37	9 37.5%	1 4.2%	1 4.2%	7 29.2%	0 0.0%	5 20.8%	11	12
26	PALI	20	0.1	8.85	0.6	7.19	4 20.0%	2 10.0%	3 15.0%	7 35.0%	1 5.0%	1 5.0%	9	9
27	RAJSAMAND	27	0.08	8.26	0.06	14.62	9 33.3%	3 11.1%	2 7.4%	6 22.2%	2 7.4%	5 18.5%	14	13
28	SAWAI MADHOPUR	17	0.6	2.19	0.39	13.06	3 17.6%	1 5.9%	0 0.0%	5 29.4%	2 11.8%	6 35.3%	4	13
29	SIKAR	21	0.19	1.1	0.02	3.62	2 9.5%	0 0.0%	0 0.0%	16 76.2%	3 14.3%	0 0.0%	2	19
30	SIROHI	13	0.5	4.36	0.3	6.8	2 15.4%	1 7.7%	1 0.0%	4 30.8%	3 23.1%	2 0.0%	4	9
31	TONK	15	0.1	3.62	0.04	2.4	5 33.3%	3 20.0%	0 0.0%	5 33.3%	2 13.3%	0 0.0%	8	7
32	UDAIPUR	40	0.03	6.34	0.09	8.55	9 22.5%	4 10.0%	2 5.0%	13 32.5%	5 12.5%	6 15.0%	15	24
	Grand Total	788	0.01	34.30	0.01	25.66	245 32.3%	59 7.8%	55 7.2%	254 33.5%	78 10.3%	68 9.0%	359	400

8.5 Long Term Ground Water Scenario

Long-term behaviour of water levels was studied by analysing the data for decadal average water levels and fluctuation of water level with respect to decadal average water levels.

8.5.1 Decadal Average Depth to Water Level

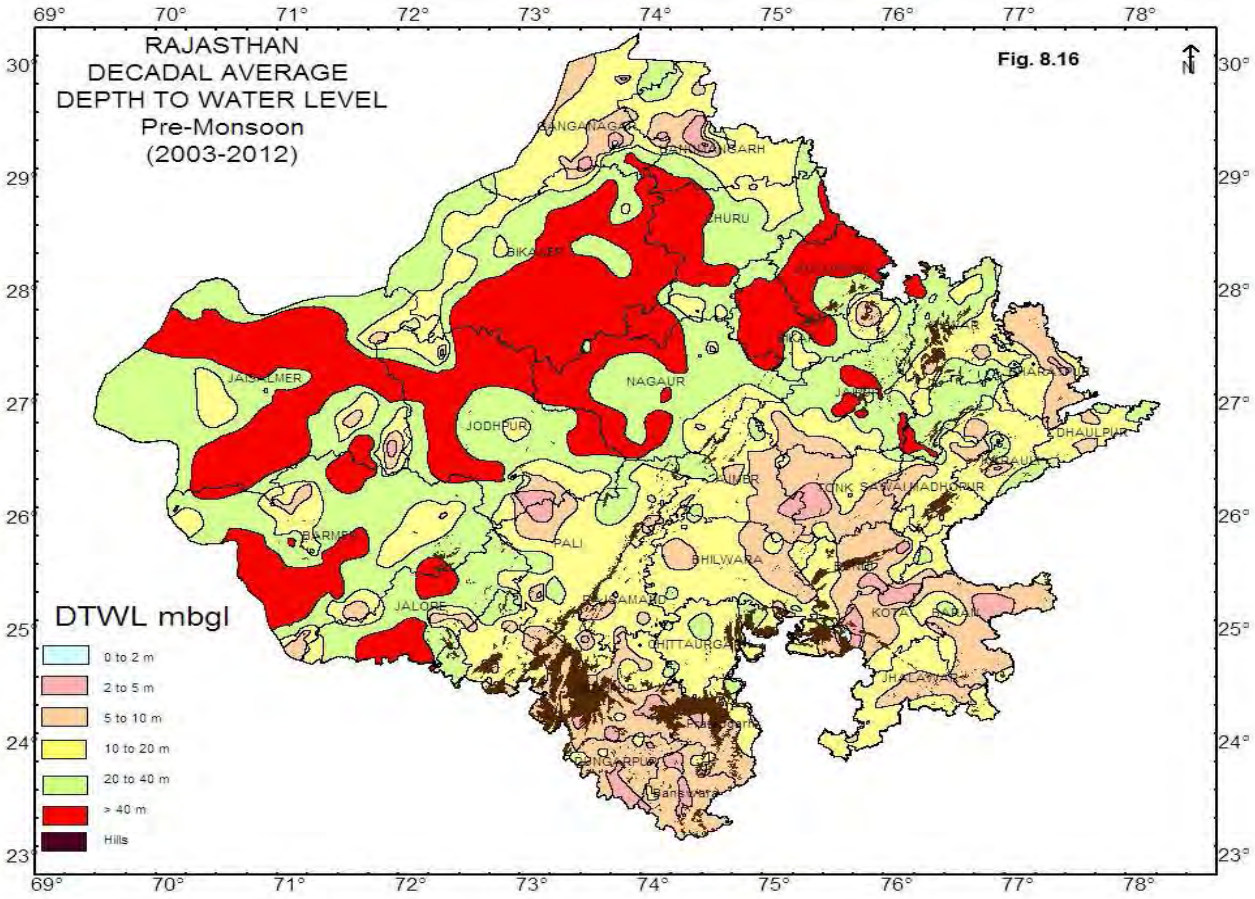
Parametric maps for the decade 2002-2011 have been prepared to evaluate the long-term changes in the ground water regime. Decadal average depth to water table data is given in Annexure II and distribution of the same is discussed below.

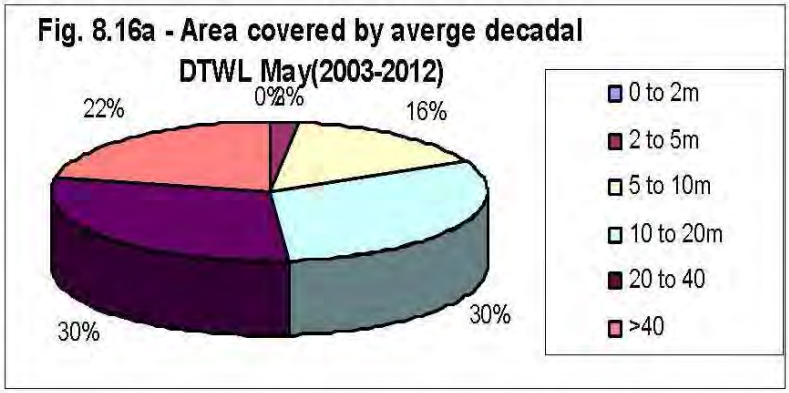
8.5.1.1 Pre-monsoon Water Levels

Decadal average water level map for the period May 2003 to May 2012 (**Fig. 8.16**) reveals that the decadal average water level in Rajasthan is covered 60% (**Fig. 8.16a**) of the area by water level ranges from 10 to 40 mbgl. Water level more than 40 m bgl is covered 22% of the area of state and exist in patch extending from east to west direction in northern part . Shallow water level less than 5 m bgl is seen in very limited area (2% of State).

8.5.1.2 Post Monsoon Water Levels

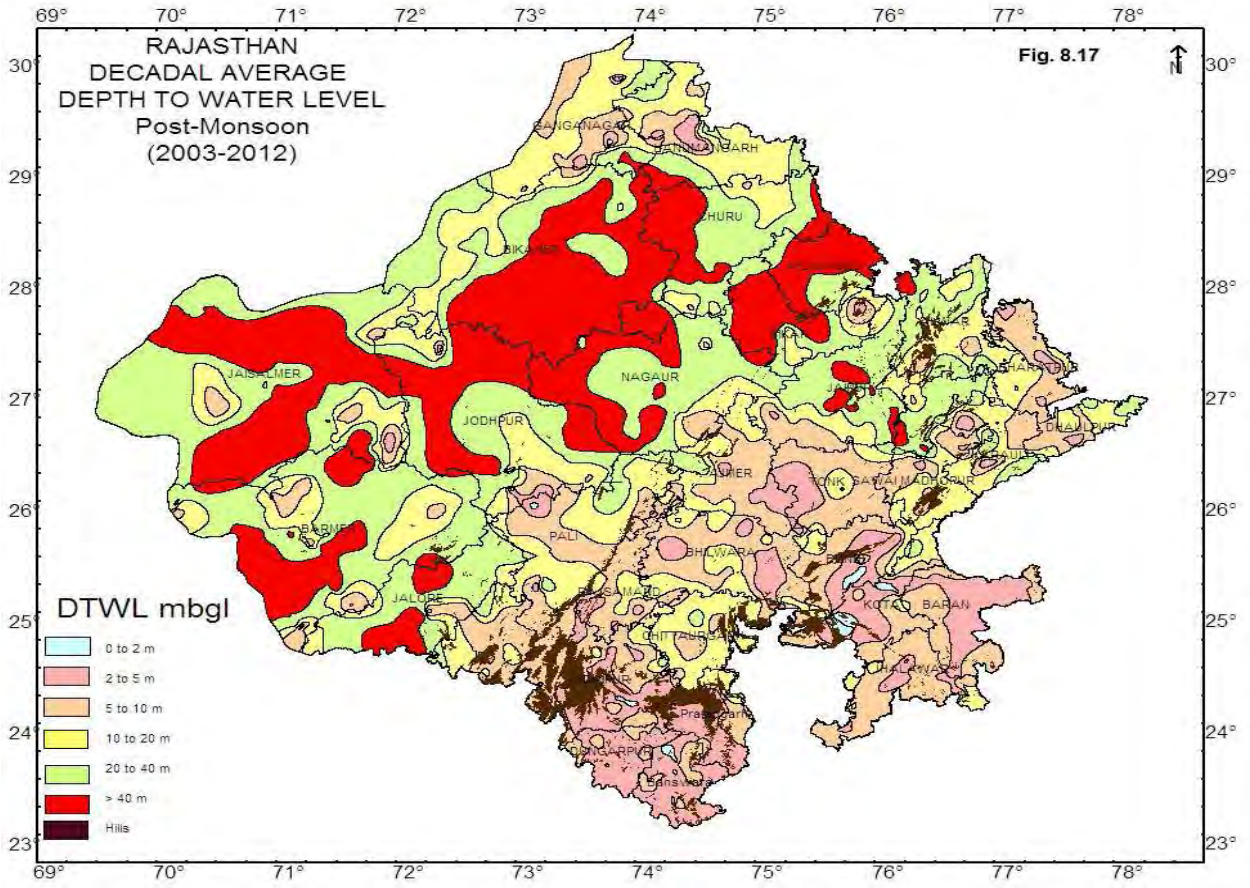
Decadal average water level map for the period November 2003 to November 2012 (**Fig. 8.17**) reveals that major parts of the area (50% of State, **Fig. 8.17**) covered by water level ranges from 10 to 40 m bgl. Water level more than 40 m bgl is exist in northern part of the State in patch extending from east to west. Shallow water level less than 5m bgl is observed in only 9% of the area of the State.

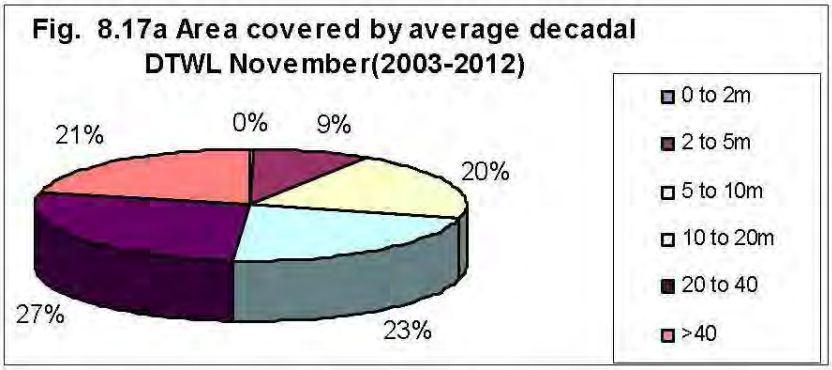




AREA COVERED IN DIFFERENT RANGES OF DECADAL AVERAGE (2003-2012) DEPTH TO WATER LEVEL IN M BGL IN RAJASTHAN STATE

Month	0 to 2	2 to 5	5 to 10	10 to 20	20 to 40	>40
May	0.05%	2.09%	15.80%	30.73%	29.62%	21.70%





AREA COVERED IN DIFFERENT RANGES OF DECADAL AVERAGE (2003-2012) DEPTH TO WATER LEVEL IN M BGL IN RAJASTHAN STATE

Month	0 to 2	2 to 5	5 to 10	10 to 20	20 to 40	>40
Nov	0.31%	8.80%	19.69%	22.52%	27.40%	21.28%

