केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report

on

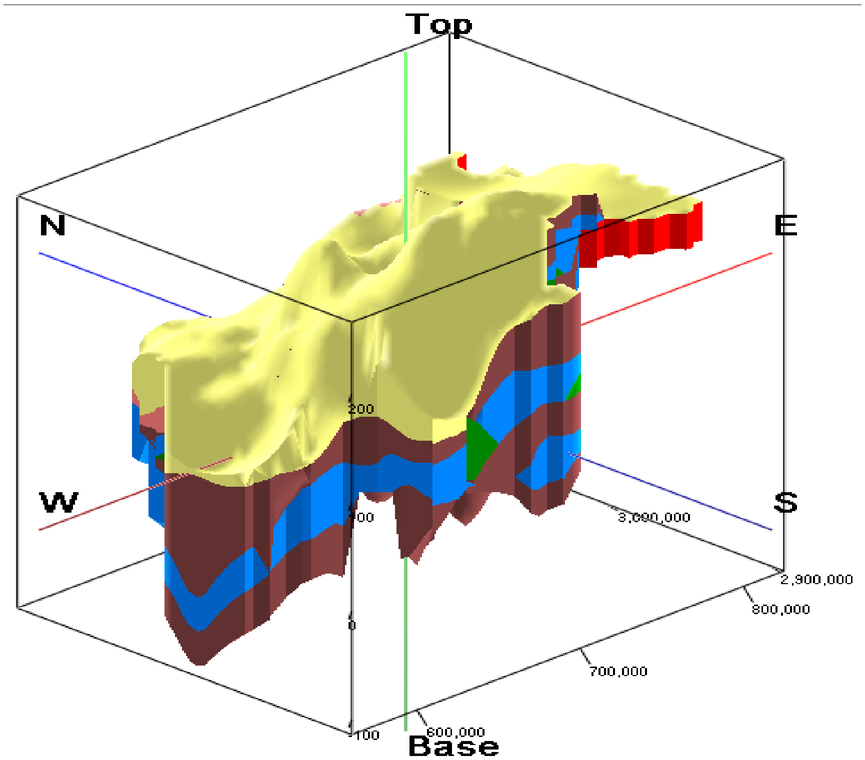
AQUIFER MAPPING AND GROUND WATER MANAGEMENT

Jaisalmer District, Rajasthan

पश्चिमी क्षेत्र जयपुर

Western Region, Jaipur

Report on
AQUIFER MAPPING AND GROUND WATER MANAGEMENT
DISTRICT JAISALMER, RAJASTHAN
(UNDER XII PLAN)



CENTRAL GROUND WATER BOARD
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVANATION
GOVERNMENT OF INDIA
WESTERN REGION, JAIPUR

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(Based on Available Data)

District Jaisalmer, Rajasthan

1. Introduction

1.1 Objectives

Various developmental activities over the years have adversely affected the groundwater regime in the state. There is a need for scientific planning in development of groundwater under different hydrological condition and to evolve effective management practices with involvement of community for better ground water governance. In view of emergent challenges in the ground water sector in the state, there is an urgent need for comprehensive and realistic information pertaining to various aspects of groundwater resource available in different hydrological setting through a process of systematic data collection, compilation, data generation, analysis and synthesis and interlinking of data. Hence, aquifer mapping of the study area is the need of the hour.

1.2 Scope of the Study

Aquifer mapping can be understood as a scientific process wherein a combination of geological, Geophysical, hydrological, chemical (fields and laboratory) analysis are applied to characterized the quantity, quality and sustainability of ground water in aquifers. Aquifer mapping is expected to improve our understanding of the geological framework of aquifer , their hydrologic characteristics, water level, aquifer and water level changes over time and space , and effect of natural and anthropogenic contaminants, affecting the potability of ground water .Results of these studies will have contribution on tools of resource management such as long term aquifer monitoring network and conceptual and quantitative regional ground water flow models used by planners , policy makers and stake holders. Aquifer mapping at appropriate scale can help to prepare, implement and monitor the efficacy of various management interventions aimed at long term sustainability of our precious ground water resources, which in term will help to achieve solution for domestic water scarcity, improved irrigation facilities and sustainability of precious water resource in the state.

1.3 Prevailing Water Conservative Practices

There are age old traditional water conservative practices in the district which includes construction of tanka, village pond of limited storage, Khadin and conventional baories (Dug wells). As the district is a part of great Indian Thar desert covered by sandy horizon lacking rainfall and characterized by scanty rainfall. Surface runoff rarely generate on the sandy horizon, only in stormy intense rainfall periods surface runoff is generated on the stony and impermeable strata and is collected on topographical depressions during stormy rainfall days .

1.4 Approach & Methodology

Aquifer mapping is thus an attempt to integrate the geological, geophysical, hydrological and chemical analysis to characterized the quality, quantity and sustainability of groundwater in aquifer.

1.5 Data Gap

To fill the data gap of information data was collected from state government department (GWD). This report has been prepared under the Annual Action Plan for 2016-17 under the programme of issuing district wise reports for the whole of country by Central Ground Water Board. The available hydro geological, hydro meteorological and hydro chemical data of the Jaisalmer district was compiled processed and presented in this report. The present ground water resources estimates have been taken from the report of estimates for 2013 made by Ground Water Department, Rajasthan.

1.6 Location and Extent

Jaisalmer district lies in the western portion of the state between 26◦04' and 28◦08' north latitude and 69◦30' to 72◦20' east longitude covering 38401 sq.km. of area. Towards north and west the district is bounded with international boundary with Pakistan and towards south and east lies Jodhpur and Barmer and north east by Bikaner district of the State.

1.7 Administrative Divisions of the District

The district has been administratively divided into four tehsils as per 2011 Census data namely Jaisalmer, Pokaran, Bhiniyana and Fatehgarh. There are 16 ICR circles 117 Patwar Circles and 799 revenues villages. For developmental purposes, the district has been divided into three blocks; Jaisalmer, Sam and Sankra. The administratiove set up of district is given in Table 1.

Table 1: Administrative set up of the district

Panchayat Samity	No .of gram Panchayat	No. of villages
Jaisalmer	40	236
Sam	49	335
Sakra	39	228
Total in the district	128	799

1.8 Land Use Pattern

The table 2 shows the land use pattern of the Jaisalmer district.

Table 2: Land Use Pattern (in Hectares)

Forest	Hillocky	Barren land (Not suitable for agriculture)	Fallow land (Kept for non agricultural purpose)	Land for fodder (Pasture)	Land for agriculture and horticulture use
27400	107842	267699	197361	84594	1946245

1.9 Demography of the District

The total population of the district is 6,69,919 as per Census, 2011.. The demographic data is shown in table 3.

