केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

BARMER DISTRICT
RAJASTHAN

पश्चिमी क्षेत्र, जयपुर

Western Region, Jaipur

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Report on

AQUIFER MAPPING AND GROUND WATER MANAGEMENT PLAN

BARMER DISTRICT, RAJASTHAN

(24361.74 sq.km)

AAP 2019-20

पश्चिमी क्षेत्र, जयपुर

Western Region, Jaipur

CONTRIBUTORS

AQUIFER MAPPING AND MANAGEMENT PLAN
BARMER DISTRICT, RAJASTHAN
(24361.74sq.km.)

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REPORT ON AQUIFER MAPPING AND MANAGEMENT PLAN
BARMER DISTRICT, RAJASTHAN
(24361.74 sq.km.)

1.0 Introduction

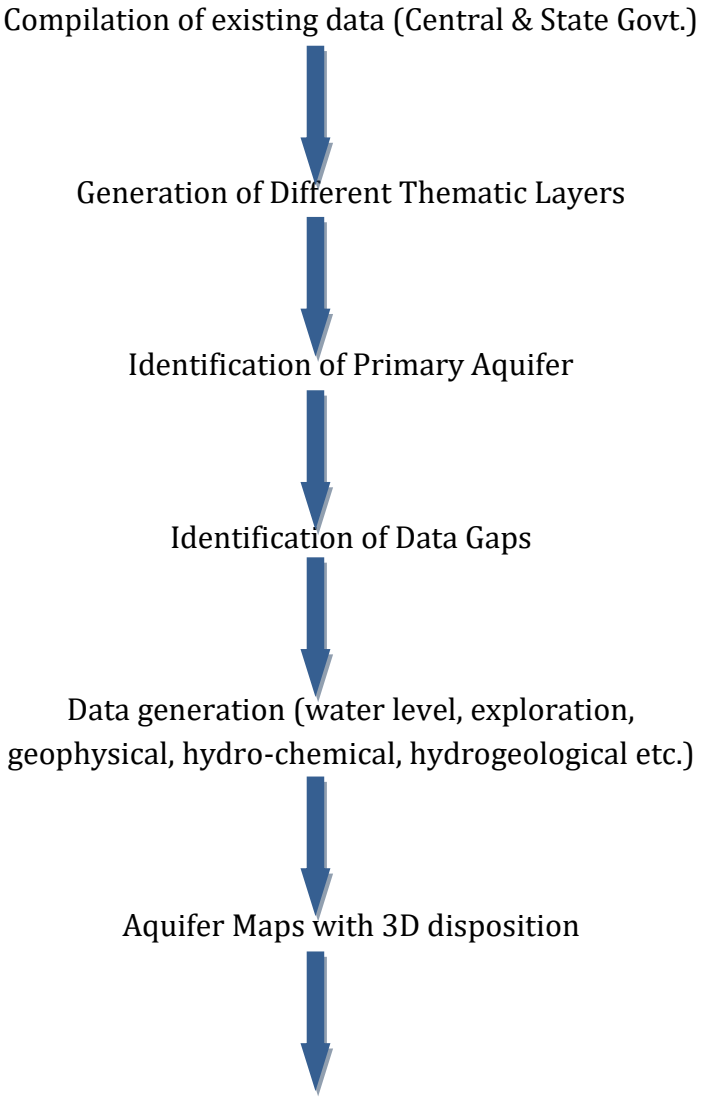
Various developmental activities over the years have adversely affected the groundwater regime in the state. There is a need for scientific planning in development of groundwater under different hydrogeological situation and to evolve effective management practices with involvement of community for better ground water governance. In view of sprouting 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 hydrogeological setting through a process of systematic data collection, compilation, data generation, analysis and synthesis. Hence, aquifer mapping and management 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 analyses are applied to characterize 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 in aquifer and how they change over time and space and the occurrence of natural and anthropogenic contaminants that affect the portability of groundwater. Results of these studies will contribute significantly to resource management tools such as long-term aquifer monitoring network and conceptual and quantitative regional groundwater flow models to be used by planners, policy makers and other 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 groundwater recourses, which in turn will help to achieve drinking water scarcity, improved irrigation facilities and sustainability of water resource in the state.

1.3 Approach & Methodology

Aquifer mapping is an attempt to integrate the geological, geophysical, hydrological & chemical field and laboratory analyses and are applied to characterize the quality, quantity and sustainability of groundwater in aquifer. Under the National Aquifer Program, it is proposed to generate Aquifer Maps on 1:50000 scale, which basically aims at characterizing the aquifer geometry, behavior of groundwater levels and status of groundwater development in various aquifer system to facilitate planning of their suitable management. The major activities involved in this process encompass compilation of existing data, identification of data gaps, generation of data for feeling data gaps and preparation of different aquifer layers.



1.4 Study Area

Barmer district is situated between 24°40' 00" & 26° 32' 00" North latitudes and 70°05' 00" & 72° 52' 00" East longitudes covering geographical area of 24,361.74 sq km. It is the second largest district in the State covering about 8.29% of its total area. The district forms part of the Great Indian Thar Desert. The district is divided into four sub-divisions. There are seventeen blocks in the district namely Baetu, Balotra, Barmer, Chohtan, Dhanau, Dhorimanna, Gadra Road, Gida, Gudamalani, Kalyanpur, Patodi Ramsar, Samdari, Sedwa, Siwana, Sheo, Sindhari. The district has 2 Municipalities, and 2460 Revenue Villages. It is surrounded by Jaisalmer in the north, Jalore in the south, Pali and Jodhpur in the east and Pakistan in the west. Total population (as per 2011 census) of the district is 2,603,751 out of which 2,421,914 is rural population and 181,837 is urban population. Decadal population growth rate of the district during 2001 to 2011 has been 35.06. Population density of the district is 92 persons/sq km. The district is known for its bentonite, lignite and petroleum mineral wealth. A map showing the blocks of the district is presented as.