8.5.2 Decadal Variations

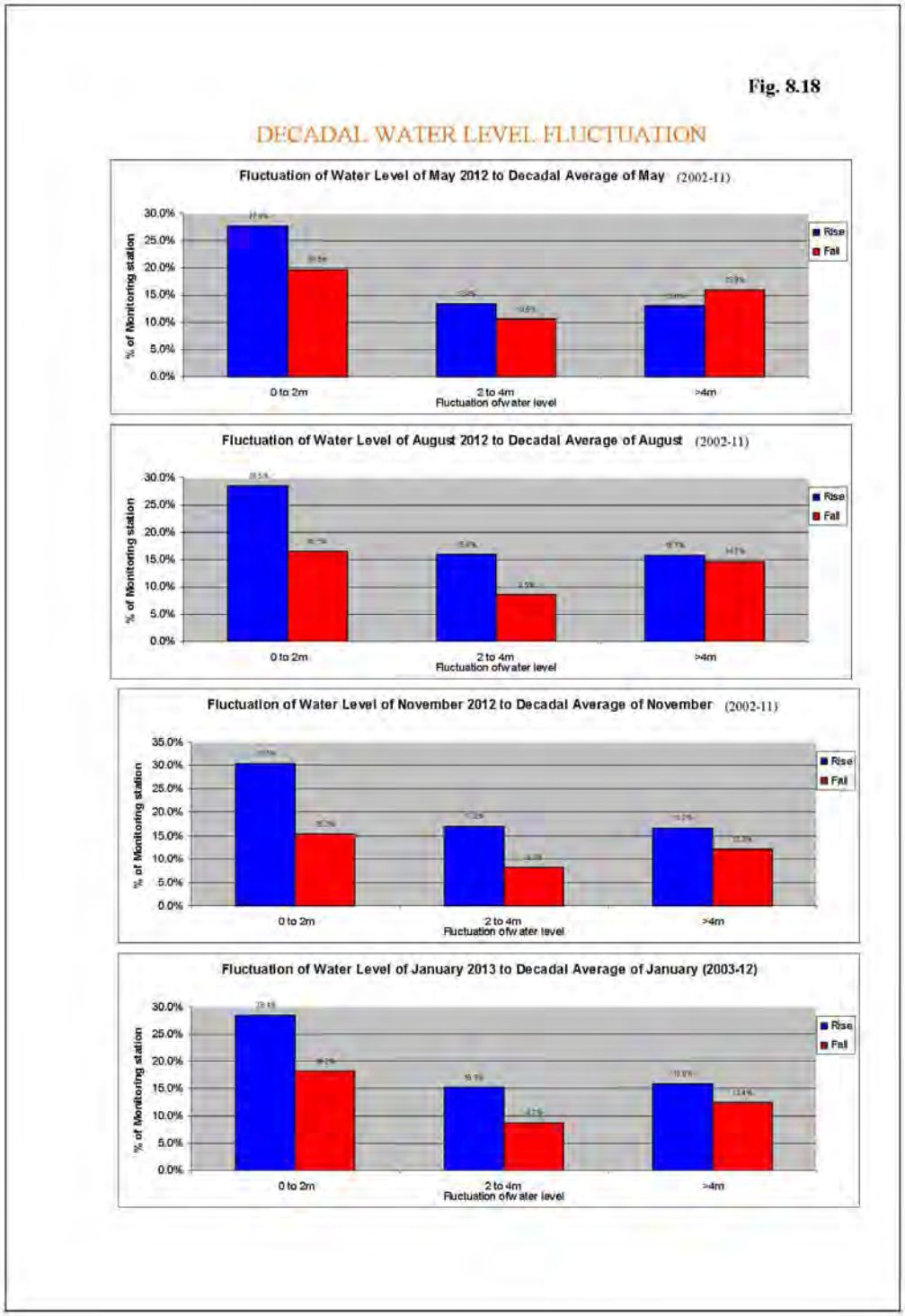


Fig. 8.18 illustrates a comparison of the changes of the water levels during different seasons with their respective decadal averages **(Annexure- II).**

8.5.2.1 Decadal average of May to May 2011

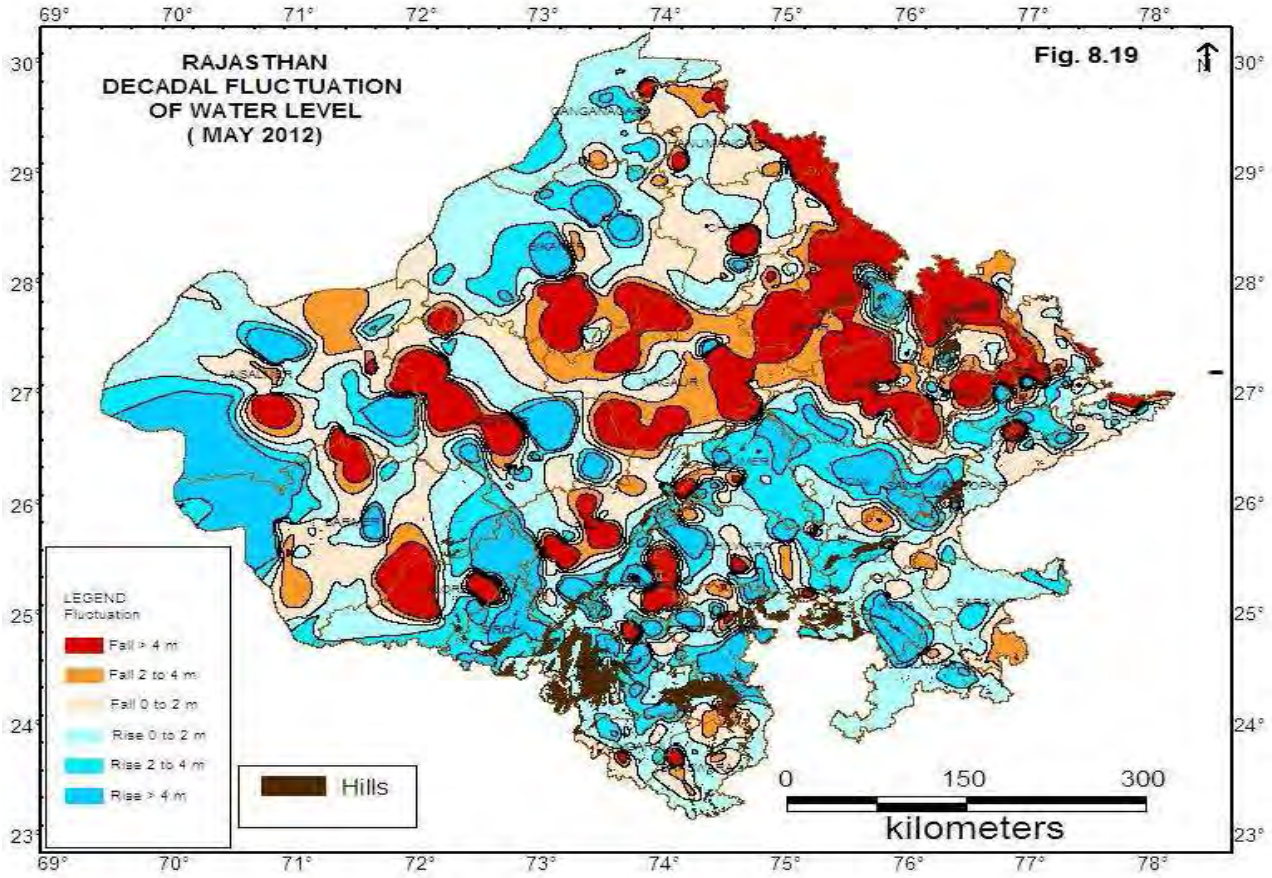
A comparison of the water levels of May 2012 with the average water level of the May of last one decade (**Fig. 8.19**, **Table 8.12**) reveals that rise in water level has been experienced in 54% of stations analysed in the State. Rise is mostly in the range of 0-2m (28 %). Rise of more than 4 m is observed mainly in the districts of Ajmer, Barmer, Bikaner, Chittourgarh, Jaisalmer, Jalore, Jhalawar, Karauli, Jodhpur, Rajsamand, Swai Madhopur, Tonk and Udaipur. Fall in water level has been mainly recorded in central parts of the State in patches extending from north east to south west direction. Fall of more than 4 m has been recorded mainly in the districts of Alwar, Bharatpur, Bhilwara, Bikaner, Dausa, Dhaulpur, Jaipur, Jalore, Jhunjhunu, Nagaur and Sikar.

The maximum rise of 25.88 m has been recorded at Lalera in Bikaner whereas the maximum decline of 28.29 m has been observed at Arniyala in Nagaur districts.

8.5.2.2 Decadal average of August to August 2011

A comparison of the water levels of August 2012 with the average water level of the August of last one decade (**Fig. 8.20**, **Table 8.13**) reveals that rise in water level has been experienced in 60% of stations analysed in the State. Rise is mostly in the range of 0-2m (29 %). Rise of more than 4 m is observed mainly in the districts of Ajmer, Barmer, Bhilwada, Chittourgarh, Jaipur, Jaisalmer, Jodhpur, Rajsamand, and Udaipur. Fall in water level has been mainly recorded in central parts of the State in patches extending from north east to south west direction. Fall of more than 4 m has been recorded mainly in the districts of Barmer, Bharatpur, Bikaner, Churu, Dausa, Jaipur, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur and Sikar.

The maximum rise of 16.07 m has been recorded at Dolia in Barmer and Devalia in Jaipur whereas the maximum decline of 27.70 m has been observed at Dharmi in Jodhpur districts.


RAJASTHAN
DECADAL FLUCTUATION
OF WATER LEVEL
(MAY 2012)
Fig. 8.19
LEGEND
Fluctuation
Fall > 4 m
Fall 2 to 4 m
Fall 0 to 2 m
Rise 0 to 2 m
Rise 2 to 4 m
Rise > 4 m
Hills
0
150
300
kilometers

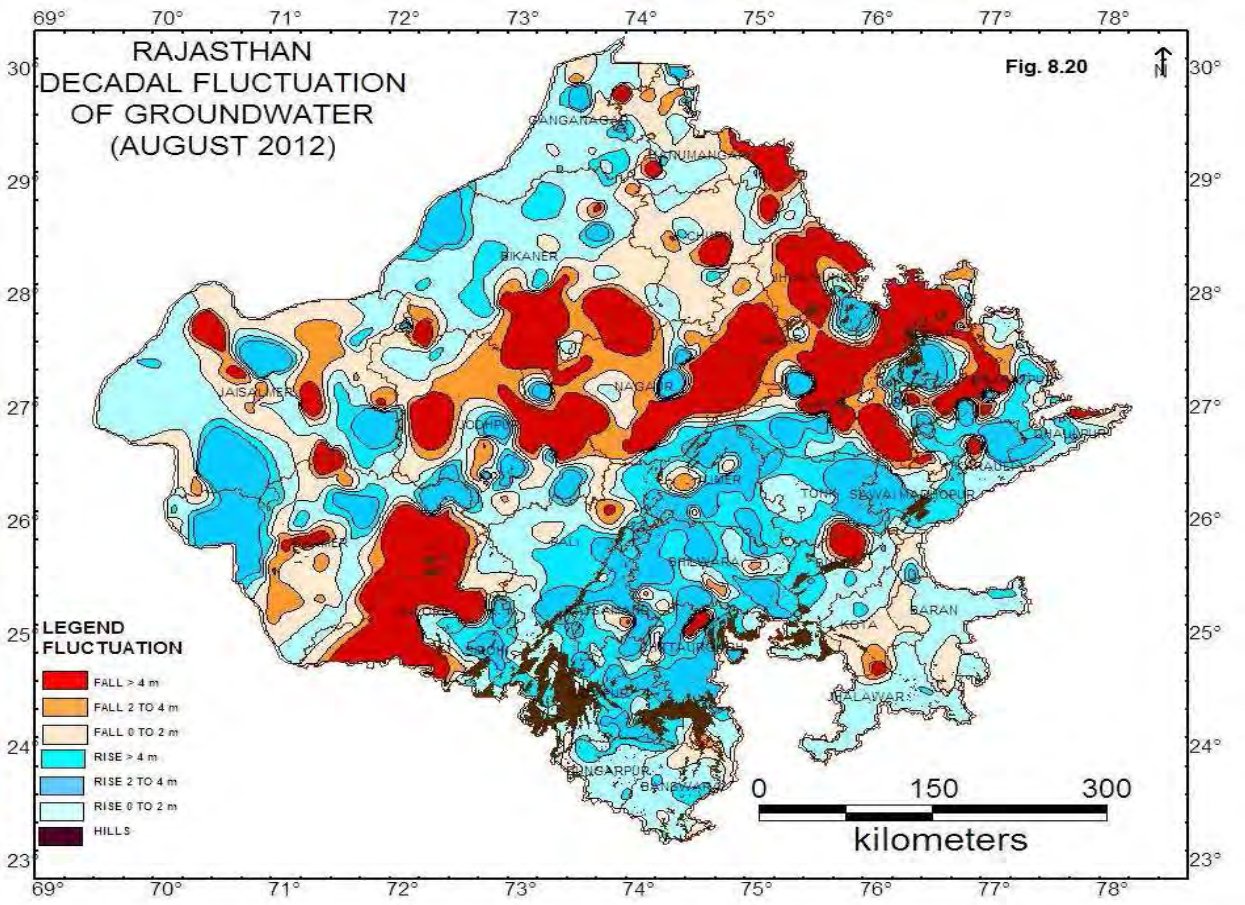

RAJASTHAN
DECADAL FLUCTUATION
OF GROUNDWATER
(AUGUST 2012)
Fig. 8.20
LEGEND
FLUCTUATION
FALL > 4 m
FALL 2 TO 4 m
FALL 0 TO 2 m
RISE > 4 m
RISE 2 TO 4 m
RISE 0 TO 2 m
HILLS
0
150
300
kilometers

Table 8.12

WELL WISE CATEGORISATION OF CHANGES IN WATER LEVEL DURING MAY 2012 WITH RESPECT TO DECADAL AVERAGE OF MAY (2002 TO 2011)