Table 3: Demography of Jaisalmer district (2001 & 2011 Census data)

Census Year	2001	2011
Population	508247	669919
Male	279,101	361708
Female	229147	308211
Population Growth (%)	24.39	31.81
Density	13	17

1.10 Climate

Jaisalmer district has arid climatic conditions, characterized by low precipitation, high evaporation and evapo-transpiration. There are 5 rain gauge stations in the district. The average annual rainfall in the district during the period 1901 to 2006 works out to be 184.34 mm, however the actual average annual rainfall recorded during 2015 is shown in table 4.

Table 4: Rainfall Data of Jaisalmer district (2015)

Station	Jaisalmer	Pokaran	Ramgarh	Sam	Nokh	Fatehgarh
Rainfall during the year 2015	497.5	485.0	198.0	133.0	460	207
Rainfall range (mm.)	17 to 532.2	26 to 459	2 to 326.6	4.8 to 633.5	45 to 522	0 to 518
% Departure from average rainfall	(-) 91.2 to 175.18	(-)85.45 to 156.85	(-)124.6 to 200	(-) 97.00 to 295.69	(-) 74.53 to 195.41	(-) 100 to 244.41
Average rainfall (mm.)	193.41	178.7	126.61	160	176.71	150.41

The mean minimum and maximum temperatures are 2°C and 45°C in winters and summer, respectively. Winds are very active during April to June resulting in to transportation and shifting of sand dunes. There are 5 rain gauge stations in the district. The detail data analysis of these rain gauge stations are given in table 5.

Table 5: Monthly rate of evaporation and evapo-transpiration (mm)

Month	Evaporation	Evapo-transpiration
January	108.0	70.6
February	134.0	91.6
March	232.0	153.2
April	324.00	203.5
May	388.0	281.0
June	349.0	313.4
July	349.0	247.6
August	297.00	210.7
September	251.00	192.0
October	210.0	147.0
November	140.00	83.7
December	107.00	64.1
Total	2768.0	2062.4

1.11 Cropping Pattern in the District

The cropping pattern of Jaisalmer district is given in Table 6.

Table 6: Cropping Pattern of Jaisalmer District

Kharif Crops			Rabi Crops		
	Irrigated	Unirrigated		Irrigated	Unirrigated
Jawar	10	1902	Wheat	10887	1555
Millet	6013	65349	Barley	26	0
Moth	197	153	Gram	127983	3634
Green Gram	6231	1120	Bejad	0	143
Sesamum	1126	671	Rai	0	12
Ground Nut	15334	72	Taramira	41	194
Castor	5034	2	Mustard	26325	212
Sun Flower	0	177	Rayda	18741	976

Kharif Crops			Rabi Crops		
Cotton	278	0	Castor	5	0
Gwar	31263	494528	Rajka	51	0
Jwar-Fodder	6	0	Cuminseed	38940	43
Vegetables	232	0	Coriander	14	7
Gwar Patha	47	0	Sauf	38	0
Chilli	4	0	Methi	743	0
Total	65775	563974	Isabgole	36247	7
Source :- Land Records District – Collector (Jaisalmer)			Vegetable	86	0
			Sunflower	0	5
			Fodder	22	0
			Total	260149	6788

1.12 Irrigation Statistics

The irrigated area under different sources of irrigation is shown in table 7

Table 7: Irrigated area under different sources

Canal	Pond	Tube wells	Wells	Other sources	Total irrigated area	Non irrigated area
210880	00	129732	1632	18	342262	685600

It is observed that at present about 38.38% area of total irrigation is done by ground water and about 61.61% area is irrigated by canal (IGNP)) Most part of the area which use ground water for irrigation are underlain by Lathi formation, other formations are occasionally used for irrigation. The blockwise irrigated area under different sources is given in Table 8.

Table 8: Blockwise irrigated area under different sources

Block	Canal (area ha)	Ground water (Area- ha)	Total (ha)
Jaisalmer	149996	45290	195286
Sam	60884	32127	93011
Sakra	0	53963	53963

Total	210880	131380	342260

(Source: Land record section, Collectorate: Jaisalmer)

The statistics of abstraction structures in the district are given in Table 9.

Table 9: Statistics of Abstraction Structures in the district

Electrified Tube wells	Diesel operated Tube wells	Total Nos. of Tube wells	Electrified dug wells	Diesel pump operated Dug wells	Fitted with Rahat
5342	42	5390	1879	35	13

1.13 Drinking Water Sources in the District

As there is no uniformity in the distribution of potential aquifer with potable water zig-zag and localized distribution of surface water. The domestic and drinking water in the district is supplied either through canal or from potential aquifers containing potable water from pipe lines. Pond water is also utilised for domestic purposes and tanker water is purchased by individuals at very high rate. Generally tankers fetch domestic water from the tube wells of PHED through own tankers.

1.14 Physiography

Most part of the district is covered by a sheet of sand dunes but around Jaisalmer there are series of ridges and rocky Plateau. Physiographic set up of the district can be divided in to 4 categories. Valleys, Plains Hills and Hillocks and low elevated Plateau. The major part of the district is dissected plain bordered by valleys.

(i) The Northern and western part along international border is highly dissected forming narrow valleys and itself is a part of valley. Western, Northern, North-eastern belt running parallel to the district boundary is covered mostly by thick layers of windblown sand forming undulating topography. The trend of sand dunes is NE-SW with the apex towards north east. Dunes are longitudinal and at rare places (Barchans) parabolic in nature. They form a low lying undulating valley and among them dunal ridges with intervening valley like structure is found with low depth. A narrow valley is also seen in the central south western part which continues towards south in the adjoining Barmer district.

(ii)The area bordering the Dunes covered by Hard Rock pan forming in the major part of the area north of the district head quarter and adjoining areas running approximately east- west , forming relict and residual geomorphic units of mesa , and buttes and forms an undulating plain. The mesa like geomorphic units show scarp exposed in south or west direction.

Hilly and Hilocky: Hills and hillocks of low elevation are seen south of Jaisalmer. This hillocky area is highly dissected forming high hillocks and mounds. This elevated ridge also extends in NW-SE direction north of Jaisalmer.

Central plains: The central region comprises of rocky exposures of consolidated hard and semi consolidated rocks with stony waste material and occasionally covered by hard and compact stony pan. This plain shows gentle slope.

In the south central part a low altitude dissected Plateau with gentle slope and flat lying area with occasional parallel ridges, exist which is covered with scattered or continuous windblown sand dunes small valley fill bounded by scarp of low elevation, or scattered mesas. This low elevated plateau continues towards further south in Barmer district and is surrounded by narrow valley on the west. The south- eastern region forming comparatively flat topography as small mound or Table land flat plain .

1.15 Topography and Drainage Pattern

Topography in the district is highly variable but in major parts it is undulatory plain, around Jaisalmer it is hillocky, uneven and dissected. In other parts, especially along borders it is uneven with sheet of dunal sand. In dunes parallel ridges exist among these ridges narrow valleys are found. The elevation in general decreases from south to north or north west .The highest elevated area exist at Randha (368m.) in southern parts near to Barmer district border. But in western parts of the district the general elevation decreases towards west and in north eastern parts towards north east.