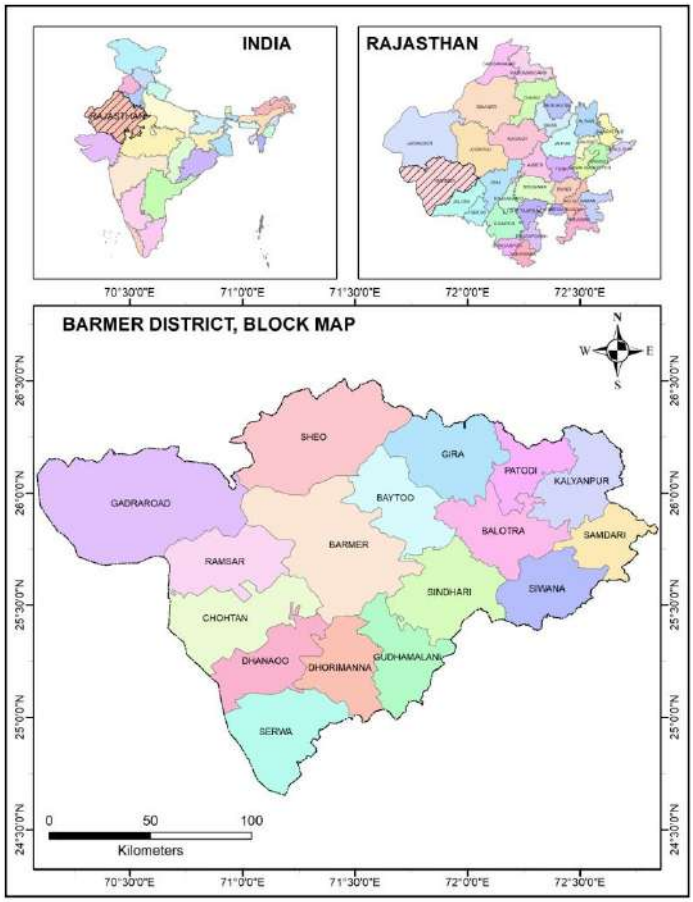


Figure1.1. Administrative Map of Barmer District

Data Availability and Data Gap Analysis:

The available data of the Exploratory wells drilled by Central Ground Water Board, Western Region, Jaipur, Geophysical Survey carried out in the area, Ground water monitoring stations and ground water quality stations monitored by Central Ground Water Board were compiled and analysed for adequacy of the same for the aquifer mapping studies. In addition to these the data on ground water monitoring stations and ground water quality stations of the State Government (GWD) was also utilized for data adequacy and data gap analysis. The data adequacy and data gap analysis was carried out for each of the quadrant falling in the study area in respect of various attributes of ground water and is presented in table 1.

Table 1.1: Data Availability and Data Gap Analysis in Barmer District

S.No	Study Aspect	Data Requirement	Data Availability	Data Gap
1	Rainfall and Other climatic Data	6 Meterological Stations in the area	Data partially available	Other Climatic data other than rainfall
2.	Soil	Soil Map and Soil infiltration rate	Soil Map	Soil Infiltration rate across the area
3.	Land Use	Latest land use Pattern in GIS Platform	Not available	Latest data in GIS platform required
4.	Geomorphology	Digitized Geomorphological Map	Available	-
5.	Geophysics	Geophysical Survey in all toposheets	Available 11 VES	Required in every toposheet
6.	Exploration	Exploratory wells along with aquifer parameters	Exploratory wells along with aquifer parameters are available	-
7.	Recharge Parameters	Recharge parameters of different soil and aquifer types based on field studies	Recharge parameters are given in Ground Water resource estimation	-
8.	Discharge Parameters	Discharge parameters for different GW abstraction structures	Discharge parameters are given in Ground Water Resource Estimation	-

2.0 Climate and Rainfall

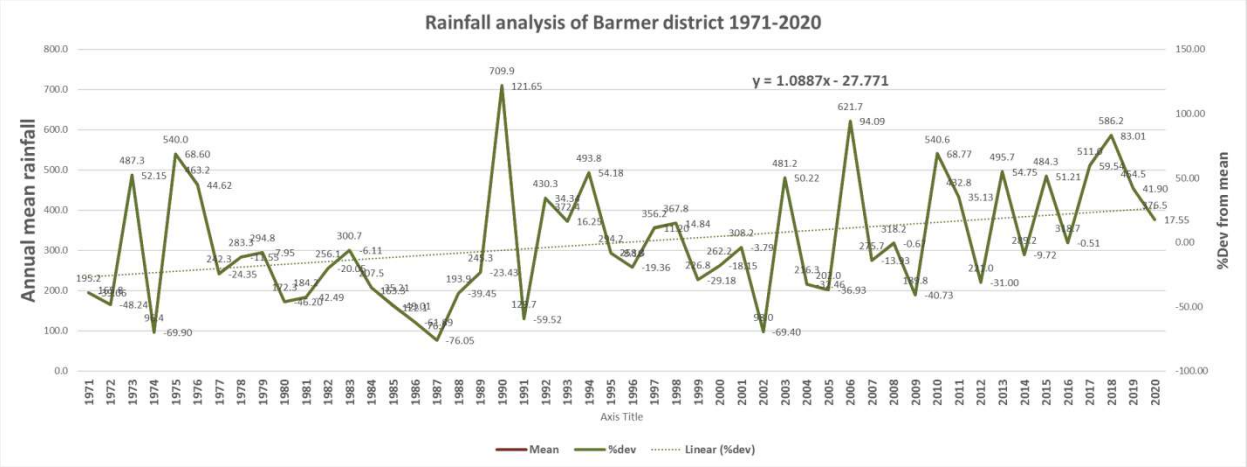
The annual rainfall of 50 years from 1971 to 2020 has been analyzed to know the behavior of rainfall (Figure). The analysis indicates that annual variation of rainfall is large and significant.

The average annual rainfall from 1971 to 2020 is 320.3mm. The highest rainfall of 121.65% more than the average was recorded in 1990 whereas the lowest -76.05% less than the average was experienced in 1987 as show in Table.
The standard deviation of rainfall from 1971 to 2020 is 151 mm which indicates that 169.2 mm rainfall is assured. The coefficient of variation of rainfall is 47.17%. It indicates that rainfall in the area is highly variable.

The trend of annual rainfall by least square method shows decreasing trend of rainfall which is insignificant. The possibility of Excess, normal, and deficient rainfall are 30%, 28%, and 42% respectively as given in Table 3.

Rainfall study for 50 years depicts that only 42% of the years i.e.., 1971, 1972, 1974, 1977, 1980, 1981, 1982, 1984, 1985, 1986, 1987, 1988, 1989, 1991, 1996, 1999, 2002, 2004, 2005, 2009, 2012 experienced drought conditions. It means that study area is classified under chronically drought affected area. The probability of mild and severe drought is 12%and 18% respectively. One drought of mild intensity may be possible after 7 or 8 years. In6-years1977 1982 1989 1996 1999 2012this area is affected with drought of mild intensity, and one severe drought would be possible within 6 to 7 years.

Almost 90% of the total annual rainfall is received during the southwest monsoon, which enters the district in the first week of July and withdraws in the mid of September. As the district lies in the desert area, it faces extremes of heat in summer and cold in winter. Both day and night temperatures increase gradually and reach their maximum values in May and June. The temperature varies from 48 degree in summer to 2 degree in winter. Atmosphere is generally dry except during the monsoon period. Humidity is at its highest in August with mean daily relative humidity of 43%. The annual maximum potential evapotranspiration in the district is 1850 mm and it is highest (260 mm) in the month of May and lowest (77 mm) in the month of December.