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	26	0.3	5.59	1.62	12.51	4 15.4%	10 38.5%	7 26.9%	2 7.7%	1 3.8%	2 7.7%	21	5
2	ALWAR	30	0.19	4.63	0.03	22.94	3 10.0%	0 0.0%	1 3.3%	5 16.7%	6 20.0%	15 50.0%	4	26
3	BANSWARA	26	0.08	4.89	0.09	13.17	14 53.8%	0 0.0%	1 3.8%	6 23.1%	4 15.4%	1 3.8%	15	11
4	BARAN	14	0.22	3.83	1	3.2	6 42.9%	3 21.4%	0 0.0%	4 28.6%	1 7.1%	0 0.0%	9	5
5	BARMER	44	0.18	6.62	0.17	6.62	10 22.7%	7 15.9%	8 18.2%	13 29.5%	2 4.5%	4 9.1%	25	19
6	BHARATPUR	36	0.55	8.97	0.02	19.82	8 22.2%	3 8.3%	2 5.6%	12 33.3%	5 13.9%	6 16.7%	13	23
7	BHILWARA	33	0.48	9.2	0.43	10.02	9 27.3%	9 27.3%	3 9.1%	2 6.1%	4 12.1%	6 18.2%	21	12
8	BIKANER	50	0.03	25.88	0.06	12.27	19 38.0%	6 12.0%	6 12.0%	9 18.0%	5 10.0%	5 10.0%	31	19
9	BUNDI	11	0.24	5.02	0.5	2.61	4 36.4%	3 27.3%	1 9.1%	2 18.2%	1 9.1%	0 0.0%	8	3
10	CHITTAURGARH	23	0.07	14	0.02	5.72	7 30.4%	1 4.3%	7 30.4%	5 21.7%	1 4.3%	2 8.7%	15	8
11	CHURU	34	0.02	5.54	0.01	23.08	13 38.2%	0 0.0%	1 2.9%	15 44.1%	2 5.9%	3 8.8%	14	20
12	DAUSA	13	2.1	3.07	0.11	12.82	0 0.0%	3 23.1%	0 0.0%	1 7.7%	3 23.1%	6 46.2%	3	10
13	DHAULPUR	17	0.46	4.9	0.17	7.54	3 17.6%	3 17.6%	1 5.9%	4 23.5%	2 11.8%	4 23.5%	7	10
14	DUNGARPUR	21	0.22	4.28	0.08	7.83	8 38.1%	5 23.8%	1 4.8%	6 28.6%	0 0.0%	1 4.8%	14	7
15	GANGANAGAR	35	0.25	4.85	2.07	14.64	22 62.9%	8 22.9%	2 5.7%	0 0.0%	2 5.7%	1 2.9%	32	3
16	HANUMANGARH	35	0.13	2.81	0.01	16.43	9 25.7%	2 5.7%	0 0.0%	12 34.3%	9 25.7%	3 8.6%	11	24
17	JAIPUR	40	0.07	6.59	0.3	19.93	5 12.5%	3 7.5%	3 7.5%	5 12.5%	5 12.5%	19 47.5%	11	29
18	JAISALMER	48	0.03	11.95	0.03	17.91	17 35.4%	2 4.2%	7 14.6%	13 27.1%	4 8.3%	5 10.4%	26	22
19	JALORE	12	0.61	11.91	0.6	16.19	1 8.3%	2 16.7%	4 33.3%	1 8.3%	0 0.0%	4 33.3%	7	5
20	JHALAWAR	8	0.33	9.41	2.84	2.84	5 62.5%	0 0.0%	2 25.0%	0 0.0%	1 12.5%	0 0.0%	7	1
21	JHUNJHUNU	16	1	4.94	1.67	12.76	1 6.3%	0 0.0%	1 6.3%	1 6.3%	4 25.0%	9 56.3%	2	14
22	JODHPUR	35	0.02	25.4	0.03	27.02	7 20.0%	6 17.1%	6 17.1%	10 28.6%	2 5.7%	4 11.4%	19	16
23	KARAULI	15	0.9	12.85	0.25	8.06	2 13.3%	2 13.3%	3 20.0%	5 33.3%	2 13.3%	1 6.7%	7	8
24	KOTA	16	0.1	6.78	0.4	3.45	6 37.5%	2 12.5%	2 12.5%	4 25.0%	2 12.5%	0 0.0%	10	6
25	NAGAUR	29	0.33	8.82	0.23	28.29	6 20.7%	0 0.0%	2 6.9%	3 10.3%	9 31.0%	9 31.0%	8	21
26	PALI	23	0.54	11.6	0.19	14.17	7 30.4%	1 4.3%	2 8.7%	8 34.8%	1 4.3%	4 17.4%	10	13
27	RAJSAMAND	26	0.2	7.68	0.08	9.84	5 19.2%	8 30.8%	8 30.8%	2 7.7%	1 3.8%	2 7.7%	21	5
28	SAWAI MADHOPUR	18	1.17	11.13	0.36	12.5	3 16.7%	5 27.8%	4 22.2%	4 22.2%	1 5.6%	1 5.6%	12	6
29	SIKAR	24	8.65	8.65	0.11	9.44	0 0.0%	0 0.0%	1 4.2%	4 16.7%	5 20.8%	14 58.3%	1	23
30	SIROHI	15	0.58	9.42	-	-	4 26.7%	4 26.7%	7 0.0%	0 0.0%	0 0.0%	0 0.0%	15	0
31	TONK	13	0.41	7.44	0.29	0.29	2 15.4%	4 30.8%	6 46.2%	1 7.7%	0 0.0%	0 0.0%	12	1
32	UDAIPUR	43	0.05	14.08	0.43	14.26	19 44.2%	9 20.9%	9 20.9%	3 7.0%	2 4.7%	1 2.3%	37	6
	Grand Total	829	0.02	25.88	0.01	28.29	229 27.6%	111 13.4%	108 13.0%	162 19.5%	87 10.5%	132 15.9%	448	381

Table-8.13

WELL WISE CATEGORISATION OF CHANGES IN WATER LEVEL DURING AUGUST 2012 WITH RESPECT TO DECADAL AVERAGE OF AUGUST (2002 TO 2011)

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	28	2.18	12.23	0.81	3.83	0 0.0%	9 32.1%	16 57.1%	2 7.1%	1 3.6%	0 0.0%	25	3
2	ALWAR	32	1.38	10.17	1.12	19.93	3 9.4%	4 12.5%	2 6.3%	2 6.3%	4 12.5%	17 53.1%	9	23
3	BANSWARA	23	0.03	3.96	0.1	1.98	14 60.9%	4 17.4%	0 0.0%	5 21.7%	0 0.0%	0 0.0%	18	5
4	BARAN	15	0.21	2.44	0.42	1.98	8 53.3%	2 13.3%	0 0.0%	5 33.3%	0 0.0%	0 0.0%	10	5
5	BARMER	58	0.09	16.07	0.02	20.53	11 19.0%	8 13.8%	8 13.8%	16 27.6%	6 10.3%	8 13.8%	27	30
6	BHARATPUR	34	0.66	6.78	0.11	14.49	7 20.6%	8 23.5%	2 5.9%	8 23.5%	5 14.7%	4 11.8%	17	17
7	BHILWARA	36	0.13	11.28	0.37	3.77	9 25.0%	8 22.2%	13 36.1%	2 5.6%	4 11.1%	0 0.0%	30	6
8	BIKANER	51	0.04	7.4	0.44	12.89	24 47.1%	8 15.7%	2 3.9%	4 7.8%	4 7.8%	9 17.6%	34	17
9	BUNDI	11	0.15	4.12	0.78	9.67	3 27.3%	4 36.4%	1 9.1%	1 9.1%	0 0.0%	2 18.2%	8	3
10	CHITTAURGARH	29	0.05	12.91	0.07	10.63	7 24.1%	5 17.2%	9 31.0%	5 17.2%	1 3.4%	2 6.9%	21	8
11	CHURU	35	0	3.91	0.12	26.79	10 28.6%	3 8.6%	0 0.0%	16 45.7%	2 5.7%	4 11.4%	13	22
12	DAUSA	14	0.15	8.24	0.72	14.26	2 14.3%	1 7.1%	3 21.4%	1 7.1%	0 0.0%	7 50.0%	6	8
13	DHAULPUR	16	0.03	5.06	0.35	8.72	5 31.3%	1 6.3%	4 25.0%	4 25.0%	0 0.0%	2 12.5%	10	6
14	DUNGARPUR	22	0.01	4.5	2.12	2.12	15 68.2%	5 22.7%	1 4.5%	0 0.0%	1 4.5%	0 0.0%	21	1
15	GANGANAGAR	40	0.06	11.25	0.08	16.58	23 57.5%	6 15.0%	2 5.0%	7 17.5%	1 2.5%	1 2.5%	31	9
16	HANUMANGARH	37	0.04	9.46	0.18	16.76	9 24.3%	2 5.4%	3 8.1%	14 37.8%	7 18.9%	2 5.4%	14	23
17	JAIPUR	41	0.57	16.07	0.52	18.17	3 7.3%	4 9.8%	6 14.6%	5 12.2%	5 12.2%	18 43.9%	13	28
18	JAISALMER	56	0.02	7.2	0.02	19.3	21 37.5%	4 7.1%	7 12.5%	10 17.9%	6 10.7%	8 14.3%	32	24
19	JALORE	14	0.58	3.79	0.47	19.23	3 21.4%	3 21.4%	0 0.0%	2 14.3%	0 0.0%	6 42.9%	6	8
20	JHALAWAR	6	0.35	2.22	4.92	4.92	4 66.7%	1 16.7%	0 0.0%	0 0.0%	0 0.0%	1 16.7%	5	1
21	JHUNJHUNU	15	2.76	2.76	0.82	10.97	0 0.0%	1 6.7%	0 0.0%	2 13.3%	6 40.0%	6 40.0%	1	14
22	JODHPUR	43	0.08	12.74	0.24	27.7	11 25.6%	2 4.7%	9 20.9%	8 18.6%	6 14.0%	7 16.3%	22	21
23	KARAULI	13	0.89	11.77	0.63	2.32	3 23.1%	2 15.4%	4 30.8%	2 15.4%	2 15.4%	0 0.0%	9	4
24	KOTA	16	0.13	7.16	0.38	1.7	8 50.0%	2 12.5%	1 6.3%	5 31.3%	0 0.0%	0 0.0%	11	5
25	NAGAUR	30	0.17	15.41	1.47	27.36	4 13.3%	3 10.0%	4 13.3%	1 3.3%	9 30.0%	9 30.0%	11	19
26	PALI	29	0.27	9.57	0.07	4.5	14 48.3%	6 20.7%	2 6.9%	5 17.2%	1 3.4%	1 3.4%	22	7
27	RAJSAMAND	29	1.48	10.03	0.39	4.42	4 13.8%	7 24.1%	15 51.7%	2 6.9%	0 0.0%	1 3.4%	26	3
28	SAWAI MADHOPUR	19	0.13	11.71	0.31	11.06	4 21.1%	8 42.1%	3 15.8%	2 10.5%	0 0.0%	2 10.5%	15	4
29	SIKAR	24	1.05	9.23	0.11	9.3	1 4.2%	0 0.0%	1 4.2%	5 20.8%	3 12.5%	14 58.3%	2	22
30	SIROHI	15	0.38	7.56	0.19	3.38	3 20.0%	3 20.0%	5 0.0%	2 13.3%	2 13.3%	0 0.0%	11	4
31	TONK	14	0.77	9.57	0.09	0.47	3 21.4%	5 35.7%	4 28.6%	2 14.3%	0 0.0%	0 0.0%	12	2
32	UDAIPUR	45	0.01	9.52	0.53	1.48	18 40.0%	12 26.7%	13 28.9%	2 4.4%	0 0.0%	0 0.0%	43	2
	Grand Total	890	0.00	16.07	0.02	27.70	254 28.5%	141 15.8%	140 15.7%	147 16.5%	76 8.5%	131 14.7%	535	354

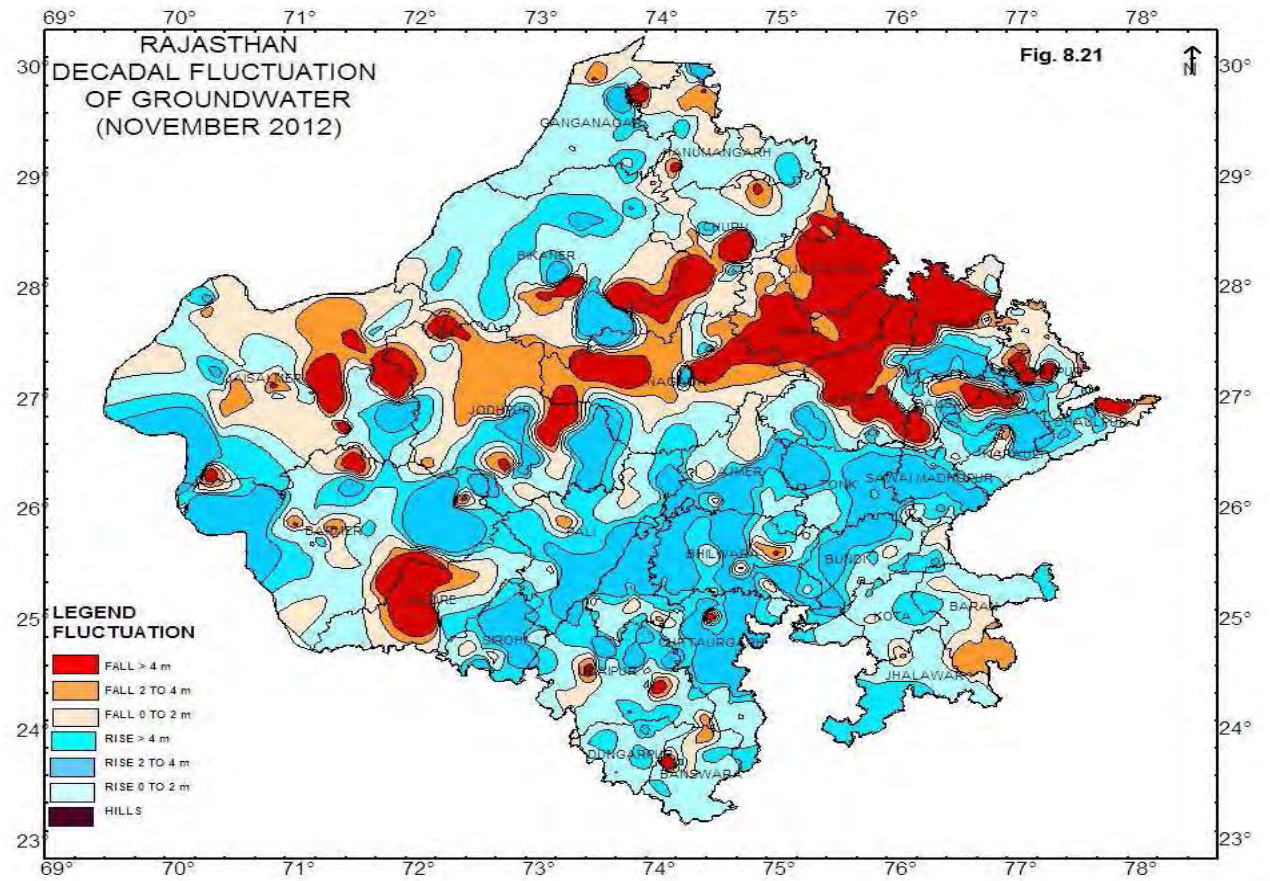
8.5.2.3 Decadal average of November to November 2011

A comparison of the water level of the November 2012 with the average water level of the November of last one decade (**Fig. 8.21**, **Table 8.14**) reveals that rise in water level is experienced in 64% of stations analysed in the State. Rise is mostly in the range of 0-2m (30.5 %). Rise of more than 4 m is observed mainly in the districts of Ajmer, Bhilwara, Chittourgarh, Jodhpur, Rajsamand and Udaipur. Fall in water level is mainly recorded in the central parts of the State extending from East to West direction. Fall of more than 4 m is exist in the Eastern parts mostly covering the district of Alwar, Jaipur, Sikar, Nagaur, Churu and Jhunjhunu and in the western side in the district of Jalore and Jaisalmer. The maximum rise of 19.01 m is recorded at Doli in Barmer whereas the maximum decline of 24.26 m is observed at Dudwa in Churu districts.

8.5.2.4 Decadal average of January to January 2012

A comparison of the water level of the January 2013 with the average water level of the January of last one decade (**Fig. 8.22**, **Table 8.15**) reveals that rise in water level is experienced in 61% of stations analysed in the State. Rise is mostly in the range of 0-2m (28 %). Rise of more than 4 m is observed mainly in the districts of Ajmer, Bhiwara, Chittaurgarh, Jaisalmer, Jodhpur Rajsamand and Shihori. Fall in water level is mainly recorded in the central parts of the State extending from north east to south west direction. Fall of more than 4 m is recorded mainly in the districts of Alwar, Barmer, Bharatpur, Bikaner, Dausa, Jaipur, Jhunjhunu, Jodhpur and Sikar.