Drainage in major parts is internal only in few rocky exposures near Jaisalmer , Ramgah and around chandan and sakra where it is dendritic to sub parallel(Ramgarh area)The major streams are Ghughari, sukri Ramgarh etc which are ephemeral in nature . Small rivulets lost in sand dunes towards there flow path.

1.16 Vegetation

The area lacks vegetative cover specially that area which is covered by dunes. In other parts sparse vegetation is observed in the form of small bushes and other xerophytes in which major species is acacia. Government (Forest department) is engaged in plantation of acacia on sand dunes.

2. Aquifer System

2.1 Geological set up of District

The district registers rocks from age group Precambrian to recent age. The geological set up of the district is given in Table 10.

Table 10: Geological set up of district

Major group	Age	Formation group	Lithology
Quaternary	Recent ,Sub Recent	Aeolian sand Alluvium	Sand dune and wind blown sand
	Holocene to Pleistocene	Shumar formation	Sand stone with, Quartzite, pebbles, conglomerate, calcareous and ferruginous

Major group	Age	Formation group	Lithology
			sand stone, Limestone, clay
Tertiary	Eocene	Bundah formation	Lime stone, shale with sand stone, clay stone , Clays
		Khuiyala formation	Lime stone, shale with sand stone
	Paleocene	Sanu formation	Sandstone, shale
Mesozoic	Cretaceous	Habur formation	Lime stone, shale, sand stone, clay
	(Jurassic)	Parewar formation	Sandstone with shale
		Bhadesar formation	Sand stone and shale
		Baisakhi formation	Shale with thin beds of sand stone
		Jaisalmer formation	Lime stone and shale with sand stone
		Lathi formation	Sand stone , shale with thin beds of Lime stone
Proterozoic	Marwar Super group.	Birmania Formation	Sand stone and shale
		Randha Formation	
		Jodhpur group	
Precambrian	Malani Group	Intrusive Crystalline	Rhyaolite, Granite
	Metamorphics	Meta sediments	Scistose and Gneisses.

2.2 Structures

Tectonically the area suffered many disturbances in geologic past and there are major structural features made by large faulting and unconformity which continued across the district boundary also and which form the major structures of valleys and up land. The whole district is divided into 3 sub basins which have different structures and disposition of beds and rock formation where there is vertical and lateral variation and bed rock is found at varying depth. There are inliers and outliers in the area. The strike and dip of the formations and unconformities stored in the formations are major structures.

2.3 Hydrogeology

Basin, Sub Basin and Watersheds:

The district Jaisalmer is a part of Indus basin and on the basis of geological set up of the area the district is divided into different sub basins which are mainly structurally control due to occurrence of fault .The basement of sedimentary rock determines the depth of sub basin. The major formations follow the NE-SW trend in major parts of the district, but in the western parts they show N-S strike following the Indus lineament. A change in strike of beds is seen in Ramgarh (40 I/7) also. Similarly the Tertiary beds in the east show different strike. The thickness of Lathi beds increases towards south western side near Barmer district border. Even in the same sub basin there are faulting of different scale dislocating the normal sequence of beds.

2.4 Ground Water Scenario

The district represents a havoc picture of ground water due to hydro geological set up and scanty rainfall. The district in general has very deep water level in major parts of the district.

Groundwater occurs in unconfined in shallow weathered, fractured Granite, Rhyolite, Limestone and sand stone and sandy alluvium to semi confined to confined condition in deeper aquifers.

Granites:

This hydrogeological unit is extended in the villages Sanawara, Nedan, Madasar, Chok, Gudi Ka Talo, Sakra, Bhainsra Dangri, Ola, the southern part of the Sankra block and south eastern part of the district. In granites ground water occurs under unconfined conditions in the rock fractures and joints and in weathered portions.

Rhyolites:

It extends from souh west Loharki to extreme south east of the district covering villages Angi Ki Dhani Chandani, Mahesha Ki Dhni, Modardi, Dudia in south Jhalora Tala, Swami Ji Ki Dhani, Phalsund, Phulasaar, Uncha Padra, Jhaloria , Lawan et. covering large area of the Sankra block of the district. Ground Water occurs under unconfined condition in the secondary porosity developed by the rock fractures and weathered portions. The depth to water level is in general less than 20.00 mbgl.

Jodhpur Group:

Jodhpur sandstone forms aquifer around north of Pokaran, Bhari, Ratoria, Padroda, Jhoba, Sangram Ki Dhani, Betia and Khalana. In this ground water occurs under unconfined condition in the intergranular spaces and in the openings provided by the joints and fractures. Depth to water level ranges between 10 to 30 mbgl.

Lathi Sandstone:

The Lathi sandstone forms the most important aquifer in the district. It consists of dark red to yellow and white sandstone, poorly to moderately cemented medium grained sandstone. There are large ranges of poorly cemented red or greenish grey silt stone and shales which are interspersed in the sandstone. The upper part of the Lathi formation generally contains fine-grained material with intercalations of silt and shales, thus giving rise to confined aquifer conditions. At the same time, at few places perched water conditions with shallow depth to water level and limited yield here also been observed. Depth to water level ranges from 30 to more than 100 mbgl. Piezometeric surface is shallower north of Jaisalmer Pokaran road due to lower altitude of topography.

The piezometeric surface in the lath ranges from 120 to 190 m amsl. The piezometeric gradient ranges from 0.1 m/km. to 1.6 m/km. There are generally 3 aquifer zones in the depth ranges 67 to 100 m. 150 to 200 m and 240 to 280 m bgl, which are hydraulically connected. The figure shows that thickness of Lath aquifer increases from 123 m to 500 m. The deeper Lathi aquifer are under confined conditions.

Jaisalmer Limestone:

Groundwater in Jaisalmer limestone occurs under unconfined condition in the primary porosity of intergranular space and also in the secondary porosity provided by the inter connected opening of joints and fractures. Depth to water ranges from 20 to 100 mbgl but generally between 40-60 mgl. Depth of the open wells ranges from 20 to 100 mts., The average yield varies from 2 o 4 m3/day . Depth of the tubewells ranges from 150 to 400m., water level ranges from 50 to 60 mbgl and yield of tubewells ranges from 45-100m3/day. The quality of groundwater is generally unfit for drinking and domestic use due to high salinity.

Baisakhi Shales:

This formation comprises of fine grained ferruginous sandstone, intercalated with bands of shale and clay. It does not form aquifer due to lack of granular zone. Most of the wells drilled in this formation shows perched water table conditions. Water level in this zone ranges from 30 to 60 m bgl with dug well depth from 30 to 60mbgl.

Bhadesar formation:

These formations comprise of ferruginous sandstone, silts intercalated with gypseous bands. Sandstone is medium to coarse grained intercalated with shales and clayey beds. It forms isolated aquifer comprising of sandstone which is of poor potential. Depth to water level varies from 60 to 125 m bgl. Depth of open wells ranges from 70 to 150 mbgl . Quality of ground water is unfit for drinking and domestic purposes due to high salinity.