RAINFALL PATTERN IN BARMER DISTRICT (1971-2020)

Mean		320.27	
Standard Deviation		151.06	
CV%		47.17	
Assured Rainfall		169.21	
Rainfall	Number of Years	Possibility of occurrence(per year)	
Excess	15	30.00	
Normal	14	28.00	
Deficient	21	42.00	
Draught	Number of Years	Possibility of occurrence (per year)	
Mild	6	12.00	
Severe	9	18.00	
Moderate	6	12.00	
Maximum Rainfall (mm)	710	in year 1990	121.65% (dev)
Minimum Rainfall (mm)	77	in year 1987	-76.05% (dev)

TOPOGRAPHY DISTRICT

3.0 Physiographic Set Up

Most part of the district comes under the Great Indian Desert. In the eastern part of the district and to the west of Barmer city, exposures of hill ranges are seen is trending east – west direction. The district is actually a vast sandy tract. The only major drainage course in the area is Luni River, which flows from Balotra and Sindhari Charnan block towards Jalor district. Salt lakes are found in the northeast and northwest parts of the district. The general topographic elevation in the district is between 125 m to 250 m above mean sea level. Elevation ranges from a minimum of 0.00 m above mean sea level in Chohtan block in the southwest part of the district to maximum of 931.8 m above mean sea level In Siwana block in eastern part of the district which is part of Aravalli range.

3.2 Geomorphology

Geographically Barmer district is a part of Thar Desert with varying geomorphic land forms which are present in sandy dunes. There are plains both Aeolian and alluvial origin over which a few scattered hills and hillocks protrude. The western part of the district is marked by well defined valley, surrounded by linear ridges. Among dunes are barchans and longitudinal dunes both stationary and shifting nature. The south eastern part is hilly which the offshoot of Jalore hills is (A part of Aravalli hills). The Luni River represents flood plain in the district. The surface elevation of the district varies from 70 m. above mean sea level (m amsl) at Sindhari to 457 m above msl at Ghonia village. The only major drainage course in the area is Luni River, which flows from Samdari and passing through Balotra takes a turn towards south from Sindhary. The river is ephemeral, flowing only in response to heavy precipitation. In the year of drought there is no run off.

Geomorphology Map of Barmer District

Aeolian	Dune Complex	An undulating plain composed of number of sand dunes of crescent shape.
	Dune Valley Complex	Cluster of dunes and interdunal spaces with undulating topography formed due to wind-blown activity, comprising of unconsolidated sand and silt.
	Eolian Plain	Formed by aeolian activity, with sand dunes of varying height, size, slope. Long stretches of sand sheet. Gently sloping flat to undulating plain, comprised of fine to medium grained sand and silt. Also scattered xerophytic vegetation
	Interdunal Depression	Slightly depressed area in between the dunal complex showing moisture and fine sediments
	Interdunal Flat	Flat, narrow land between dunes.

	Sandy Plain	Formed of aeolian activity, wind-blown sand with gentle sloping to undulating plain, comprising of coarse sand, fine sand, silt and clay.
Denudational	Buried Pediment	Pediment covers essentially with relatively thicker alluvial, colluvial or weathered materials
	Pediment	Broad gently sloping rock flooring, erosional surface of low relief between hill and plain, comprised of varied lithology, criss-crossed by fractures and faults
Fluvial	Alluvial Plain	Mainly undulating landscape formed due to fluvial activity, comprising of gravels, sand, silt and clay. Terrain mainly undulating, produced by extensive deposition of alluvium
	Paleochannel	Mainly buried on abandoned stream/river courses, comprising of coarse textured material of variable sizes.
	Salt Encrustation/Playa	Topographical depression comprising of clay, silt, sand and soluble salts, usually undrained and devoid of vegetation.
Hills	Denudational, Structural Hill, Linear Ridge	Steep sided, relict hills undergone denudation, comprising of varying lithology with joints, fractures and lineaments. Linear to arcuate hills showing definite trend-lines with varying lithology associated with folding, faulting etc. Long narrow low-lying ridge usually barren, having high run off may form over varying lithology with controlled strike.

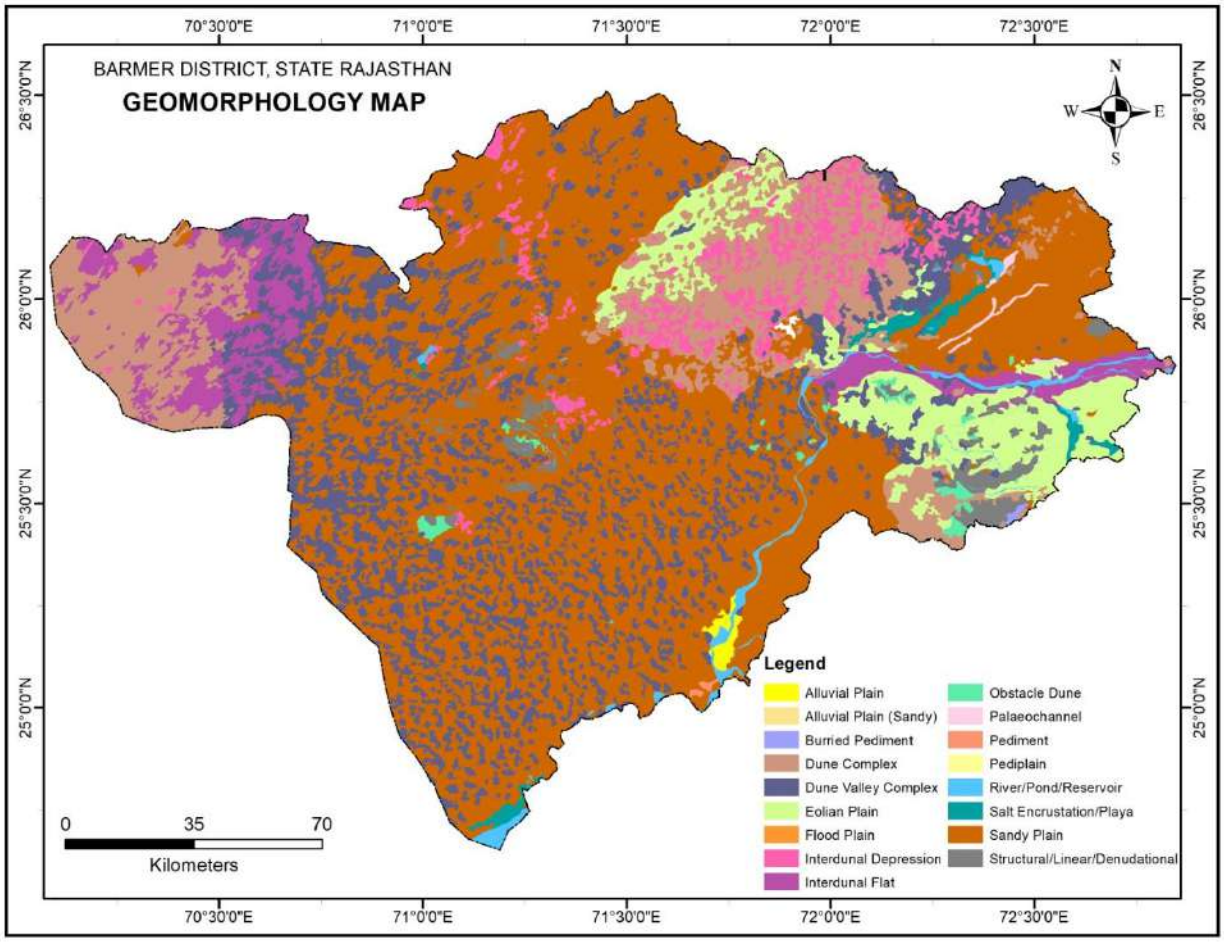


Figure1.2. Geomorphology Map of Barmer District

3.3 SOILS

The soils of the district belong to desertic type coarse sandy in texture. The main soil types are