The maximum rise of 54.59 m is recorded at Napat in Barmer whereas the maximum decline of 27.19 m is observed at Dudwa in Churu districts.


RAJASTHAN
DECADAL FLUCTUATION
OF GROUNDWATER
(NOVEMBER 2012)
Fig. 8.21
LEGEND
FLUCTUATION
FALL > 4 m
FALL 2 TO 4 m
FALL 0 TO 2 m
RISE > 4 m
RISE 2 TO 4 m
RISE 0 TO 2 m
HILLS

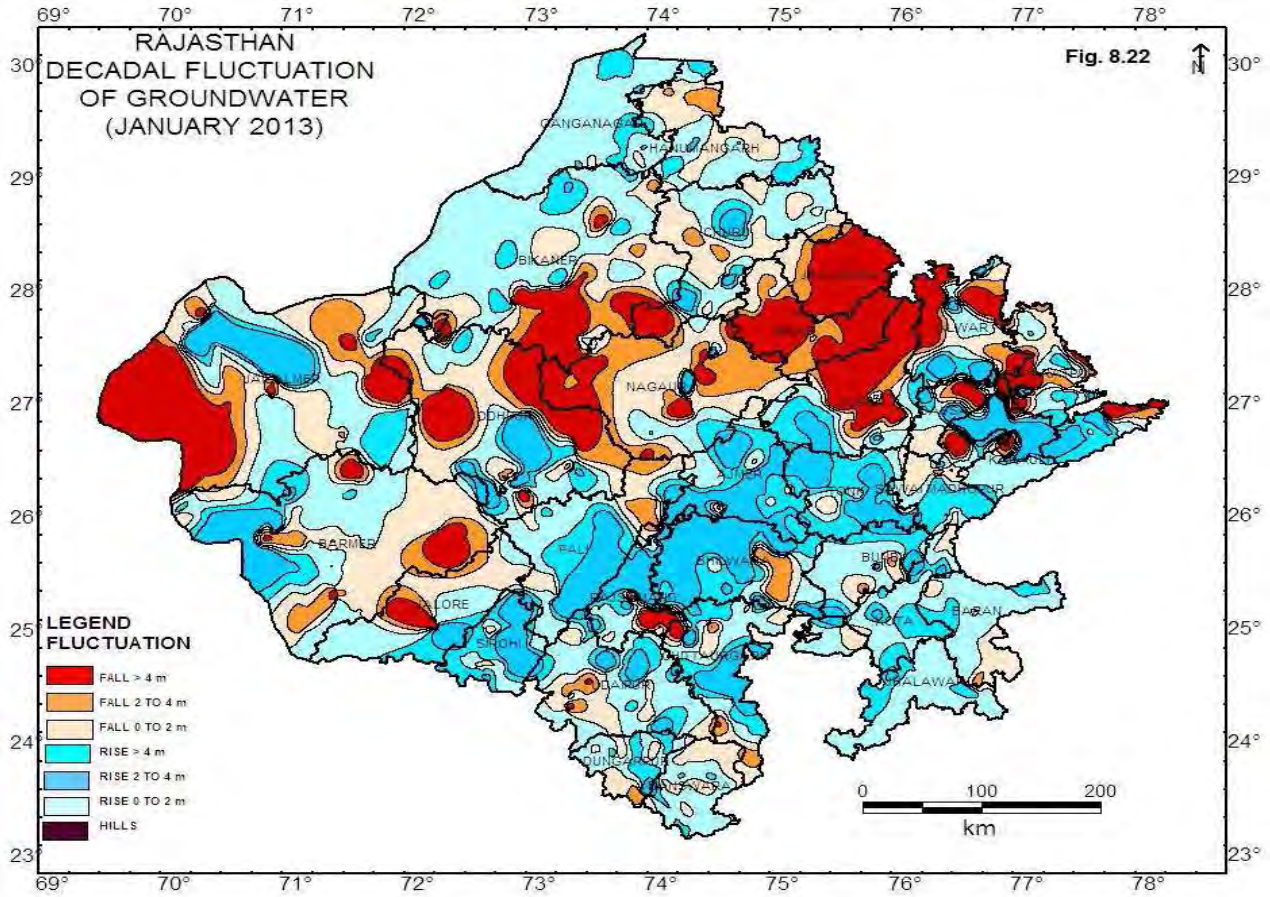

RAJASTHAN
DECADAL FLUCTUATION
OF GROUNDWATER
(JANUARY 2013)
Fig. 8.22
LEGEND
FLUCTUATION
FALL > 4 m
FALL 2 TO 4 m
FALL 0 TO 2 m
RISE > 4 m
RISE 2 TO 4 m
RISE 0 TO 2 m
HILLS
0
100
200
km

Table-8.14

WELL WISE CATEGORISATION OF CHANGES IN WATER LEVEL DURING NOVEMBER 2012 WITH RESPECT TO DECADAL AVERAGE OF NOVEMBER (2002 TO 2011)

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	25	1.14	10.37	0.9	1.79	3 12.0%	5 20.0%	14 56.0%	3 12.0%	0 0.0%	0 0.0%	22	3
2	ALWAR	26	0.11	10.37	0.35	14.15	3 11.5%	3 11.5%	3 11.5%	3 11.5%	3 11.5%	11 42.3%	9	17
3	BANSWARA	25	0.05	3.37	0.01	11.3	14 56.0%	4 16.0%	0 0.0%	5 20.0%	1 4.0%	1 4.0%	18	7
4	BARAN	15	0.05	2.31	0.66	3.87	6 40.0%	2 13.3%	0 0.0%	3 20.0%	4 26.7%	0 0.0%	8	7
5	BARMER	48	0	19.01	0	6.48	14 29.2%	7 14.6%	9 18.8%	10 20.8%	2 4.2%	6 12.5%	30	18
6	BHARATPUR	34	0.15	6.75	0.02	19.96	9 26.5%	3 8.8%	4 11.8%	10 29.4%	3 8.8%	5 14.7%	16	18
7	BHILWARA	30	0.42	12.82	1.46	4.31	6 20.0%	4 13.3%	15 50.0%	1 3.3%	3 10.0%	1 3.3%	25	5
8	BIKANER	43	0.19	7.53	0.19	21.53	18 41.9%	10 23.3%	5 11.6%	5 11.6%	2 4.7%	3 7.0%	33	10
9	BUNDI	12	0.83	9.42	0.12	1.32	4 33.3%	3 25.0%	3 25.0%	2 16.7%	0 0.0%	0 0.0%	10	2
10	CHITTAURGARH	24	0.23	10.83	0.03	6.91	7 29.2%	6 25.0%	9 37.5%	1 4.2%	0 0.0%	1 4.2%	22	2
11	CHURU	31	0.03	4.58	0.09	24.26	11 35.5%	1 3.2%	1 3.2%	10 32.3%	3 9.7%	5 16.1%	13	18
12	DAUSA	13	0.54	5.46	0.41	11.3	2 15.4%	3 23.1%	1 7.7%	1 7.7%	2 15.4%	4 30.8%	6	7
13	DHAULPUR	15	0.02	5.1	0.28	7.58	3 20.0%	3 20.0%	2 13.3%	3 20.0%	0 0.0%	4 26.7%	8	7
14	DUNGARPUR	22	0.01	5.64	0.04	0.04	13 59.1%	6 27.3%	2 9.1%	1 4.5%	0 0.0%	0 0.0%	21	1
15	GANGANAGAR	37	0.03	9.03	0.01	15.08	23 62.2%	5 13.5%	1 2.7%	6 16.2%	0 0.0%	2 5.4%	29	8
16	HANUMANGARH	35	0.03	8.41	0.3	7.07	12 34.3%	5 14.3%	1 2.9%	7 20.0%	8 22.9%	2 5.7%	18	17
17	JAIPUR	33	0.44	9.5	0.6	16.76	7 21.2%	2 6.1%	4 12.1%	5 15.2%	3 9.1%	12 36.4%	13	20
18	JAISALMER	55	0.03	9.9	0.05	20.09	12 21.8%	7 12.7%	5 9.1%	15 27.3%	7 12.7%	9 16.4%	24	31
19	JALORE	10	0.34	3.86	1.92	15.21	4 40.0%	2 20.0%	0 0.0%	1 10.0%	0 0.0%	3 30.0%	6	4
20	JHALAWAR	20	0.15	4.47	2.22	2.22	11 55.0%	7 35.0%	1 5.0%	0 0.0%	1 5.0%	0 0.0%	19	1
21	JHUNJHUNU	13	-	-	1.33	16.77	0 0.0%	0 0.0%	0 0.0%	1 7.7%	4 30.8%	8 61.5%	0	13
22	JODHPUR	39	0.05	8.73	0.28	8.3	10 25.6%	4 10.3%	9 23.1%	5 12.8%	6 15.4%	5 12.8%	23	16
23	KARAULI	13	0.19	9.69	1.95	3.47	4 30.8%	2 15.4%	4 30.8%	1 7.7%	2 15.4%	0 0.0%	10	3
24	KOTA	17	0.02	5.5	0.38	0.79	9 52.9%	5 29.4%	1 5.9%	2 11.8%	0 0.0%	0 0.0%	15	2
25	NAGAUR	23	0.31	13.87	0.23	8.7	5 21.7%	1 4.3%	3 13.0%	2 8.7%	7 30.4%	5 21.7%	9	14
26	PALI	28	0.25	14.19	0.04	5.63	8 28.6%	9 32.1%	4 14.3%	6 21.4%	0 0.0%	1 3.6%	21	7
27	RAJSAMAND	27	0.26	9.72	1.06	2.3	6 22.2%	8 29.6%	10 37.0%	2 7.4%	1 3.7%	0 0.0%	24	3
28	SAWAI MADHOPUR	16	1.33	8.87	0.35	0.35	3 18.8%	6 37.5%	6 37.5%	1 6.3%	0 0.0%	0 0.0%	15	1
29	SIKAR	19	0.1	0.1	0.68	10.73	1 5.3%	0 0.0%	0 0.0%	4 21.1%	5 26.3%	9 47.4%	1	18
30	SIROHI	17	0.02	8.48	0.03	0.94	5 29.4%	2 11.8%	7 0.0%	3 17.6%	0 0.0%	0 0.0%	14	3
31	TONK	13	0.88	8.3	0.73	0.73	3 23.1%	4 30.8%	5 38.5%	1 7.7%	0 0.0%	0 0.0%	12	1
32	UDAIPUR	44	0.13	10.92	0.13	6.5	15 34.1%	12 27.3%	8 18.2%	6 13.6%	1 2.3%	2 4.5%	35	9
	Grand Total	822	0.00	19.01	0.00	24.26	251 30.5%	141 17.2%	137 16.7%	126 15.3%	68 8.3%	99 12.0%	529	293

Table-8.15

WELL WISE CATEGORISATION OF CHANGES IN WATER LEVEL DURING JANUARY 2013 WITH RESPECT TO DECADAL AVERAGE OF JANUARY (2003 TO 2012)

Sr. No.	District Name	No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
			Rise		Fall		Rise			Fall				
			Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
1	AJMER	27	0.32	10.94	0.13	2.34	2 7.4%	5 18.5%	17 63.0%	2 7.4%	1 3.7%	0 0.0%	24	3
2	ALWAR	27	0.13	13.65	0.05	36.11	6 22.2%	1 3.7%	4 14.8%	3 11.1%	3 11.1%	10 37.0%	11	16
3	BANSWARA	23	0.2	2.66	0.09	1.57	9 39.1%	5 21.7%	0 0.0%	9 39.1%	0 0.0%	0 0.0%	14	9
4	BARAN	20	0.05	2.92	0.09	3.13	11 55.0%	4 20.0%	0 0.0%	4 20.0%	1 5.0%	0 0.0%	15	5
5	BARMER	54	0.07	45.72	0	9.93	14 25.9%	3 5.6%	10 18.5%	12 22.2%	7 13.0%	5 9.3%	27	24
6	BHARATPUR	34	0.52	9.06	0.05	18.5	9 26.5%	6 17.6%	5 14.7%	7 20.6%	4 11.8%	3 8.8%	20	14
7	BHILWARA	29	0.79	11.4	3.36	3.76	3 10.3%	7 24.1%	16 55.2%	0 0.0%	3 10.3%	0 0.0%	26	3
8	BIKANER	51	0.18	4.39	0.07	16.77	22 43.1%	8 15.7%	1 2.0%	8 15.7%	4 7.8%	8 15.7%	31	20
9	BUNDI	12	0.41	10.04	0.24	3.04	5 41.7%	1 8.3%	2 16.7%	2 16.7%	2 16.7%	0 0.0%	8	4
10	CHITTAURGARH	28	0.42	9.81	0.07	7.11	6 21.4%	5 17.9%	6 21.4%	7 25.0%	1 3.6%	3 10.7%	17	11
11	CHURU	36	0.04	7.11	0.12	24.12	13 36.1%	1 2.8%	3 8.3%	14 38.9%	3 8.3%	2 5.6%	17	19
12	DAUSA	12	0.31	7.43	2.13	11.31	3 25.0%	2 16.7%	2 16.7%	0 0.0%	1 8.3%	4 33.3%	7	5
13	DHAULPUR	15	0.06	7.24	2.62	12.83	3 20.0%	2 13.3%	5 33.3%	0 0.0%	2 13.3%	3 20.0%	10	5
14	DUNGARPUR	22	0.04	13.35	0.5	3.12	8 36.4%	6 27.3%	1 4.5%	6 27.3%	1 4.5%	0 0.0%	15	7
15	GANGANAGAR	35	0.11	3.42	0.24	0.73	25 71.4%	7 20.0%	0 0.0%	3 8.6%	0 0.0%	0 0.0%	32	3
16	HANUMANGARH	39	0.39	3.8	0.15	23.95	9 23.1%	10 25.6%	0 0.0%	13 33.3%	6 15.4%	1 2.6%	19	20
17	JAIPUR	36	0.1	10.1	0.03	21.22	6 16.7%	5 13.9%	3 8.3%	5 13.9%	2 5.6%	15 41.7%	14	22
18	JAISALMER	50	0.14	46.82	0.03	13.92	13 26.0%	5 10.0%	5 10.0%	11 22.0%	6 12.0%	10 20.0%	23	27
19	JALORE	8	0.67	8.42	1.39	13.89	4 50.0%	1 12.5%	1 12.5%	1 12.5%	0 0.0%	1 12.5%	6	2
20	JHALAWAR	19	0.02	4.82	-	-	12 63.2%	6 31.6%	1 5.3%	0 0.0%	0 0.0%	0 0.0%	19	0
21	JHUNJHUNU	12	-	-	0.92	11.58	0 0.0%	0 0.0%	0 0.0%	2 16.7%	4 33.3%	6 50.0%	0	12
22	JODHPUR	47	0.12	9.93	0	28.27	8 17.0%	6 12.8%	8 17.0%	9 19.1%	5 10.6%	7 14.9%	22	21
23	KARAULI	14	0.18	11.23	2.84	2.85	5 35.7%	0 0.0%	7 50.0%	0 0.0%	2 14.3%	0 0.0%	12	2
24	KOTA	18	0.11	5.06	0.52	0.52	11 61.1%	3 16.7%	3 16.7%	1 5.6%	0 0.0%	0 0.0%	17	1
25	NAGAUR	25	0.24	15.47	0.52	9.97	3 12.0%	3 12.0%	2 8.0%	5 20.0%	5 20.0%	6 24.0%	8	16
26	PALI	25	0.69	12.81	0.13	2.38	6 24.0%	8 32.0%	3 12.0%	5 20.0%	2 8.0%	0 0.0%	17	7
27	RAJSAMAND	27	0.04	12.77	0.07	12.31	4 14.8%	3 11.1%	12 44.4%	3 11.1%	2 7.4%	3 11.1%	19	8
28	SAWAI MADHOPUR	18	1.1	5.59	1.19	9.45	2 11.1%	7 38.9%	1 5.6%	3 16.7%	2 11.1%	3 16.7%	10	8
29	SIKAR	25	-	-	0.6	20.29	0 0.0%	0 0.0%	0 0.0%	5 20.0%	5 20.0%	15 60.0%	0	25
30	SIROHI	16	0.38	9.69	0.07	1.02	4 25.0%	2 12.5%	6 0.0%	4 25.0%	0 0.0%	0 0.0%	12	4
31	TONK	16	0.65	10.26	1.48	1.48	2 12.5%	5 31.3%	8 50.0%	1 6.3%	0 0.0%	0 0.0%	15	1
32	UDAIPUR	45	0.08	11.16	0.09	5.7	18 40.0%	5 11.1%	6 13.3%	12 26.7%	1 2.2%	2 4.4%	29	15
	Grand Total	865	0.02	46.82	0.00	36.11	246 28.4%	132 15.3%	138 16.0%	157 18.2%	75 8.7%	107 12.4%	516	339