Parewar Sandstone:

Upper horizon is compact and fine to medium grained, while the lower horizon are partly consolidated and fine to coarse grained. The aquifer has moderate permeability and does not form very good aquifer. The old wells located in the formation have become dry.

Habur Limestone:

This formation form perched aquifer in calcareous sand stone in weathered and fractured portions which support wells .This formation has very limited exposure.

Tertiary Formations:

Among them are included Sanu sandstone, Khuiala limestone and Bandah limestone. These formations belong to Eocene period. The limestone is silicified associated with fullers earth and bentonitic clay and loosely consolidated sandstone. Due to high salinity these aquifers are not promising. Water level ranges from 20 to 130 m bgl but generally between 40 to 60 m bgl. The deeper beds are under confining conditions in valleys.

Quaternry Formation:

The Quaternary formation comprise of sands, gravel, kankar, silt, clay and grits. It forms unconsolidated sediments of varying sizes and proportions of sand and clay and Kankar with pebbles .At many places intercalations of clay beds and gravel beds are frequently encountered. The composition of these sediments pays a vital role to decide the potential of the aquifer.

Ground water in this formation occur in general under unconfined conditions and depth to water level ranges from 20 to 90.0 m bgl, however shallow water level 5-10 mbgl has been observed towards extreme western side where water table rises up and quality of water is also shallow. In deeper horizons alluvial aquifer are generally intercalated with alternate clay material and quality generally become saline at depth. Depth of the open wells is generally 40 to 50 mgl. Depth of the tube wells ranges from 100 to 250 mbgl.

Three dimension regional lithology model has been prepared using Rock Works Software which is given in Figure 1.

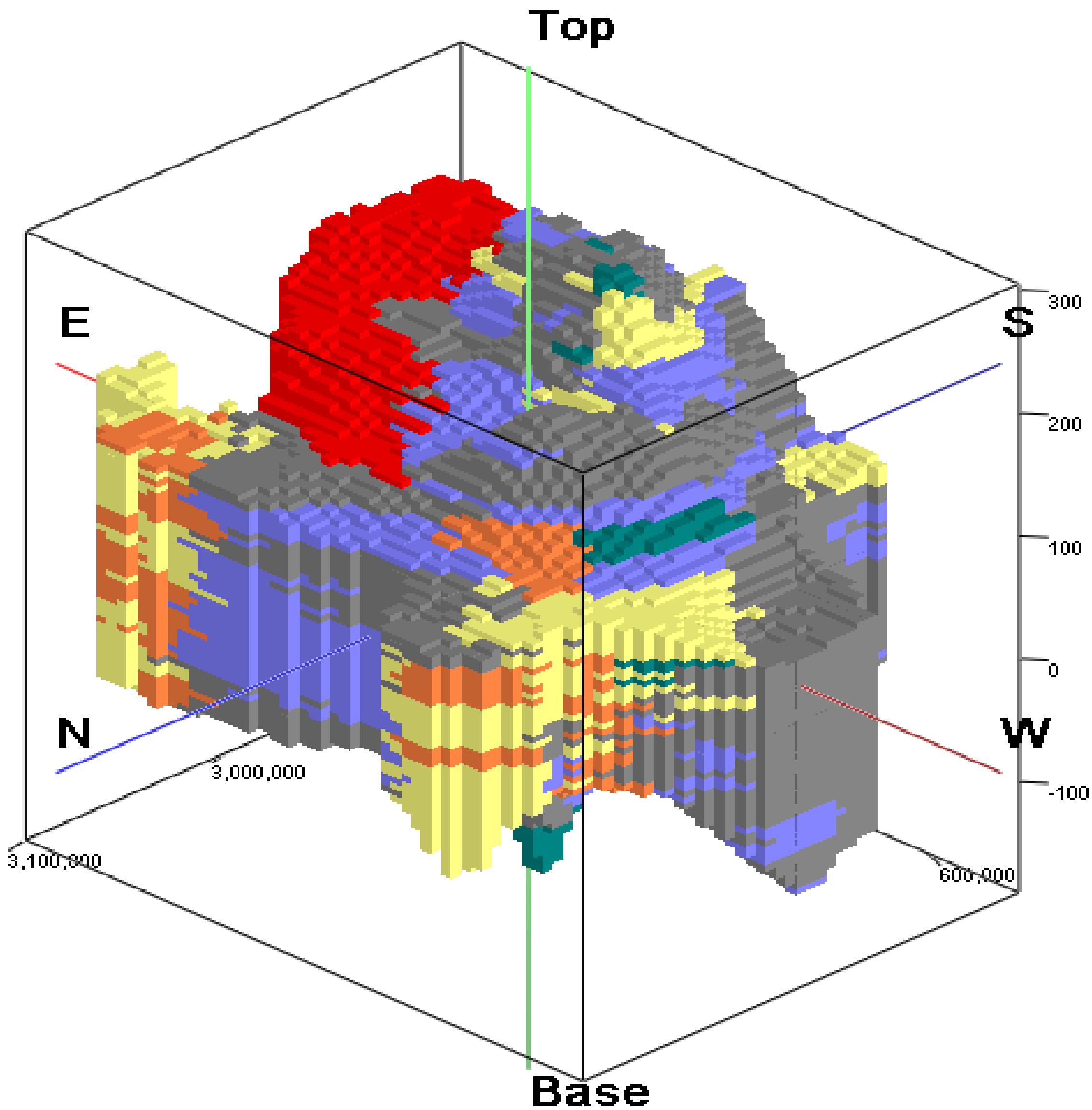

Figure 1: Regional Lithology Model

The 2-D regional set up of the Jaisalmer district is shown in Figure 2.