1. Desert soil: Desert soil area is occupied by wind blown sand, yellowish brown, sandy to little sandy loamy, loose, structure less, well drained with high permeability and lies in northern, western and central parts of the district.
2. Sand dunes: These are non-calcareous soil, sandy to loamy sand, loose, structure less and well drained. Sand dunes lie in northern, western and central parts of the district.
3. Red desertic soil: These are pale brown to reddish brown soils, structure less, loose, and well drained. Texture varies from sandy loam to sandy clay loam. These soils occupy eastern and southeastern parts of the district.
4. **Saline soil of depressions**: This type of soil is found in salt lakes. They are dark grey to pale brown, heavy soils with water table very near to the surface and are distinctly saline.

5. Lithosols & Regosols of hills: This type of soil is found in isolated hills on lithoslopes. These soils are shallow with gravels very near to the surface, high textured, fairly drained, reddish brown in colour and lie in south eastern part of the district.

3.3 Land Use

Land Use

The socio-cultural and economic factors have significantly influenced over land use both in rural and urban areas in the district. Land forms, slope, soils and natural resources are some of the important which control the land use pattern of the district. The land use pattern of district is based on the statistical outline of the district is presented in Table 3.3

Table 3.3: Land Use Pattern of Barmer District

S.No.	Land Use	Area in hectare	%
1	Total geographical area (as per village papers)	2817432	
2	Forest	33375	1.18
3	Uncultivable land	73860	2.62
4	Land not cultivated including pasture land; barren land; trees, grooves & orchards	242048	8.59
5	Fallow and current fallow land	550429	19.54
6	Net sown area (subtracting double)	1630989	57.89
7	Gross sown area	1916447	68.02
8	Area sown more than once	285458	10.13

Agriculture

Agriculture activity in the district is, by and large, confined to traditional kharif cultivation depending on monsoon rainfall and rabi cultivation is prevailing in areas where irrigation facilities are available. The major crops grown in the area are given in table no. 3.4 and season-wise crops are presented in table 3.5.

Table 3.4: Major crops of Barmer District

Food Grain	Jowar, Bajra,Wheat, Barley, Maunth, Moong
Cereals	Gram, other kharif cereals, other rabi cereals
Oil seeds	Rai & Mustard, Til, Ground Nut, Arandi/Taramira

Non-food grains	Cotton, Pomegranate, fodder

Table 3.5: Season-wise crops Pattern of Barmer District

Season	Crops covered
Kharif	Jwar, Bajra, Maunth, Moong, Til, Moongfli, Arandi, Gwar
Rabi	Wheat, Barley, Gram, Alsi, Rai/Raida/Mustard, Arandi, Pomegranate, vegetables, Cumin seeds
Zaid	Fruits like watermelon, Gwar, Vegetables, Bajra, fodder

Apart from these, vegetable and fruits are also being produced in the district. Onion, Cauliflower,.are main vegetables and Aonla, Ber are main fruits which are produced in district

Irrigation

Open wells/Dug-cum-Borewells and Tube well are the main source of irrigation in the district. During 2019-20, the net irrigated area in the district was 479953 hectares of which 93.38 percent was irrigated by open wells/dug-cum-borewells and tube well. Other sources constituted canals/other sources and the percentage of area irrigated by them are 6.62 percent. The area irrigation by different means of irrigation in 2019-20 in the district is as given below, figures in the brackets indicate the percent of area irrigated by difference sources to total area irrigated in that category

Table 3.6: Details of Area irrigated with sources in Barmer District

	Dugwells	Tubewells	Canals	Other	Total
Net Sown Area	254063	194108	30984	798	479953
Gross Sown Area	325498	264481	35100	1021	626100

4.0 Hydrogeological Framework

4.1 Geology:

Geologically, the district is underlain by intrusive rocks at the basement (Post Delhi (formation) consisting of Jalore and Siwana granite & Malani rhyolite and granite followed by Mesozoic and Tertiary formations consisting of sandstone, shale, conglomerate. Rocks of Mesozoic era are comprised of Lathi series of Jurassic and Fathgarh series of Cretaceous period. Tertiaries consist of Akali and Kapurdi series of Eocene period. These formations are overlain by Pleistocene to recent alluvium consisting mainly of clay, sand and silt.

Table: Geologic succession

Group	**Series/Super Group**	**Formation**
Recent to Sub-recent		Sand, Sandy soil, Kankar vast gypsum & Selenite deposite
Lower to middle Eocene		Kapurdi formation
Paleocene		Mandhi formation & Akli formation
--X--------X--------X--------X---Unconformity---X--------X--------X-------X--		
Deccan Traps	Cretaceous	Fateh garh formation
	Jurassic	Lathi formation
--X--------X--------X--------X---Unconformity---X--------X--------X-------X--		
Post-Delhi	Proterozoic	Malani igneoues rock