9.0 HYDROCHEMISTRY

For the evaluation of hydro chemical status and distribution of various chemical constituents in Ground water of Rajasthan state, 684 water samples were collected from NHS during May, 2012. These were chemically analyzed in chemical laboratory. The detailed chemical analysis results of 684 ground water samples (district wise) have been given in Annexure III. **Table- 9.2** shows district wise percentage of stations where the principal chemical constituents are beyond permissible limits for drinking purpose and **Table 9.3** shows the distribution of major constituents in various permissible limits in State. District wise distribution of major constituents in (1) within permissible limit (2) maximum permissible limit (3) beyond permissible limit have been shown in **Table 9.4**. District wise minimum and maximum values of various chemical constituents are given in **Table 9.5a** and **9.5b** . The distribution of some major chemical constituents in Rajasthan state have been shown by maps.

9.1 Standards for drinking use

The presence of various chemical constituents in excess quantity in water affects the human health adversely. In our country Bureau of Indian Standard has prescribed standards for drinking purpose (IS-10500:91). The desirable and maximum limits for major constituents and their probable effects on human body have been shown in the following **Table 9.1** and area covered by different constituents are shown in **Fig. 9.1.**

Table: 9.1 Standard for drinking water use.

S.No.	Constituents	Desirable limit(ppm)	Maximum permissible limit (ppm)	Probable effects
1	TDS	500	2000	Beyond limit water bitter in taste and can cause stomach disorder.
2	Chloride	250	1000	Indigestion, bitter taste
3	Sulphate	200	400 (if Mg does not exceeds 30ppm)	Causes stomach disorder.
4	Nitrate	--	100	Mathaemoglobinaemia in bottle fed infants and Castro intestinal problems

				Gastro-intestinal problems.
5	Fluoride	1	1.5	Above permissible limit causes skeletal and dental fluorosis and non skeletal manifestation.
6	Total Hardness	300	600	Calcification of arteries, urinary concretions, diseases of kidney or bladder, stomach disorder.
7	Calcium	75	200	Insufficiency causes rickets, excess causes stones in kidney or bladder, essential for human health.
8	Magnesium	30	100	Its salts are cathartic & diuretic, excess is laxative.
9	Iron	0.3	1.0	Bitter sweet taste, staining of laundry, trace is essential for nutrition.

Table - 9.2 Percentage distribution of stations in major constituents in Rajasthan during year 2012

Sr. No.	Limit	Constituents								
		TDS	Cl	SO4	F	NO3	TH	Ca	Mg	Fe
1	Within desirable	11.40	53.07	61.55	53.65	58.33	42.25	61.26	30.70	53.36
2	Within Max.permissible	63.60	35.09	20.76	16.52	21.20	36.99	31.14	52.19	22.37
3	Beyond permissible	25.29	11.84	17.69	29.97	20.61	20.76	7.60	17.54	24.27

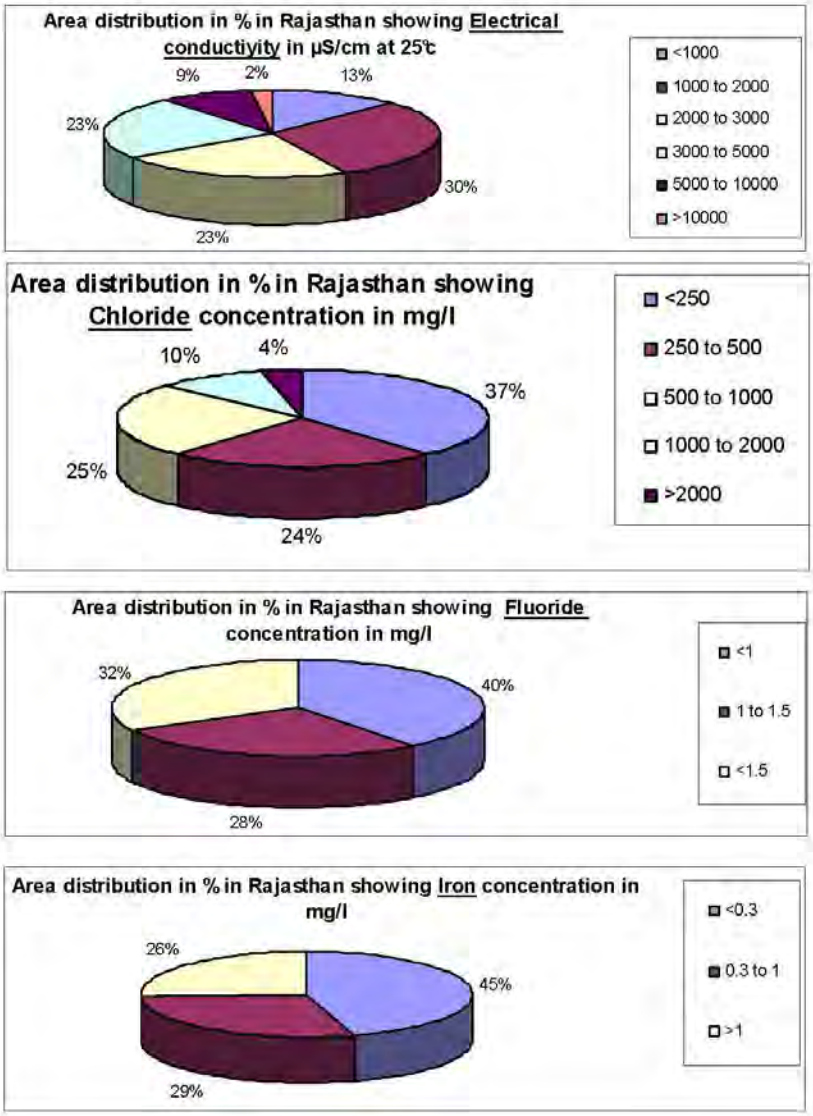


Fig. 9.1 Area covered in percentage by major constituents for the chemical analysis of water samples collected during May-2012 in Rajasthan.

Table 9.3 DISTRICT WISE PERCENTAGE OF STATIONS WHERE THE PRINCIPAL CHEMICAL CONSTITUENTS ARE BEYOND PERMISSIBLE LIMIT FOR DRINKING WATER (BASED ON THE ANALYSIS OF NHS WATER SAMPLES OF YEAR 2012)

District	No. of samples	Ca	Cl	F	Fe	NO3	Mg	SO4	TDS	TH
AJMER	25	8.00%	16.00%	28.00%	40.00%	20.00%	20.00%	20.00%	24.00%	28.00%
ALWAR	30	6.67%	6.67%	33.33%	16.67%	6.67%	3.33%	10.00%	10.00%	6.67%
BANSWARA	15	0.00%	0.00%	6.67%	33.33%	13.33%	0.00%	0.00%	0.00%	0.00%
BARAN	17	11.76%	0.00%	0.00%	47.06%	11.76%	23.53%	11.76%	17.65%	29.41%
BARMER	33	15.15%	36.36%	36.36%	6.06%	27.27%	36.36%	30.30%	51.52%	36.36%
BHARATPUR	33	3.03%	24.24%	18.18%	21.21%	12.12%	39.39%	33.33%	45.45%	36.36%
BHILWARA	29	6.90%	10.34%	68.97%	37.93%	17.24%	17.24%	10.34%	20.69%	20.69%
BIKANER	42	7.14%	11.90%	28.57%	16.67%	7.14%	21.43%	9.52%	14.29%	21.43%
BUNDI	12	8.33%	0.00%	0.00%	33.33%	16.67%	16.67%	33.33%	33.33%	25.00%
CHITTORGARH	10	10.00%	0.00%	0.00%	30.00%	20.00%	10.00%	0.00%	10.00%	10.00%
CHURU	22	4.55%	31.82%	50.00%	9.09%	59.09%	40.91%	31.82%	63.64%	45.45%
DAUSA	19	5.26%	5.26%	42.11%	5.26%	0.00%	21.05%	15.79%	31.58%	26.32%
DHAULPUR	13	23.08%	15.38%	23.08%	38.46%	23.08%	30.77%	0.00%	30.77%	30.77%
DUNGARPUR	9	0.00%	0.00%	0.00%	11.11%	0.00%	11.11%	0.00%	0.00%	0.00%
Ganganagar	19	0.00%	5.26%	52.63%	15.79%	5.26%	10.53%	5.26%	10.53%	5.26%
Hanumangarh	13	15.38%	0.00%	53.85%	46.15%	15.38%	7.69%	38.46%	23.08%	23.08%
JAIPUR	37	0.00%	2.70%	24.32%	56.76%	10.81%	2.70%	16.22%	21.62%	2.70%
JAISALMER	32	9.38%	34.38%	50.00%	3.13%	28.13%	21.88%	53.13%	56.25%	25.00%
JALORE	10	10.00%	40.00%	30.00%	30.00%	20.00%	30.00%	40.00%	50.00%	30.00%
JHALAWAR	23	17.39%	0.00%	0.00%	43.48%	52.17%	21.74%	4.35%	8.70%	47.83%
JHUNJHUNU	16	0.00%	0.00%	37.50%	12.50%	50.00%	0.00%	12.50%	18.75%	0.00%
JODHPUR	30	6.67%	13.33%	33.33%	6.67%	30.00%	23.33%	26.67%	26.67%	26.67%
KARAULI	15	6.67%	0.00%	13.33%	13.33%	20.00%	0.00%	6.67%	6.67%	6.67%
KOTA	15	0.00%	0.00%	0.00%	6.67%	13.33%	0.00%	13.33%	6.67%	6.67%
NAGAUR	23	17.39%	26.09%	60.87%	8.70%	52.17%	30.43%	34.78%	52.17%	26.09%
PALI	19	5.26%	15.79%	42.11%	21.05%	21.05%	15.79%	5.26%	42.11%	15.79%
PRATAPGARH	9	0.00%	0.00%	22.22%	22.22%	11.11%	0.00%	0.00%	0.00%	0.00%
RAJASMAND	21	19.05%	4.76%	23.81%	33.33%	28.57%	19.05%	14.29%	19.05%	33.33%
S. MADHOPUR	20	15.00%	5.00%	10.00%	35.00%	20.00%	25.00%	15.00%	15.00%	25.00%
SIKAR	18	5.56%	11.11%	27.78%	16.67%	11.11%	5.56%	11.11%	16.67%	11.11%
SIROHI	17	0.00%	11.76%	47.06%	23.53%	17.65%	11.76%	11.76%	11.76%	17.65%
TONK	15	13.33%	6.67%	40.00%	40.00%	26.67%	13.33%	20.00%	33.33%	13.33%
UDAIPUR	23	0.00%	0.00%	8.70%	39.13%	4.35%	0.00%	0.00%	0.00%	4.35%
	684	7.60%	11.84%	29.97%	24.27%	20.61%	17.54%	17.69%	25.29%	20.76%

Table : 9.4 DISTRICT WISE DISTRIBUTION OF MAJOR CONSTUTUENTS (1) WITHIN PERMISSIBLE LIMLIT (2) MAXIMUM PERMISSIBLE LIMIT (3) BEYOND PERMISSIBLE LIMIT IN THE NHS WELLS IN YEAR 2012