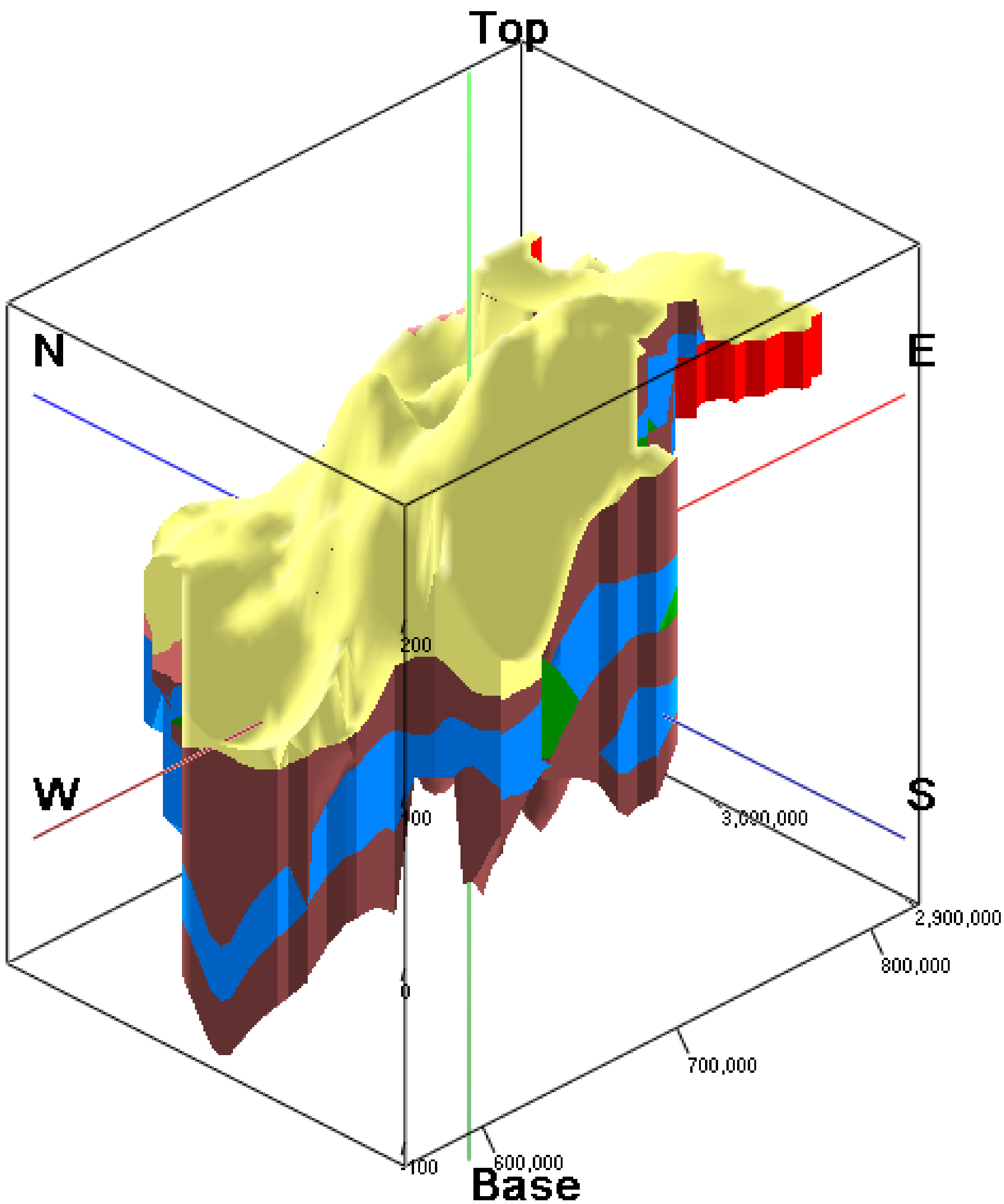

Figure 2: Regional aquifer set up of the district

2.5 Depth to Water Level

The depth to water level in the district varies from 0.8 mbgl to 124.39 mbgl. It follows the topography of the district. The central and south western part registers very deep water level which continued to neighboring district. The south western part of the district registers deep water level from Habur to further south up to Barmer district border. In general, the depth to water level decreases from south to north in the northern parts and from west to east in southern parts. The formation wise depth to water level varies as follow in table 11.

Table 11: Formation wise Variation of depth to water level

Formation	Pre monsoon water level (mbgl)	Post monsoon water level (mbgl)	Seasonal Fluctuation (m)
Lathi	10.55 (Betina) to 124.39 (Bhakharani)	13.55 to 107.52 (Ugawa)	(-)11.2 to 14.00 (Bambore ki dhani)
Jaisalmer formation	7.68 (Joshia) to 92.59 (Jaisalmer)	13.22 (Dedha) to 104.40 (Chattangarh)	(-) 1.99 to 2.66
Baisakhi	23.66 (Choudhariya) to 48.35 (Boa)	25.14 (choudhariya) to 48.57(Boa)	(-) 8.69 to 1.38
Bhadesar	62.39 (Myajlar-Pochina to 100.98 (Barsiaala)	63.65 (myajlar) to 100.54 (Barsiala)	(-) 1.58 to 0.44
Tertiary	3.69 (Falsund) to 103.50 (mandai)	2.11 (Falsund) to 103.44	(-) 3.87 to 2.35
Jodhpur sand stone	14.87 (Odhania) to 68.55 (Loharki)	11.24 (Odhaniya) to 68.50 (Loharki)	(-) 3.1 to 7.66
Granite, Rhyolite	0.80 m. (Maulana Azad Nagar) to 37.69(Kelawa)	2.99 (Chok) to 35.75 (Sanawada)	(-) 7.46 to 14.47
Alluvium	5.22 m.(Sakadia) to 66.32 (Ram ashu road)	4.33 (sakadia) to 66.30 (Ranau)	(-)7.72 to 1.33
Jodhpur sand stone	14.87 (Odhaniya to 68.55 (Loharki)	11.24 (Odhaniya) to 65.55 (Ramdevra)	(-) 5.28 to 7.66

There is a small area in the district located from Nachna (40M/10) to Jaluwala (40M/13) where ground water is in artesian condition and wells tapping the deeper formation are in auto flow condition. Here thick clay is the confining layer. The deeper Tertiary formation is also in artesian condition. The underlying Tertiary formation has leaky aquifer in other parts specially in depressions/ valleys Ground water in deeper formations is in confining conditions and the piezometric surface of the area is above the water table of the area which is according to the geometry of the aquifer.

Seasonal Fluctuation:

The district shows vide range of seasonal variation ranging from (-) 8.69 to 22.95 m. The greater seasonal fluctuation is seen in comparatively shallow depth to water level in areas which are underlain by Rhyolite / Granite or Jodhpur sandstone. Negative fluctuation is seen in those areas where ground water is used for agricultural purposes.

Movement of Ground Water:

In the district, ground water moves as per hydro geological set up towards lower gradient from east to west directions towards valleys and from north to south as per hydraulic gradient. Similarly where heavy pumping is done ground water moves from other areas from aquifer located at higher altitude. It is seen that the steep gradient of water level is found towards western end of the district where formation changes and gentle gradient towards northern side. The movement of ground water is through faults located in the formation and basal fractures located in the formations and through primary porosity of the aquifer. The water table contour clearly shows the direction of movement of water towards western side close to international border as shown in Figure 3.