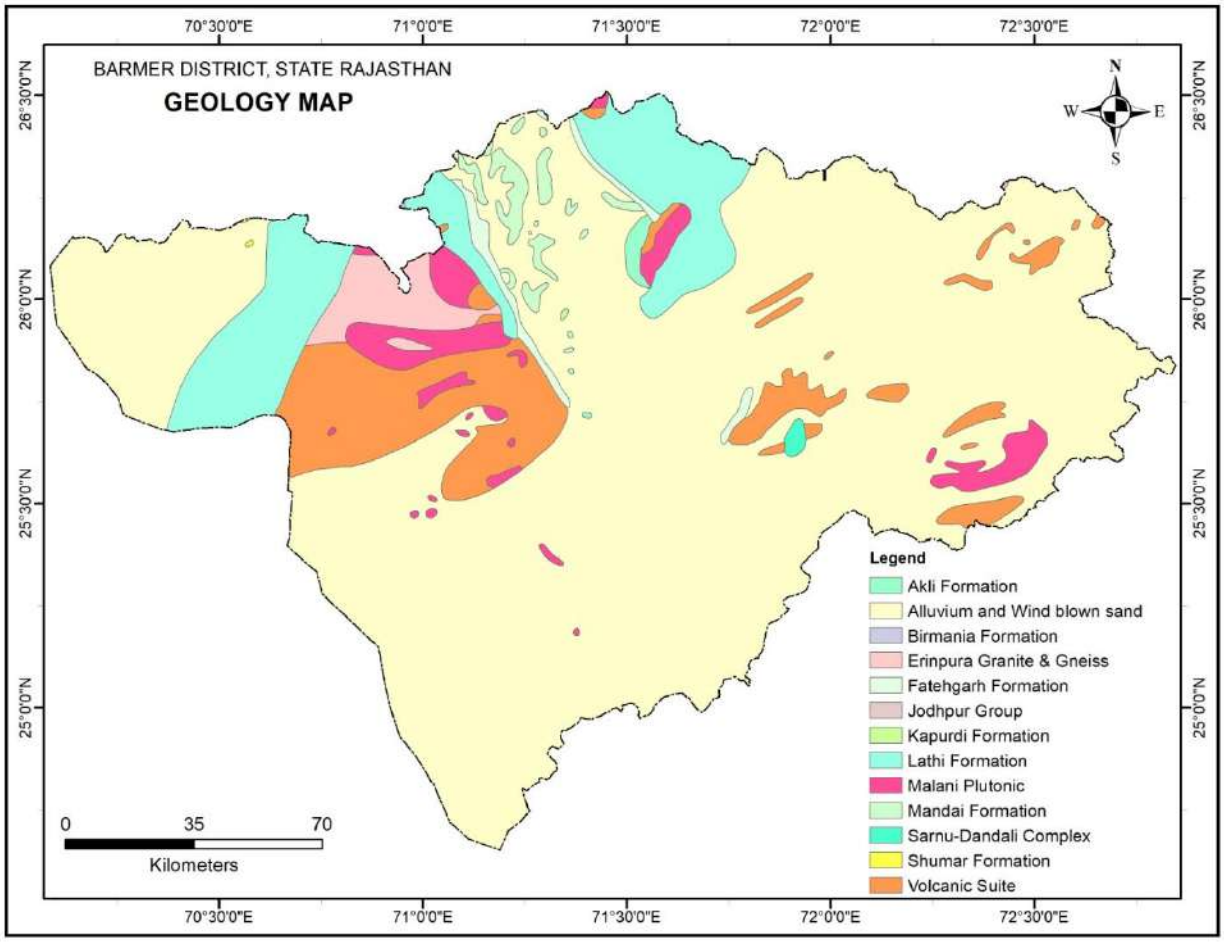


Figure 1.3: Geology of Barmer District

2 Hydrogeology:

The main water bearing formations in the district are rhyolites and granites of post Delhi; Lathi sandstone, Tertiary sandstone and Quaternary alluvium. In Quaternary alluvium, ground water occurs under semi confined to unconfined conditions. In semi consolidated Tertiary and Mesozoic formations, it occurs under unconfined to confined conditions and in weathered and fractured zones in hard rocks under phreatic conditions. Though ground water occurs in all the formations but the most productive aquifers are the Lathi sandstone, Barmer sandstone and Quaternary sediments. The Tertiary formation, which is predominantly clayey and argillaceous, is not found as productive except locally in the sandstone horizon. In general, the fractured and weathered zones in hard rocks form poor aquifers.

Consolidated formations:

Consolidated formations include intrusives of Malani rhyolite and granite and Jalore & Siwana granites of Post Delhi. They lie in northwestern part of district, south of Siwana and entire western part of Barmer upto Harsani. They form poor aquifer. Ground water occurs under water table condition in fractured and weathered residuum down to a depth of 99 m. The rhyolites are partially impervious. They are sparingly jointed and weathered into a clayey impervious residuum lessening the water bearing capacity. The rocks have secondary porosity and the water yielding capacity of rock units diminishes with depth. Yield of dug wells tapping rhyolites is the lowest and ranges from 15 to 50 m3 /day. Two exploratory well, one piezometer and 4 production wells have been constructed in consolidated formations. The depth of drilling/ depth of wells varies from 37.94 to 171.00 m and discharge of wells is meagre indicating the poor potentiality of aquifer.

Semi consolidated formations:

Semi consolidated formations encompassing rocks of Tertiary period, which comprise of alternate layers of clay and shale associated with fuller's earth are unproductive aquifer. Lathi sandstone forms the most potential aquifer and is constituted of medium to coarse grained sandstone with subordinate amount of gravel. It covers the total area of 7500 sq km and the extent of saturated Lathis with utilizable quality of ground water comprises about 3270 sq km. The aquifer portion of the Lathi formation ranges in thickness from less than 100 m in the east to over 800 m in the northern part, east of Jaisalmer. There are generally three aquifers in the depth ranges of 67 to 100 m, 150 to 200 m and 240 to 280 m which are in hydraulic continuity. The ground water in Lathi formation occurs under perched as well as main water table conditions and under confined condition. The eastern part of Lathis is unsaturated, except for perched saturated zone which supply water locally to villages. The depth to water level and piezometric heads ranges from 30 to over 120m. The perched water table occurs between 6 and 30 mbgl. The piezometeric surface is shallower in area north of Jaisalmer-Pokaran road due to lower topography. The piezometric surface ranges from 540 mamsl near Bhopa to about 490 mamsl north of