District	No. of samples	TDS			TH			Cl			SO4			NO3			Ca			Mg			F			Fe		
		0 to 500	501 to 2000	>2000	0 to 300	301 to 600	>600	0 to 250	251 to 1000	>1000	0 to 200	201 to 400	>400	0 to 45	46 to 100	>100	0 to 75	76 to 200	>200	0 to 30	31 to 100	100	0 to 1	1.01 to 1.5	>1.5	0 to 0.30	0.31 to 1.0	>1.0
AJMER	25	2	17	6	15	3	7	13	8	4	16	4	5	13	7	5	18	5	2	7	13	5	14	4	7	5	10	10
ALWAR	30	7	20	3	15	13	2	24	4	2	26	1	3	20	8	2	23	5	2	11	18	1	15	5	10	18	7	5
BANSWADA	15	3	12		6	9		15			14	1		6	7	2	7	8		8	7		13	1	1	7	3	5
BARAN	17	2	12	3	6	6	5	15	2		13	2	2	9	6	2	9	6	2	4	9	4	14	3		7	2	8
BARMER	33		16	17	8	13	12	5	16	12	13	10	10	12	12	9	15	13	5	5	16	12	14	7	12	27	4	2
BHARTPUR	33	4	14	15	7	14	12	7	18	8	13	9	11	23	6	4	24	8	1	4	16	13	24	3	6	19	7	7
BHILWADA	29	1	22	6	13	10	6	12	14	3	17	9	3	17	7	5	20	7	2	14	11	5	7	2	20	13	5	11
BIKANER	42	9	27	6	20	13	9	23	14	5	28	10	4	34	5	3	25	14	3	15	18	9	23	7	12	31	4	7
BUNDI	12		8	4	3	6	3	7	5		4	4	4	9	1	2	8	3	1	2	8	2	11	1		2	6	4
CHITTAURGARH	10	1	8	1	3	6	1	9	1		9	1		7	1	2	2	7	1	5	4	1	10			4	3	3
CHURU	22		8	14	10	2	10	4	11	7	6	9	7	3	6	13	12	9	1	6	7	9	7	4	11	15	5	2
DAUSA	19	1	12	6	8	6	5	11	7	1	12	4	3	18	2		10	8	1	8	7	4	6	5	8	5	13	1
DHAULPUR	13	4	5	4	8	1	4	8	3	2	11	2		7	3	3	10		3	4	5	4	9	1	3	5	3	5
DUNGARPUR	9	2	7		2	7		9			8	1		9			4	5		2	6	1	7	2		6	2	1
GANGANAGAR	19	9	8	2	13	5	1	15	3	1	14	4	1	16	2	1	17	2		10	7	2	3	6	10	10	6	3
HANUMANGARH	13	2	8	3	5	5	3	9	4		7	1	5	8	3	2	5	6	2	5	8	1	5	1	7	4	3	6
JAIPUR	37	2	27	8	22	14	1	22	14	1	24	7	6	28	5	4	28	9		18	18	1	21	7	9	6	10	21
JAISALMER	32		14	18	7	17	8	4	17	11	9	6	17	19	4	9	17	12	3	3	22	7	5	11	16	25	6	1
JALORE	10	1	4	5	1	6	3	1	5	4	4	2	4	4	4	2	2	7	1	2	5	3	5	2	3	4	3	3
JHALAWAD	23	2	20	2	5	7	11	15	8		18	4	1	8	3	12	6	13	4	3	15	5	20	3		10	3	10
JHUNJHUNU	16	2	12	3	13	3		12	4		12	2	2	8		8	14	2		10	6		7	3	6	12	2	2
JODHPUR	30	2	20	8	10	12	8	9	17	4	14	8	8	12	9	9	15	13	2	6	17	7	14	7	10	24	4	2
KARAULI	15	4	10	1	4	10	1	12	3		13	1	1	7	5	3	5	9	1	6	9		12	1	2	13		2
KOTA	15	4	10	1	9	5	1	12	3		11	2	2	13		2	14	1		3	12		15			7	7	1
NAGAUR	23		11	12	8	9	6	4	13	6	8	7	8	6	5	12	14	5	4	5	11	7	4	5	14	16	5	2
PALI	19	2	9	8	9	7	3	6	10	3	12	6	1	14	1	4	15	3	1	2	14	3	7	4	8	12	3	4
PRATAPGARH	9	2	7		4	5		5	4		7	2		6	2	1	6	3		6	3		6	1	2	3	4	2
RAJSAMAND	21	1	16	4	5	9	7	10	10	1	16	2	3	10	5	6	7	10	4	5	12	4	12	4	5	11	3	7
SAWAI MADHOPUR	20		17	3	8	7	5	12	7	1	10	7	3	10	6	4	11	6	3	7	8	5	14	4	2	8	5	7
SIKAR	18	3	12	3	15	1	2	10	6	2	13	3	2	8	8	2	16	1	1	9	8	1	12	1	5	14	1	3
SIROHI	17		15	2	5	9	3	12	3	2	12	3	2	10	4	3	10	7		1	14	2	8	1	8	9	4	4
TONK	15	1	9	5	9	4	2	12	2	1	6	6	3	9	2	4	12	1	2	8	5	2	8	1	6	3	6	6
UDAIPUR	23	5	18		13	9	1	19	4		21	2		16	6	1	18	5		6	18		15	6	2	10	4	9
TOTAL	684	78	435	173	289	253	142	363	240	81	421	142	121	399	145	141	419	213	52	210	357	120	367	113	205	365	153	166
PERCENTAGE		11.40	63.60	25.29	42.25	36.99	20.76	53.07	35.09	11.84	61.55	20.76	17.69	58.33	21.20	20.61	61.26	31.14	7.60	30.70	52.19	17.54	53.65	16.52	29.97	53.36	22.37	24.27

Table : 9.5a District wise minimum and maximum values pf various chemical constituents based on the chemical andalysis of groundwater samples (NHS) For the year - 2012

District	No. of samples	pH		EC in µS/cm		Total hardnes(as CaCO3) in mg/l		TDS in mg/l		CO3 in mg/l		HCO3 in mg/l		Cl in mg/l		SO4 in mg/l	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
AJMER	25	7.53	8.45	488	12520	114	1370	317.2	8138	0	36	134	1281	29	2968	10	958
ALWAR	30	7.05	8.31	500	12460	100	2030	325	8099	0	180	226	848	25	3128	8	1459
BANSWADA	15	7.38	7.94	630	1525	70	490	409.5	991.25	0	0	183	512	28	121	30	210
BARAN	17	7.02	7.68	660	3630	210	1200	429	2359.5	0	0	268	964	18	714	25	1120
BARMER	33	7.46	8.42	800	47000	139	2400	520	30550	0	120	24	1165	114	9298	13	8862
BHARTPUR	33	7.34	9	330	11950	120	2000	214.5	7767.5	0	144	116	933	18	3500	6	1535
BHILWADA	29	7.3	8.72	255	8500	80	1731	165.75	5525	0	60	104	884	20	2459	30	555
BIKANER	42	7	8.99	300	12670	70	2250	195	8235.5	0	60	49	1037	21	3700	26	622
BUNDI	12	7.45	8.43	1170	5470	200	1090	760.5	3555.5	0	42	244	1000	50	824	80	1289
H	10	7.79	8.2	700	4900	203	1750	455	3185	0	0	240	610	57	888	11	288
CHURU	22	7.31	8.8	932	16160	115	1680	605.8	10504	0	96	250	1153	100	4941	40	2150
DAUSA	19	7.96	8.48	679	4900	150	1350	441.35	3185	0	360	49	427	57	1456	12	694
DHAULPUR	13	7.79	8.64	590	10821	100	2050	383.5	7033.65	0	120	24	671	43	3625	26	284
DUNGARPUR	9	7.94	8.36	657	1700	240	600	427.05	1105	0	0	171	458	57	227	6	210
GANGANAGAR	19	7.28	8.74	330	10100	130	860	214.5	6565	0	84	90	769	7	2960	19	525
H	13	7.62	8.89	560	4420	90	1110	364	2873	0	48	140	1311	18	901	50	640
JAIPUR	37	7.64	8.8	620	7410	60	1270	403	4816.5	0	240	183	1208	21	1392	35	1945
JAISALMER	32	7.92	8.48	900	11600	180	1420	585	7540	0	120	61	537	57	3301	46	2138
JALORE	10	7.91	8.39	700	8054	100	1850	455	5235.1	0	120	146	427	57	1882	74	2168
JHALAWAD	23	7.03	8.1	460	3810	230	1311	299	2476.5	0	0	207	939	21	617	3	414
JHUNJHUNU	16	7.65	8.96	710	3980	80	530	461.5	2587	0	60	238	1043	39	756	65	480
JODHPUR	30	7.29	8.7	470	17770	150	1360	260	11505	0	192	28	2202	28	4880	16	994
KARAULI	15	7.2	8.28	480	4050	190	810	312	2632.5	0	0	140	1043	34	602	50	550
KOTA	15	7.48	8.3	400	3650	130	710	260	2372.5	0	0	135	693	15	730	6	696
NAGAUR	23	7.57	8.6	1075	16730	67	2332	698.75	10874.5	0	36	250	1226	64	3906	37	3654
PALI	19	7.27	8.29	560	6310	130	1110	364	4101.5	0	0	152	1409	71	1284	40	820
PRATAPGARH	9	7.4	8.4	590	1850	110	330	383.5	1202.5	0	12	55	335	100	400	5	245
RAJSAMAND	21	7.36	8.4	480	5850	140	1850	312	3802.5	0	0	213	760	50	1574	30	1100
MADHOPUR	20	7.45	8.53	830	6800	100	1250	539.5	4420	0	96	122	830	35	1917	25	880
SIKAR	18	7.63	8.9	450	5330	100	1410	292.5	3464.5	0	120	185	1169	28	1153	5	870
SIROHI	17	7.35	8.42	780	5250	210	1031	507	3412.5	0	12	171	590	30	1361	60	755
TONK	15	7.15	8	620	7560	130	1400	403	4914	0	0	281	900	28	1732	80	1090
UDAIPUR	23	7.4	8.75	660	2170	160	620	429	1410.5	0	48	120	659	53	326	30	230

Table : 9.5b District wise minimum and maximum values pf various chemical constituents based on the chemical andalysis of groundwater samples (NHS) For the year - 2012

District	NO3 in mg/l		Ca in mg/l		Mg in mg/l		Na in mg/l		K in mg/l		F in mg/l		Fe in mg/l		SiO2 in mg/l		PO4 in mg/l	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
AJMER	1.7	374	9	320	19	192	29	2419	1.4	37	0.2	8.3	0.18	12	9.9	29.2	0.024	6.12
ALWAR	7	150	12	332	15	292	35	2492	0.08	15	0.125	4.09	0.02	6	6.2	41.3	0.01	0.56
BANSWADA	8.9	150	16	124	4.9	55.9	45	210	0.4	42	0.09	1.65	0	3.6	10	21	0	0.18
BARAN	5	158	32	268	12	165	21	493	1	70	0.3	1.42	0.02	6.9	11	32	0.03	3
BARMER	0.01	278	29	380	13	352	51	9280	1.3	516	0.1	6.5	0	9.45	10	44	0	2.025
BHARTPUR	3	145	8	500	19	421	20	2200	0.7	230	0.1	4.25	0.01	7	7.6	72	0.03	2.89
BHILWADA	2	200	12	300	9.7	319	12	1370	0	60	0.3	6.9	0.028	6.2	10	37	0	1.3
BIKANER	1.26	528	16	500	2.4	243	17	1928	0.1	102	0.145	3.115	0	9.42	10	27	0	0.084
BUNDI	0.68	350	28	276	24	141	92	1210	0.5	94	0.12	1.36	0.05	4.45	12	36.1	0	0
CHITTAURGARH	0.9	518	56	280	13	255	18	322	1.7	20.6	0.21	0.868	0.028	4.08	12	1815	0.01	0.4
CHURU	30	1100	28	210	8.5	281	78	4160	3	177	0.08	5	0.01	2.51	10	52	0.01	0.6
DAUSA	0.27	47.08	24	240	9.7	243	18	732	1	18.1	0.07	4.21	0.02	5.09	11	23	0.004	0.08
DHAULPUR	0	584	8	360	9.7	280	36.3	1572	0.3	779	0.027	1.83	0.06	4.91	11	22	0.003	0.09
DUNGARPUR	1.71	35.63	40	112	9.7	102	40	110	1.6	24.9	0.061	1.403	0.012	3.82	10	24	0.002	0.08
GANGANAGAR	1	140	12	124	12	134	20	1855	1	213	0.9	2.86	0.05	2.65	5	32	0.01	6.4
HANUMANGARH	7	278	24	277	7.3	102	20	829	8.5	227	0.3	6.5	0.001	5.8	8.7	31	0.06	3.2
JAIPUR	0.23	420	12	168	4.9	207	24	1550	0.8	29	0.1	4.2	0.06	12.5	8.7	31	0.02	0.17
JAISALMER	0.01	2472	36	280	19	214	44	2255	3.1	448.5	0.856	3.46	0.005	1.72	10	22	0.004	4.96
JALORE	0.08	200	16	360	15	231	20	1420	0.1	56.3	0.173	2.013	0.001	7.66	9.6	35.2	0.036	0.3
JHALAWAD	3.2	645	24	240	9.7	239	16	375	0.4	90	0.32	1.42	0.05	4.1	5	29	0.03	1.2
JHUNJHUNU	6	275	13	125	9.1	89.4	113	797	3	32	0.2	3.2	0	4.07	8.7	36	0	1.74
JODHPUR	8.58	650	21	283	10	193	19	3900	0.1	98	0.2	4	0	3.5	10	48	0	6.42
KARAULI	9	440	40	216	6.1	68.1	32	700	1	101	0.29	2.85	0.04	2.6	8	32	0.03	0.48
KOTA	5	125	28	192	15	94.8	12	608	1	61	0.12	0.95	0.1	6.2	7	37	0.02	0.95
NAGAUR	5	520	13	557	8.4	398	150	3320	4.4	58	0.9	8.6	0	4.32	7.2	46	0	0.72
PALI	3.26	230	3	265	24	182	60	1270	1.6	26	0.3	5.9	0	2.7	6.3	30	0	4
PRATAPGARH	7	127	20	120	2.4	60.8	58	347	3.4	21	0.3	1.9	0.05	2.9	8.1	36	0.05	1.2
RAJSAMAND	9	400	44	276	7.3	285	18	720	5	70	0.2	5	0.03	2.6	8.1	29	0	1.2
MADHOPUR	2.75	750	16	300	12	163	40	825	0.4	292	0.084	2.345	0	13.7	9.7	32	0	0.5
SIKAR	25	283	9	249	12	192	15	1037	3	98	0.3	3.2	0	3.92	7	38	0	0.3
SIROHI	2	400	15	139	15	166	60	914	1	8	0.23	3.2	0.05	2.5	7	30	0.02	3.1
TONK	5.4	300	20	248	12	190	59	1130	1.5	148	0.09	4.2	0.09	3.41	8	29.8	0	0.22
UDAIPUR	7	117	16	172	9.7	85.1	30	380	3.7	203	0.08	3.4	0.05	3	8.1	32	0	0.32

9.2 Chemical Quality of Ground Water

In general the quality of ground water is dependent upon many factors like mineral composition of the water bearing formations, salinity ingress, all types of pollution like industrial, agricultural and other sources. For the beneficial use of water its purity is essential otherwise it may affect human health adversely. The quality of water depends on its physical and chemical properties. Physical properties include color, smell, transparency which can be determined by our senses. The chemical properties depend on the nature & quantity of various chemical constituents individually or jointly.