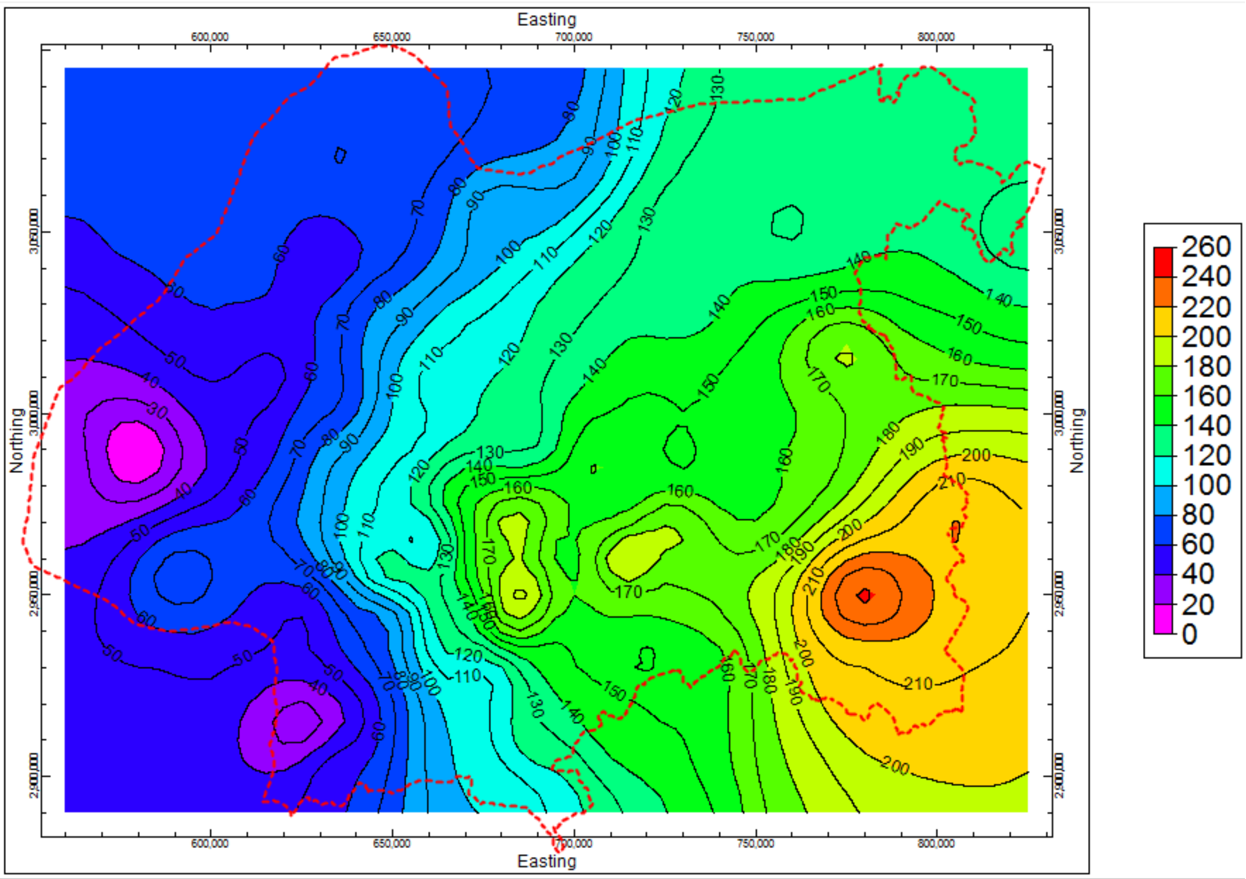

Figure 3: Water table contour Map of Jaisalmer district

Decadal Changes:

The decadal changes indicate a general decline in north eastern and south western part of the district. The north eastern part comes under canal command area, where as the south western part is part of Lathi formation which is extensively used in the district for ground water irrigation. Decadal changes are shown in Figure 4.

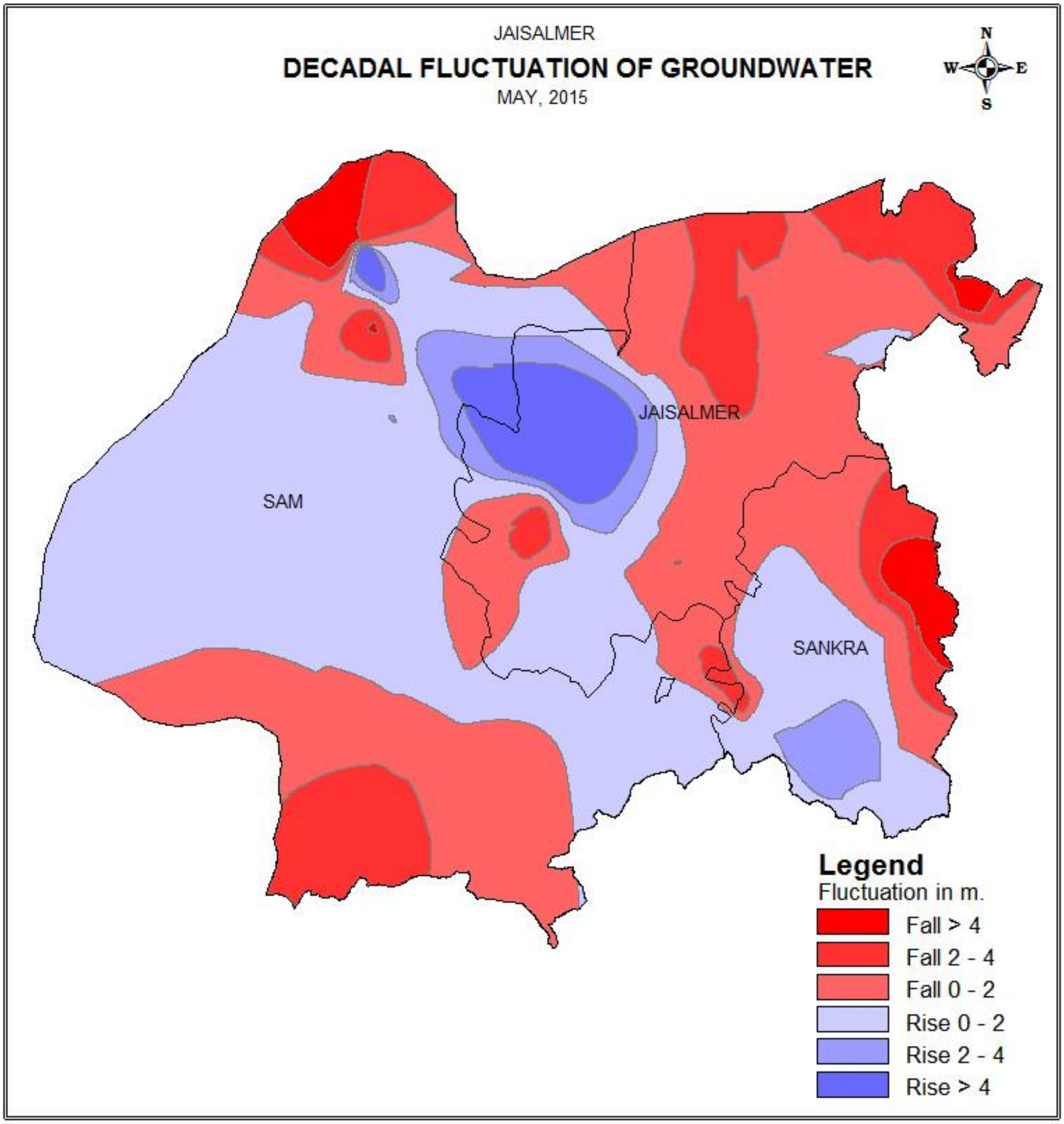

Figure 4: Decadal Water Level fluctuation Map

3. Chemical Quality

The chemical quality in the district is fresh to brackish , Variation of different radicals found in ground water is shown in table It is observed in the district that the deeper tube well water has more saline than the dug well water even in same village .It is point to note that ground water is abstracted only from those tube wells which have comparatively lesser salinity.