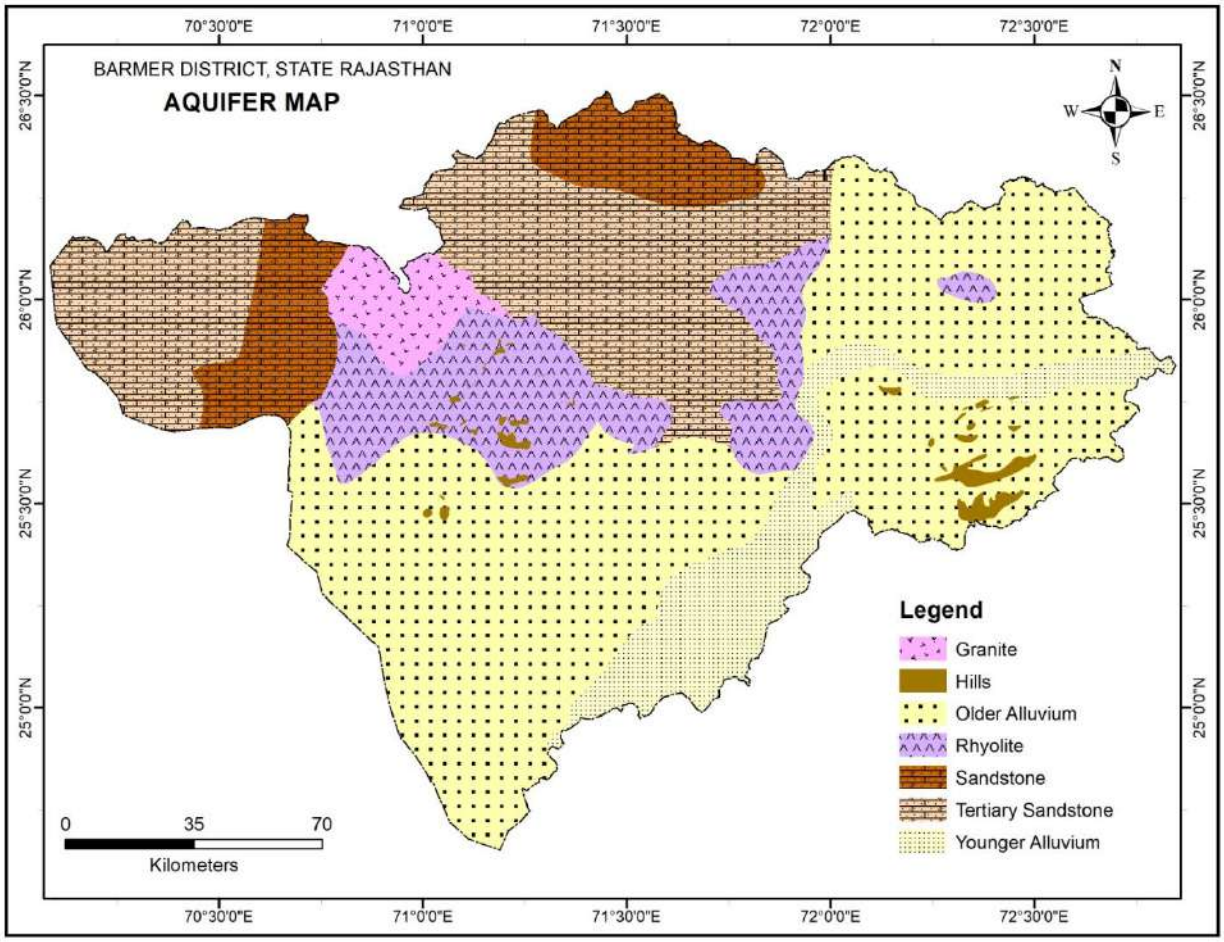
Jaisalmer-Pokaran road and south of Jaisalmer. The piezometric gradient ranges from 0.1 m/km to 1.6 m/km. In semi consolidated formations, 24 exploratory, 3 observation wells, 5 slim holes and 6 piezometers have been drilled. Depth of exploratory drilling varies from 82 to 347 m having depth of wells from 109 to 240 m. Discharge of wells especially in Lathi aquifer in its northern part varies from 303 to 852 lpm for drawdown ranging from 2 to 12 m, while southwards and towards southwest, the discharge of wells having saturated thickness of 15.85 (at Bhimda) to 123 m (at Bothia-II), varies from 632 to 1420 lpm indicating high potentiality of the aquifer. The transmissivity of the Lathi aquifer ranges from less than 100 to over 2000 m2 /day being comparatively higher in the northern part. Wells tapping the aquifer have high specific capacities ranging mostly from 150 to 500 lpm/ m.

Tertiary Formation:

Tertiary formations consisting of alternative layers of clay and shale associated with fuller's earth are unproductive aquifers. The boreholes tapping these formations were abandoned due to very poor yield and due to salinity of formation water. The piezometric level varies from 5.95 m. in the south (Dhanau borehole) to 111.25 m in the north (Gunga borehole). Boreholes tapping the fine grained sandstone in the Tertiaries yielded between 182 lpm (Karim Ka Par borehole) and 189 lpm (Dhanau Borehole) i.e. for drawdown of 10.6 and 12.37 m respectively.

Unconsolidated Formations:

Unconsolidated formation includes Quaternary alluvium that is most extensive, forms the potential aquifer and covers entire southern part and extreme western portion of the district. The exploration drilling data indicate that alluvium is composed of heterogeneous sequence of sand, silt, clay and kankar with occasional tongues and lenses of gravel and cobbles. The thickness of alluvium varies generally from 40 to 100 m except at a borehole at Padru in Balotra block where upto the depth of 140.20 m even bed rock was not encountered. The ground water occurs under water table condition to semiconfined condition. The perched water table condition occurs at shallow depth in clay beds and kankars which arrest the rain water of local precipitation. The piezometric surface lies between 5.51 and 49.87 mbgl. The perched water table condition prevails in central, northern and eastern parts of the district. A total of 28 exploratory, 5 observation wells, 15 piezometers and 9 production wells have been drilled in unconsolidated formation. The exploratory drilling data indicate that the depth of drilling ranges from 18 to 457 m with 18.0 m to 290 m depth of wells. Discharge of wells varies from 22 to 1409 lpm for drawdown ranging from 6.0 m to 35.0 m.

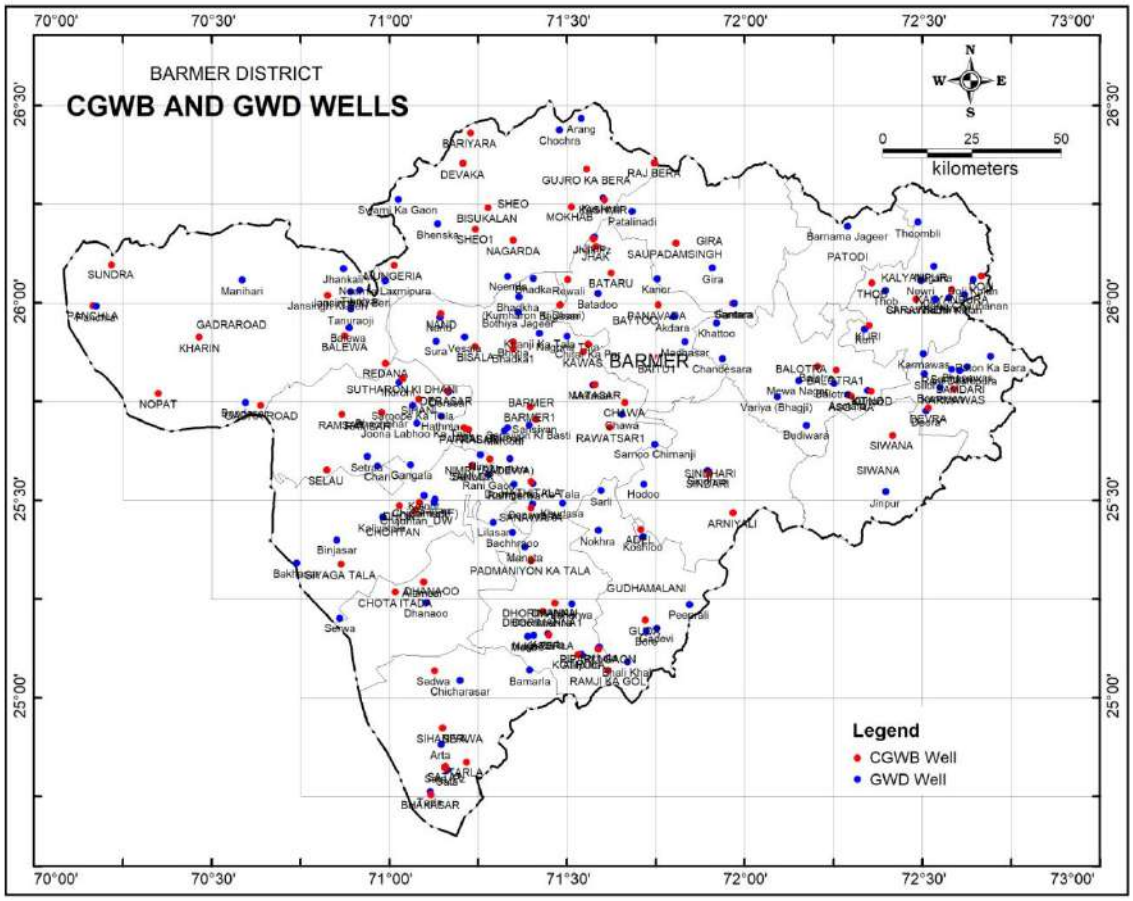


Hydrogeology of Barmer District

Ground Water Exploration

Hydrogeology is concerned primarily with mode of occurrence, distribution, movement and chemistry of water occurring in the subsurface in relation to the geological environment. The occurrence and movement of water in the subsurface is broadly governed by geological frameworks i.e., nature of rock formations including their porosity (primary and secondary) and permeability.