9.2.1.Total dissolved Solids (TDS) -

In drinking water total dissolved solids are made up primarily by inorganic salts with small concentration of organic matter. Major contribution to TDS in water is the natural contact with rocks and soils with minor contribution from pollution. In drinking water if the TDS value exceeds 2000 mg/L, definite laxative effects are observed in those not accustomed to such salinity.

Table- 9.2 shows that 11.40% of hydrograph stations monitored have TDS value within desirable limit, 63.60% stations have values within maximum permissible limit and rest 25.29% stations have TDS value beyond permissible limit of 2000 mg/l. From **Table- 9.3** it is evident that in Barmer, Churu, Jaisalmer, Jalore and Nagaur districts high TDS values have been observed as more than 50 % stations while in Bharatpur, Bundi, Dausa, Dhaulpur, Pali and Tonk districts 30 to 50 % of stations have TDS values beyond permissible limit. The minimum value of TDS in the state has been found at Salawatia (Bhilwada) as 165.75 mg/L and maximum value as 30550 mg/l at Bisukalan of Barmer district.

9.2.2.Electrical conductivity (EC) -

Electrical Conductance is the ability of a substance to conduct an electric current. Chemically pure water in liquid form has a very low conductance. The presence of dissociated ions in solution, however renders the solution conductive. Therefore, E.C. of a solution gives an idea about the quantity of ions or dissolved solids present in it.

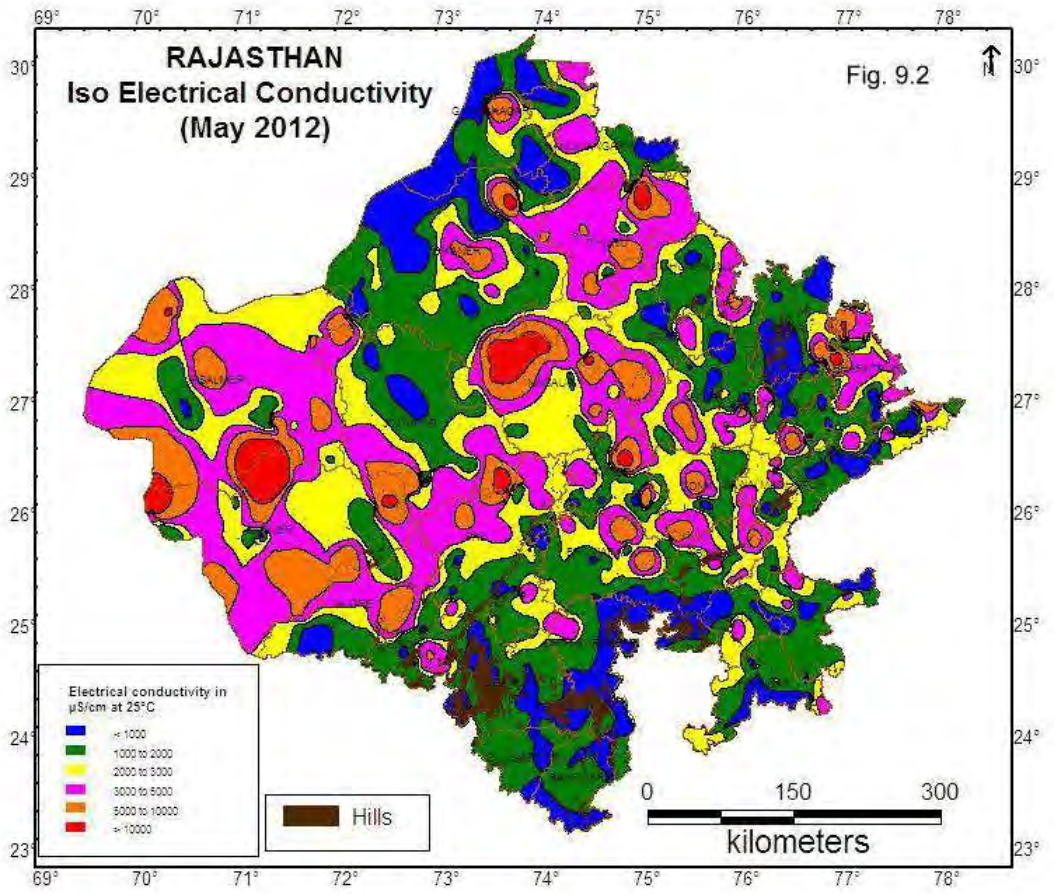
About 34% (1,18213 sq km, Fig. 9.1) of area of Rajasthan falling in the electrical conductivity more than 3000 µS/cm. The EC ranges from 255 to 47,000 µS/cm (**Fig.9.2**). Maximum part to the state (43%) observed electrical conductivity within 2000 µS/cm. Most of the Western and Central parts of the state experienced the electrical conductivity more than 3000 µS/cm. Small isolated patches of electrical conductivity less than 1000 µS/cm are scattered in whole State. Electrical conductivity more than 10000 µS/cm is found mostly in Central and Western part of the State.

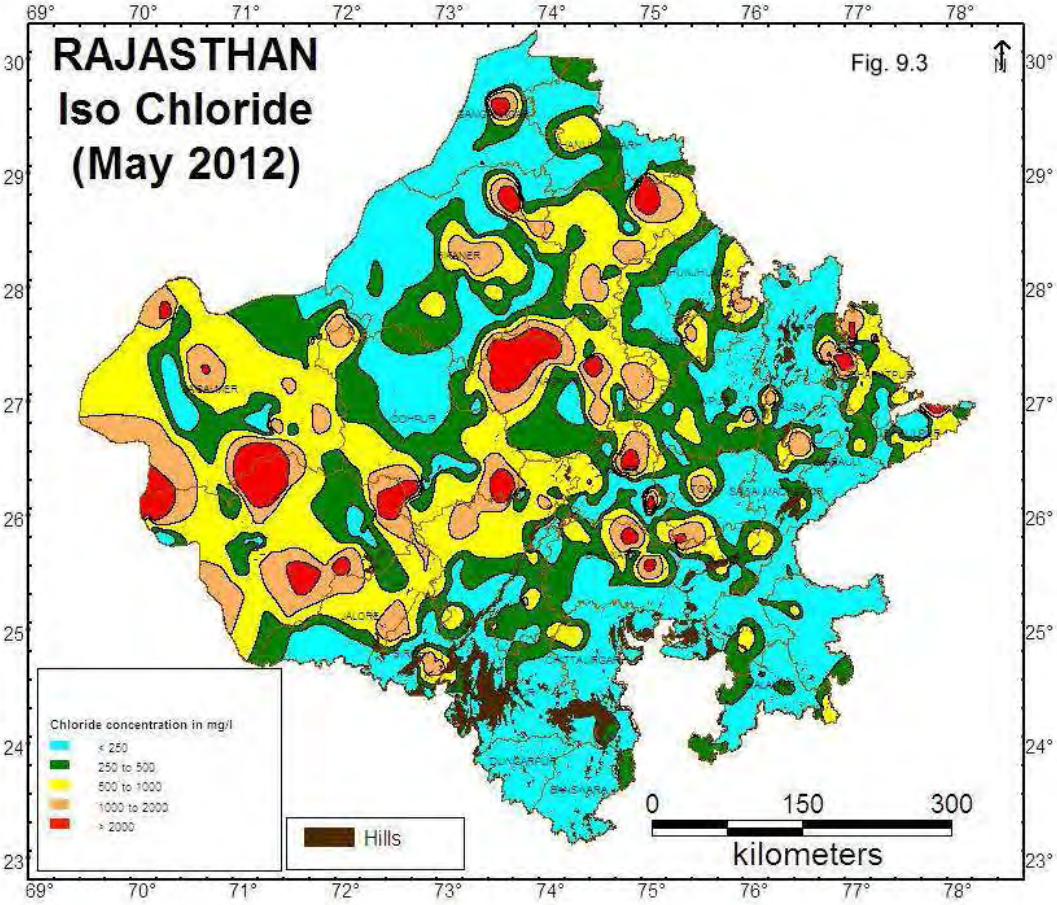
9.2.3 Chloride (Cl) -

It is one of the most common constituent present in natural water and remains soluble in water unaffected by biological processes therefore reducible by dilution. Sea water intrusion and natural mineral origin can also be a cause of high chloride content. Industrial effluents (galvanizing plants, water softening plants, oil wells, refineries and paper works) may also leach into ground water. Sewage effluents contain a larger concentration of Chlorides.

Chloride ions have some functions in the body. The tolerance limits of chloride vary with climate and excretion. It is the cation associated with chloride that has usually harmful effects on human body. Individual affected by heart and kidney disease should restrict water consumption with a high chloride concentration.

In perusal of map (Fig 9.3) reveal that most of the South- eastern half of the State observed Chloride less than 250 mg/l. Chloride more than 2000 mg/l are shown in isolated patches scattered mostly in Central and Western parts of the State. Area covered (Fig.9.1) by Chloride value more than 1000 g/l is 14%(45613 sq km) and less than 250 mg/l is 37% (131145 sq km) in the State. Out of 684 water samples analysed only 11.84% have chloride value beyond permissible limit of 1000 mg/L and rest 53.07% and 35.09% samples have values within desirable and maximum permissible limit (Table – 9.2) respectively. More than 30% of stations recorded Cl beyond permissible limit of 1000mg/l in the districts of Barmer, Churu, Jaisalmer and Jalore. In the districts of Banswara, Baran, Bundi, Chittourgarh, Dungarpur, Hanumangarh, Jhalawar, Jhunjhunu, Karauli, Kota, Pratapgarh and Udaipur have no


RAJASTHAN
Iso Electrical Conductivity
(May 2012)
Fig. 9.2
Electrical conductivity in µS/cm at 25°C
< 1000
1000 to 2000
2000 to 3000
3000 to 5000
5000 to 10000
> 10000
Hills
0
150
300
kilometers


RAJASTHAN
Iso Chloride
(May 2012)
Fig. 9.3
Chloride concentration in mg/l
< 250
250 to 500
500 to 1000
1000 to 2000
> 2000
Hills
0
150
300
kilometers

station recorded chloride value beyond permissible limit of 1000 mg/l (Table –9.3)

The maximum value of chloride in the state as 9298 mg/l has been found at Bishu Kalan of Barmer district and minimum value as 7 mg/l has been found at Piperan in the districts of Ganganagar.

9.2.4. Sulphate (SO_4) -

Sulphate are found in natural water in the final oxidized state of sulphates, Sulphide and thiosulphates or in the oxidized state of organic matter in the sulphur cycle. In all cases as a product of pollutional sources related to mining or industrial wase. Detergent add Sulphate to sewarage. Tanneries, steel mills, textile plants may also contaminate water. Sulphate ions when associated with high concentration of Magnesium and Sodium ions act as laxative and may cause gastic disorders.

Table- 9.2 shows that 61.55% of stations have sulphate value within desirable limit. Only 20.76% stations have sulphate value within maximum permissible limit. Rest 17.69% of stations have Sulphate value beyond permissible limit of 400 mg/l. 40% and more stations recorded Sulphate beyond permissible limit of 400 mg/l in the districts of Jaisalmer and Jalore. In the districts of Banswara, Chittourgarh, Dhaulpur, Dungarpur, Pratapgarh and Udaipur have no station recorded Sulphate value beyond permissible limit of 400 mg/l (Table –9.3)

The minimum and maximum values of sulphate in the state are as follows-

Minimum – 3 mg/l at Jhiri of Jhalawar district, Maximum – 8862 mg/l at Bishukalan of Barmer district.

9.2.5. Nitrate (NO3) -

Sources of Nitrate are mineral deposits (sodium and potassium nitrates) , soils, sea water and atmosphere. Nitrate is used as a fertilizer, as a food preservative and as an oxidizing agent in the chemical industries . Higher concentrations are expected where fertilizers are used, in decayed animals and vegetable matter, in leaches from sludge and refuge disposal and in industrial discharges.

Higher concentration of nitrate causes mathaemoglobinaemia disease in bottle fed infants (3 months old). Gastrointestinal disorders are also found. It may also have adverse effect on central nervous and cardio vascular system.

Churu, Jhalawad and Nagaur districts are much affected with nitrate concentration as more than 10 no. of stations have nitrate values beyond permissible limit (**Fig. 9.4 and Table- 9.4**). Around 58.33% of stations have nitrate values within desirable limit & 21.20% of stations are within maximum permissible limit & rest 20.61% stations have value beyond permissible limit in the State(Table – 9.2).

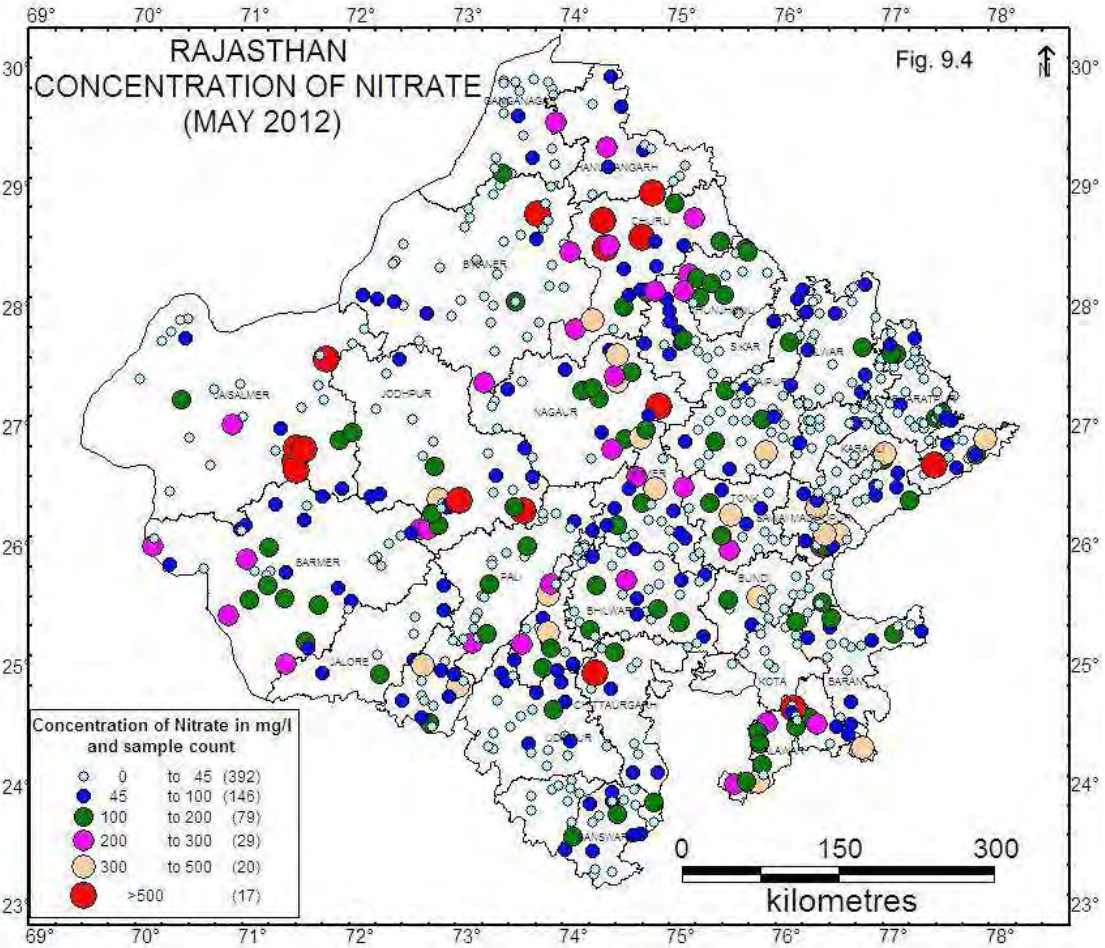
More than 30% of stations have recorded Nitrate concentration beyond permissible limit in the districts of Barmer, Churu, Jaisalmer, Jhalawar Jhunjhunu and Nagaur. The maximum value of nitrate in Rajasthan has been observed as 2472 mg/L in Jaisamer district.