The tube wells having higher salinity are not utilized. The ranges of radicals observed in the analysis of ground water in Jaisalmer district are given below in Table 12.

Table 12: Range of chemical parameters in the ground water

Radicals	Minimum	Maximum
Electrical conductivity (micro Siemensat 25^{o}C)	450	9830
Total hardness	115	2457
pH	7.35	8.65
Total dissolved solids	293	6390
Carbonate (mg/ Liter)	0	96
Bicarbonate (mg/ Liter)	1	762
Chloride (mg/ Liter)	35	3474
Sulphate (mg/ Liter)	10	1255
Nitrate(mg/ Liter)	0	275
Phosphate(mg/ Liter)	0	1.2
Calcium(mg/ Liter)	23.2	346
Magnesium(mg/ Liter)	4	387
Sodium(mg/ Liter)	20	1600
Potassium(mg/ Liter)	0.7	226.2
Fluoride (mg/ Liter)	0.2	8.80
Iron(Total) (mg/ Liter)	0	8.4
Silica as(Sio2) (mg/ Liter)	5	48

The 3-D map showing the saline-freshwater interface is shown in Figure 5.

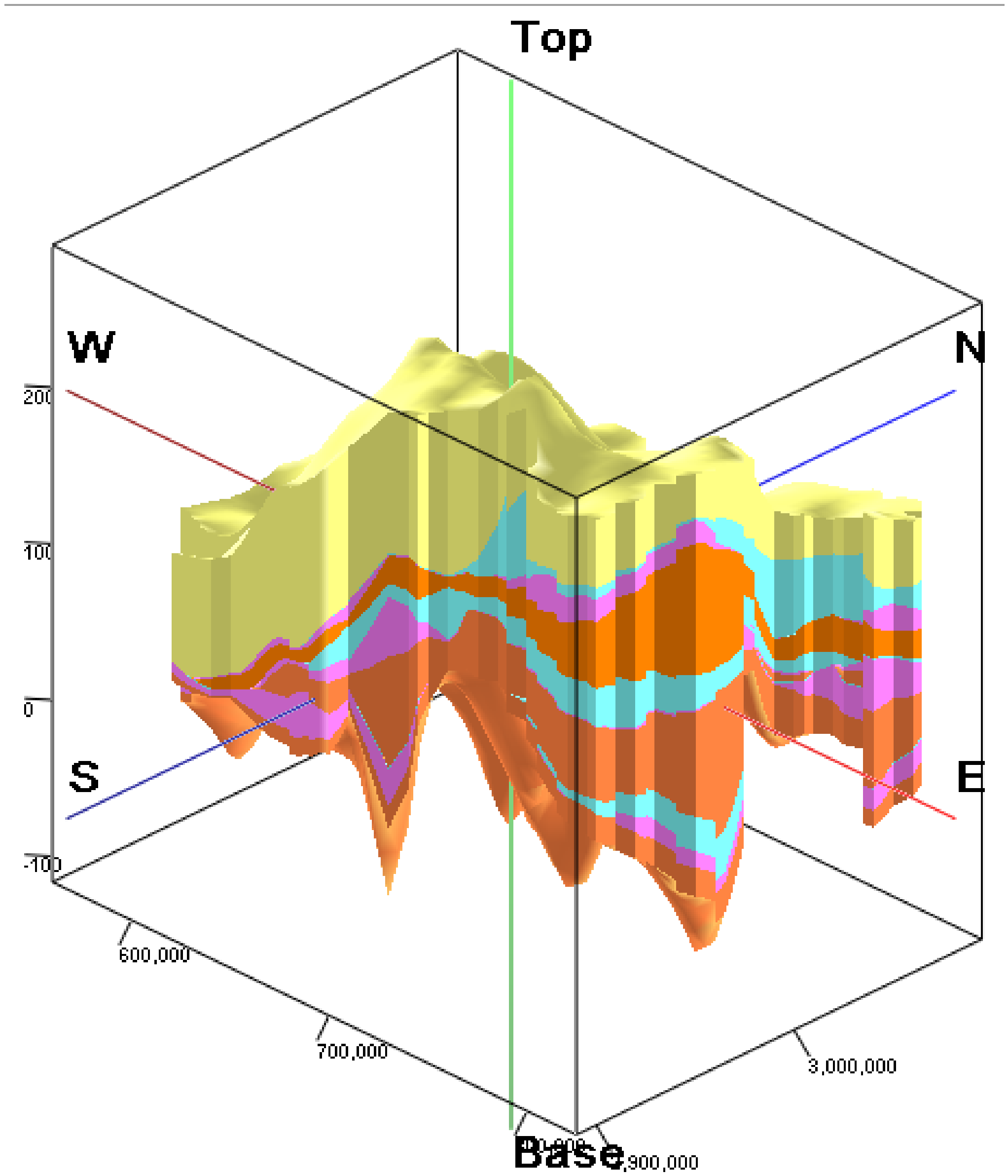

Figure 5: Map showing the disposition of Aquifer containing saline-ground water interface

4. Ground Water Related Issues

Scanty rainfall, frequent drought and continuous drought, very high evaporation and evapotranspiration in the district due to blowing wind , very deep water level in very large areas , inherent salinity , international border ,steep in gradient all along the international border, very high declining rate of water level , even in canal command areas water level is declining due to excessive use of ground water due to movement of ground water in highly pumped areas and due to improvement in quality , particularly in shallow aquifer. Increased demand due to population and industrial and agricultural growth. Sharing of aquifer across the international border, low lying area is located across the border.

5. Ground Water Resources

The Ground water resources as per 31.03.2013 assessment are presented in Table 13.

Table 13: Ground Water Resources as on 31.03.2013

Block	Area of Block	Total Annual Ground Water Recharge	Natural Discharge during non-monsoon season	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross G.W. Draft for Dom. & Ind. Use	Existing Gross Ground Water Draft for all uses	Allocation for Dom. & Ind. Requirement	Net G.W. availability for future irrigation Dev.	Stage of G.W. Development	Category of Block
Jaisalmer	11591	21.8423	1.8582	19.9841	53.2718	13.2167	66.4885	11.2878	3.8811	332.71	OVER EXPLOITED
Sam	21194.8	28.483	2.8483	25.6347	19.5125	12.6146	32.1271	8.2513	15.2119	125.33	OVER EXPLOITED
Sankra	5615.2	19.8406	1.8395	18.0011	52.8013	6.901	59.7023	6.071	4.8415	331.66	OVER EXPLOITED

The blockwise Ground water availability versus Draft chart is shown in Figure 6.