The principal aquifers in the area are Alluvium, sedimentary formations viz. Tertiary sandstone, shale's. Occurrence and movement of ground water in Alluvial aquifer is directly proportional to the granular zones i.e., the ground water accumulation will be higher in coarser formation and the formation clear of clayey admixture or intercalation. The locations of bore holes constructed in Barmer District is prepared in figure

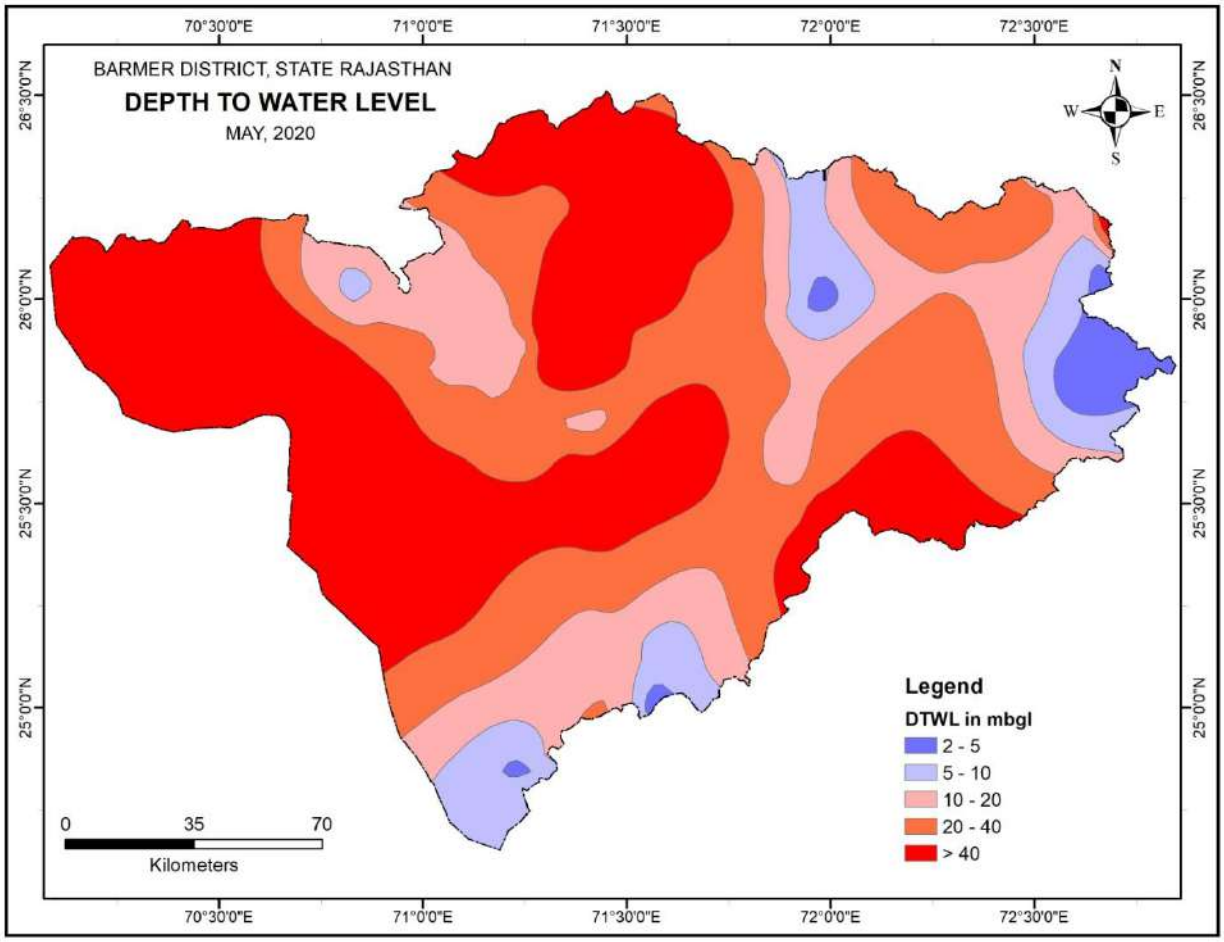


Boreholes constructed in Barmer district

Water Level Behavior

Pre-monsoon (May 2020)