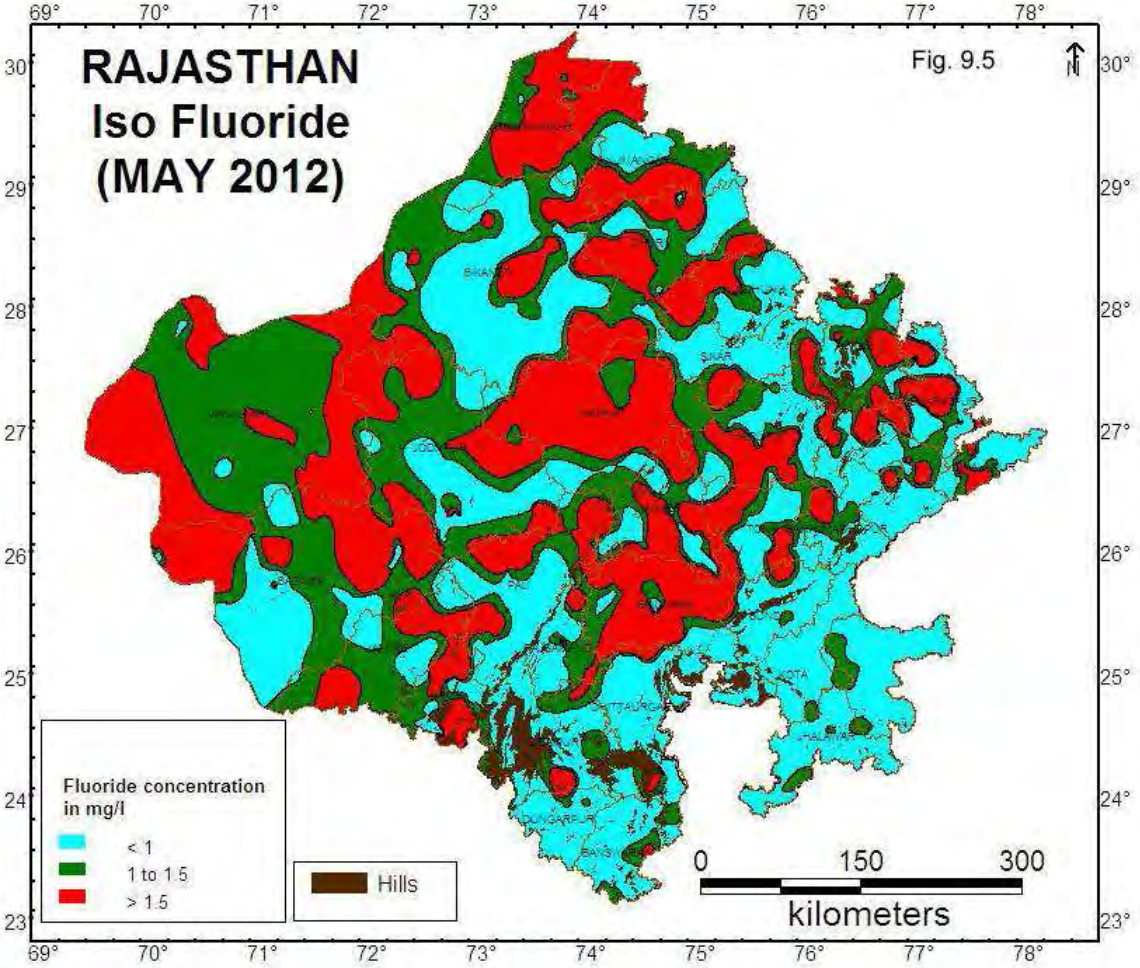
9.2.6.Fluoride (F)-

Fluoride is as inherent component of igneous rocks. The main sources of fluoride in natural water are fluorite (CaF2) ,Cryolite(Na2AlF2), Fluorapatite. In minerals like mica, amphilaiboles and topaz etc, the fluoride ions are bound on the mineral surfaces. Food in the diet is the major source of fluoride. Tea contain high fluoride concentration.

Fluoride reduces dental carries, very high concentration may cause crippling skeletal fluorosis in human body. Less than 1.0 mg/L is essential.

Occurrence of high fluoride in the ground water of Rajasthan is a great concern as 29.97% of 684 ground water samples collected for chemical analysis occupied 32% (111045 sq. km) area shows fluoride value beyond maximum permissible limit of 1.5 mg/L (**Fig. 9.1, Fig. 9.5 and Table 9.2**). Around 53.64% and 16.52% of stations are within desirable and maximum permissible limit respectively. The districts of Bhilwara, Churu, Dausa, Ganganagar, Hanumangarh, Jaisalmer, Nagaur, Pali Sirohi and Tonk are worst affected districts with fluoride contamination where more than 40% of stations have fluoride value greater than 1.5 mg/L. Min. 0.027mg/l fluoride has been observed at Sikronda of Daulpur district and the maximum value of 8.60 mg/L has been observed at Kitalsar of Nagaur district.


RAJASTHAN
CONCENTRATION OF NITRATE
(MAY 2012)
Fig. 9.4
Concentration of Nitrate in mg/l and sample count
0 to 45 (392)
45 to 100 (146)
100 to 200 (79)
200 to 300 (29)
300 to 500 (20)
>500 (17)
0 150 300
kilometres


RAJASTHAN
Iso Fluoride
(MAY 2012)
Fig. 9.5
Fluoride concentration in mg/l
< 1
1 to 1.5
> 1.5
Hills
0 150 300
kilometers

9.2.7 Total Hardness -

It is primarily determined by sum of calcium and magnesium ions expressed as calcium carbonate. Other substances such as iron, manganese, aluminium, strontium, zinc may also contribute to a very small extent due to low solubility.

An inverse correlation between hardness of water & cardiovascular diseases (heart, hypertension and stroke) has been shown. High values may cause calcification of arteries, urinary concretions and stomach disorder.

Table- 9.2 shows that 42.25% of stations are within desirable limit of 300 mg/ l. Only 20.76 % of stations have value beyond permissible limit of 600 mg/L.

Churu and Jhalawad are worst affected districts where more than 40% stations have Total Hardness value beyond permissible limit. In Banswara, Dungarpur, Jhunjhunu and Pratapgarh districts have no sample where Total Hardness value beyond permissible limit.

The minimum value of hardness as 60 mg/L has been found at Bassi of Jaipur district. The maximum value has been observed as 2400 mg/L at Bishukalan of Barmer district.

9.2.8 Calcium (Ca) –

It is always found in combination in limestone, marble and chalk. Its most common compounds are limestone, gypsum, fluorite; also calcium carbide, chloride, hypochlorite.

Calcium is essential for human body. Its low content in soft water has been linked with rickets & defective teeth. Its excess may cause stones in kidney or bladder. Gout, Rheumatism etc. are also linked with its high concentration.

There is no cause of concern about the calcium hazard as only 7.60% of stations are beyond the permissible limit of 200 mg/L (**Table - 9.2**). The districts of Banswada, Dungarpur, Ganganagar, Jaipur, Jhunjhunu, kota, pratapgarh, Sirohi and Udaipur do not have calcium value beyond permissible limit.

The minimum value of calcium has been observed as 3.0 mg/L at Pali in Pali district. The maximum value as 557 mg/L has been found at Barani in Nagaur district.

9.2.9 Magnesium (Mg) -

It is never found as a free element. It constitutes a large deposit as magnesite & common rock forming dolomite.

The presence of magnesium is beneficial for heart & nervous system. However higher concentrations have laxative and diuretic effect.

Only 17.54% of stations have magnesium value beyond permissible limit of 100 mg/L & rest are within desirable (30.70%) and maximum permissible limits (52.19%). No station found in the district of Banswara, Karauli, Kota, Pratapgarg and Udaipur have magnesium value beyond permissible limit. In Churu 40.91% of the sample have Mg value beyond permissible limit. The minimum value of Mg as 2.43 mg/L has been found at Malkisar Bikaner district) and at Mahada (Pratapgarh dist.) and maximum value 420.79 mg/L at Nigohi of Bharatpur district.

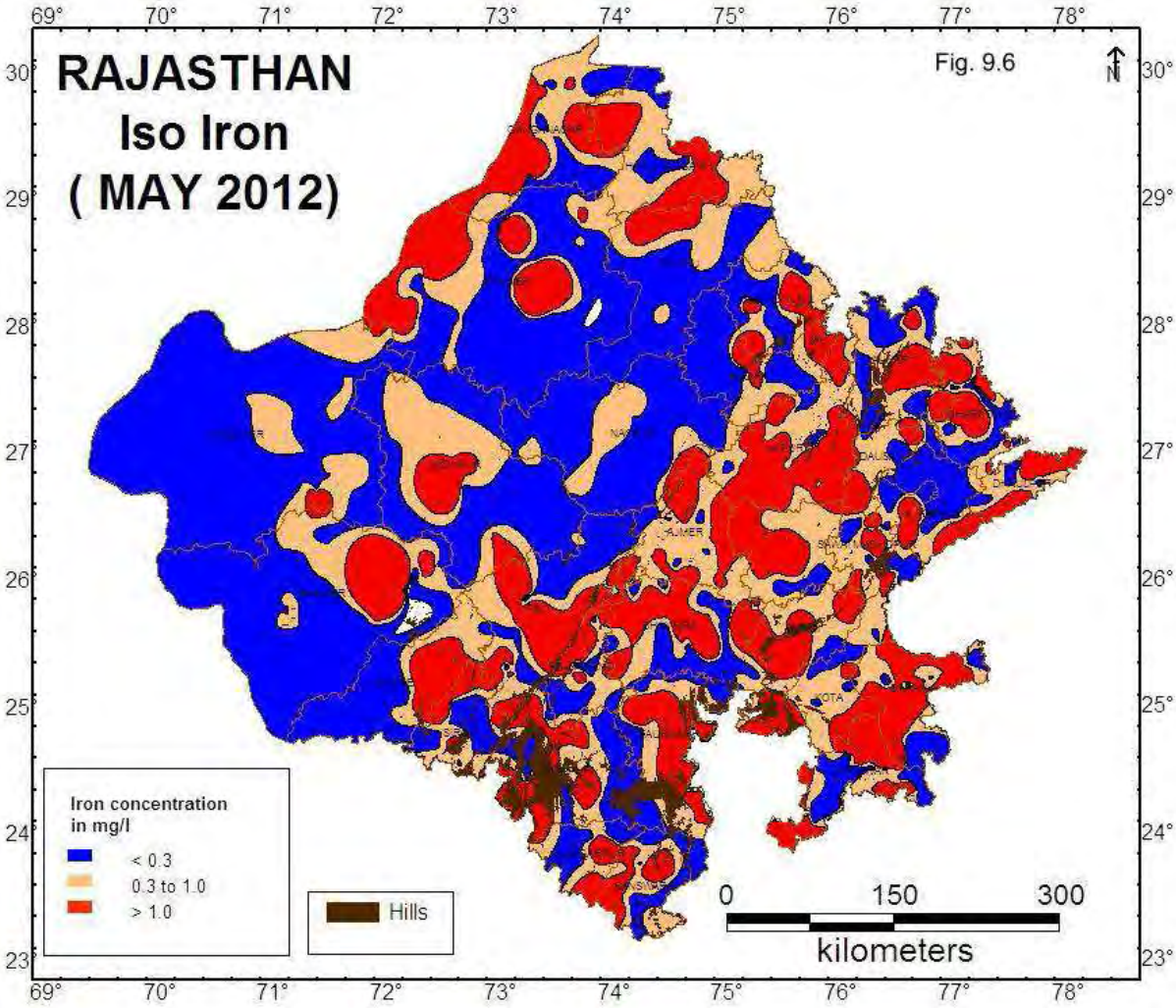
9.2.10 Iron (Fe) -

Common ores of iron are Hamatite, Magnetite, Limonite, Diderate and Pyrite. Leaching of iron salts (acid mine drainage) & iron products industrial waste may be a pollutional source.

Iron is an essential element in human nutrion. Excess of iron may cause bitter sweet astringent taste to water.

Out of 684 water samples analysed 24.27% of samples have iron value beyond the permissible limit of 1.0 mg/L & 53.36% samples are within desirable limit of 0.3 mg/L and rest 22.37% are within maximum permissible limit (0.31to 1.0 mg/L). In the districts of Ajmer, Baran, Hanumangarh, Jaipur, Jhalawad and Tonk 40% stations have recorded much iron contamination in ground water.

Minimum value of iron as 0.0 mg/L has been observed at various districts of Banswara, Barmer, Bikaner, Jhunjhunu, Jodhpur, Nagaur, Pali, S. Madhopur and Sikar and maximum value of 13.7 mg/L at Khandar of S. Madhopur district.


RAJASTHAN
Iso Iron
(MAY 2012)
Fig. 9.6
N
69°
70°
71°
72°
73°
74°
75°
76°
77°
78°
30°
29°
28°
27°
26°
25°
24°
23°
Iron concentration
in mg/l
< 0.3
0.3 to 1.0
> 1.0
Hills
0
150
300
kilometers