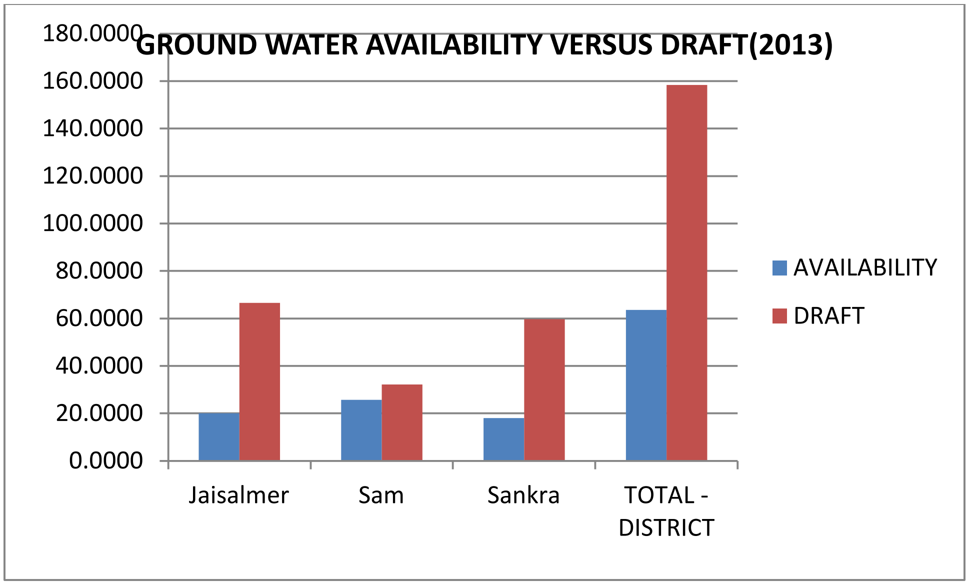

Figure 6: Ground Water availability versus Draft Chart

6. Ground Water Management

All the blocks are over exploited, thereby, leaving no/limited scope of further ground water development for various consumptions and area is devoid of sustained surface water bodies.In order to manage the ground water resources and to control further decline in water levels, a management plan has been proposed. In order to manage the ground water resources and to control further decline in water levels, a management plan has been proposed. The management plan comprises two components- supply side management and demand side management. Since there is very little surplus surface water available in this district, very little intervention in the form of supply side management could be proposed.

6.1 Supply Side Management

The supply side management of ground water resources can be done through the artificial recharge of surplus runoff available within river sub basins and micro watersheds. Also it is necessary to understand the unsaturated aquifer volume available for recharge. The unsaturated volume of aquifer for the Jaisalmer district is computed based on following; the area feasible for recharge, unsaturated depth below 5 m bgl and the specific yield of the aquifer.

6.1.1 Artificial recharge to ground water through interventions of various structures

The following parameters are inevitable for planning of artificial recharge to ground water.

- Availability of sufficient storage space to accommodate recharged water
- Availability of surplus water to recharge
- Feasibility of sub-surface geological formations

In case of Jaisalmer district, sufficient sub-surface storage space is available to accommodate the recharged water. Details of feasible recharge structures to recharge the surplus water in respective block is given in Table 14.

Table 14: Block-wise details of feasible recharge structures, Jaisalmer District

Block	Usable Surplus Water (MCM)	Recharge Shafts proposed	Percolation Tanks Proposed	Recharge from Recharge Shaft (MCM)	Recharge from Percolation Tanks (MCM)	Total Recharge (MCM)	Effective Recharge (MCM)	Remarks
Jaisalmer	0.00	0	0	0.00	0.00	0.00	0.00	No surplus
Sam	0.01	0	0	0.00	0.00	0.00	0.00	No surplus
Sankra	0.17	3	0	0.09	0.00	0.09	0.07	

It can be observed that scope of recharge is very little through supply side management due to very less amount of usable surplus water availability. Only 3 No. of recharge shafts can be proposed in Sankra block.

6.2 Demand Side Management

Though not much augmentation can be done through supply side management due to less availability of surplus water, applying the techniques of demand side management can save large amount of water. Demand side management has been proposed through two interventions – changing the more water intensive wheat crop to gram (chick pea) and use of sprinkler irrigation in the areas where rabi crop is being irrigated through ground water.

6.2.1 Change in cropping pattern

In view of the alarming decline of water level, drastic reduction in saturated thickness of aquifer and resulting of depletion of aquifer, there is need to bring paradigm change/shift in cropping pattern in the area. It is proposed to grow low water requirement crop like gram in the instead of wheat. Growing of gram will save the water to the tune of about 100 mcm per annum @ 0.1m (Table 15).

6.2.2 Adoption of modern practice of sprinkler irrigation/improved irrigation practices

Data indicate that flooding method of irrigation is still in practice in many parts of the district which causes wastage of ample quantity of water. In view of this, it is proposed to bring about 50% of total irrigated area under sprinkler irrigation which may save water to the tune of about 64.67mcm/annum @0.08m (Table 15).

Table 15: Block-wise water saving through change in cropping pattern and irrigation practice

Block	Irrigated Area (ha)	Irrigated Area proposed for irrigation through sprinkler (ha)	Water Saving by sprinkler in MCM (@0.08 m)	Irrigated Area (ha)	Irrigated Area under wheat proposed for Gram cultivation (ha)	Water Saving by change in cropping pattern in MCM @0.1 m	Total Water Saving
Jaisalmer	58428	29214	23.37	58428	-	0.00	23.37
Sam	62603	31302	25.04	62603	-	0.00	25.04
Sankra	40662	20331	16.26	40662	-	0.00	16.26

Considerable saving of ground water can be achieved if the proposed supply side and demand side management plans are implemented. With the implementation of supply side management, additional 0.07 MCM/year can be recharged. It can be seen that not much augmentation in ground water resources can be achieved through artificial recharge due to constraints of availability of surplus/non-committed surface water. However, considerable improvement in ground water situation can be achieved with implementation of demand side management plans.

With the proposed use of sprinkler irrigation in the areas where rabi crop is being irrigated through ground water it is expected that 64.68 MCM/year can be saved due to reduction in pumping. The water saving under change in cropping pattern is not possible as no area is appropriate for wheat cropping in this district. Block wise details of ground water recharged and saved along with expected improvement in stage of ground water development is given in Table 16.

Table 16: Summary of expected benefit of management strategies, Jaisalmer district

Block	Net Annual Ground Water Availability	Additional recharge from RWH & conservation (mcm)	Total net GW availability after intervention (mcm)	Existing Gross Ground Water Draft for all uses	Saving of GW through projects (mcm)	Net GW draft after interventions (mcm)	Present stage of GW development (%)	Projected stage of GW development (%)
Jaisalmer	19.98	0	19.98	66.49	23.37	43.12	332.71	215.81582
Sam	25.63	0	25.63	32.13	25.04	7.09	125.33	27.662895
Sankra	18	0.07	18.07	59.7	16.26	43.44	331.66	240.39845
Total	63.61	0.07	63.69	158.32	64.68	93.69	248.85	147.02