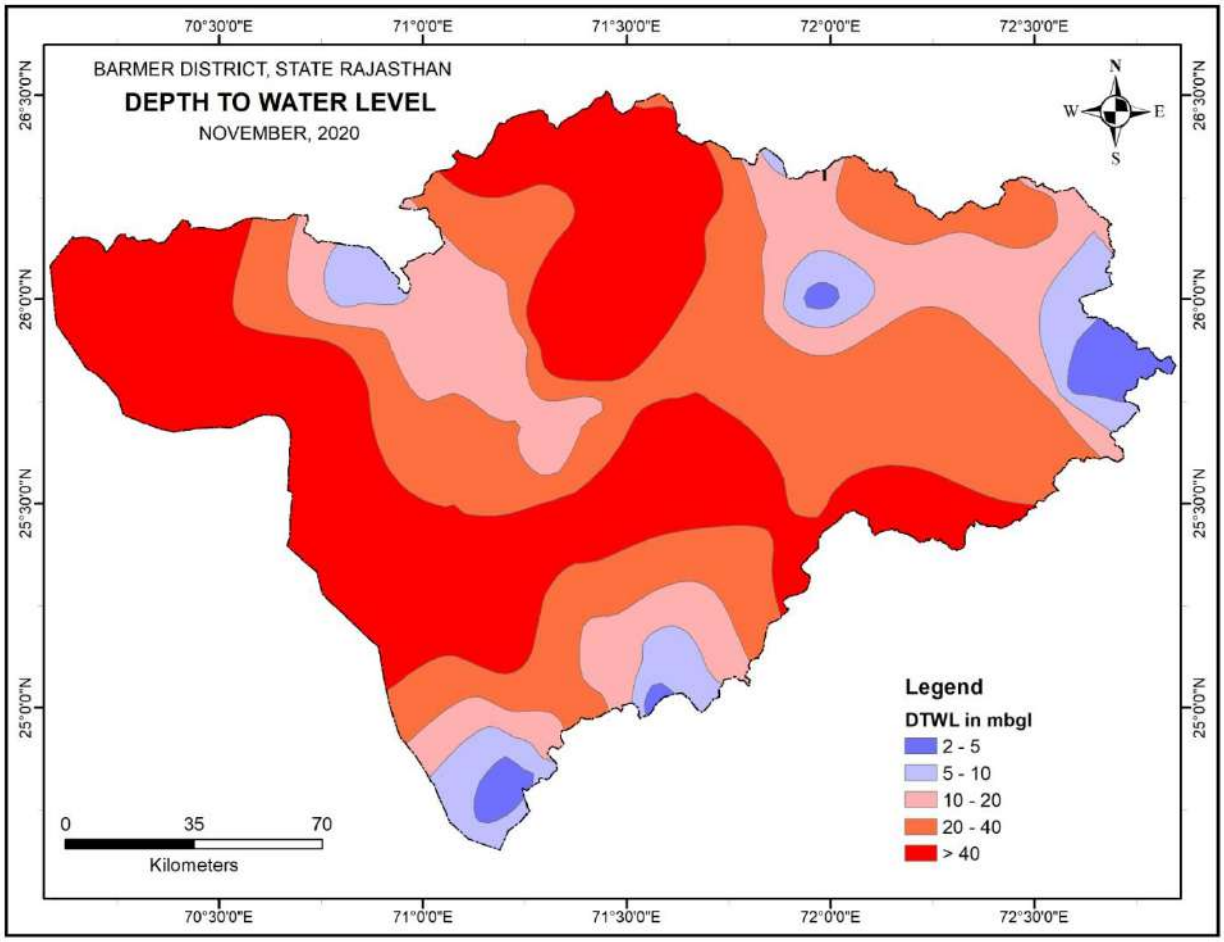
Depth to water level varied from 3.90 to 98.55 m during pre-monsoon 2020. Depth to water level between 10 to 20 m has been observed in 10 observation wells covering about 23% area of the district Deeper water level i.e. more than 20 to 100 m has been recorded in 25 observation wells lying in the north eastern, north eastern and south western part of the district. No area in the block has water level between 0 and 2 m below ground level. In terms of area pre monsoon scenario is presented in figure



Depth to Water Level Map of May 2020 in Barmer District.

Post monsoon (November 2020)

Depth to water level varied from 3.95 to 99.75 m during the Post monsoon season. Depth to water level behavior is almost same as Pre-monsoon water level between 10 to 20 m has been observed in 9 observation wells covering about 22 % area of the district Deeper water level i.e. more than 20 to 100 m has been recorded in 26 observation wells lying in the north eastern, north eastern and south western part of the district. No area in the block has water level between 0 and 2 m below ground level. In terms of area post monsoon scenario is presented in figure



Depth to Water Level Map of November 2020 in Barmer District

Aquifer Maps and Aquifer Characteristics

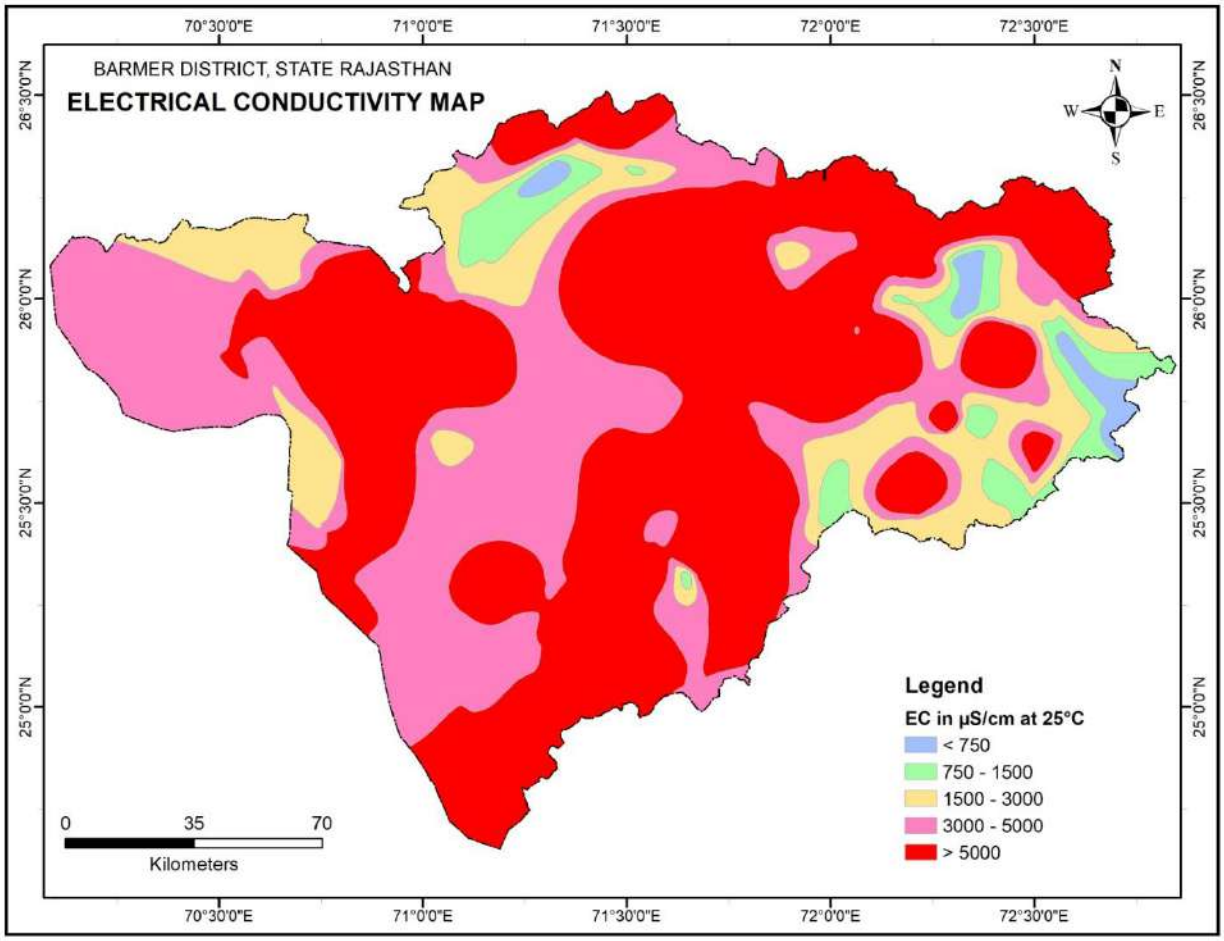
GROUND WATER QUALITY

The ground water of Barmer district possesses relatively high mineral concentration, which varies considerably laterally and vertically. Generally, the perched water has less salt concentration, whereas in Gol of Balotra area where it is highly saline with electrical conductivity around 33280 µS/cm at 25°C. Shallow ground water of the dug well zone has electrical conductivity within 3000 µS/cm at 25°C.

Major Quality Parameters

Electrical Conductivity (EC)

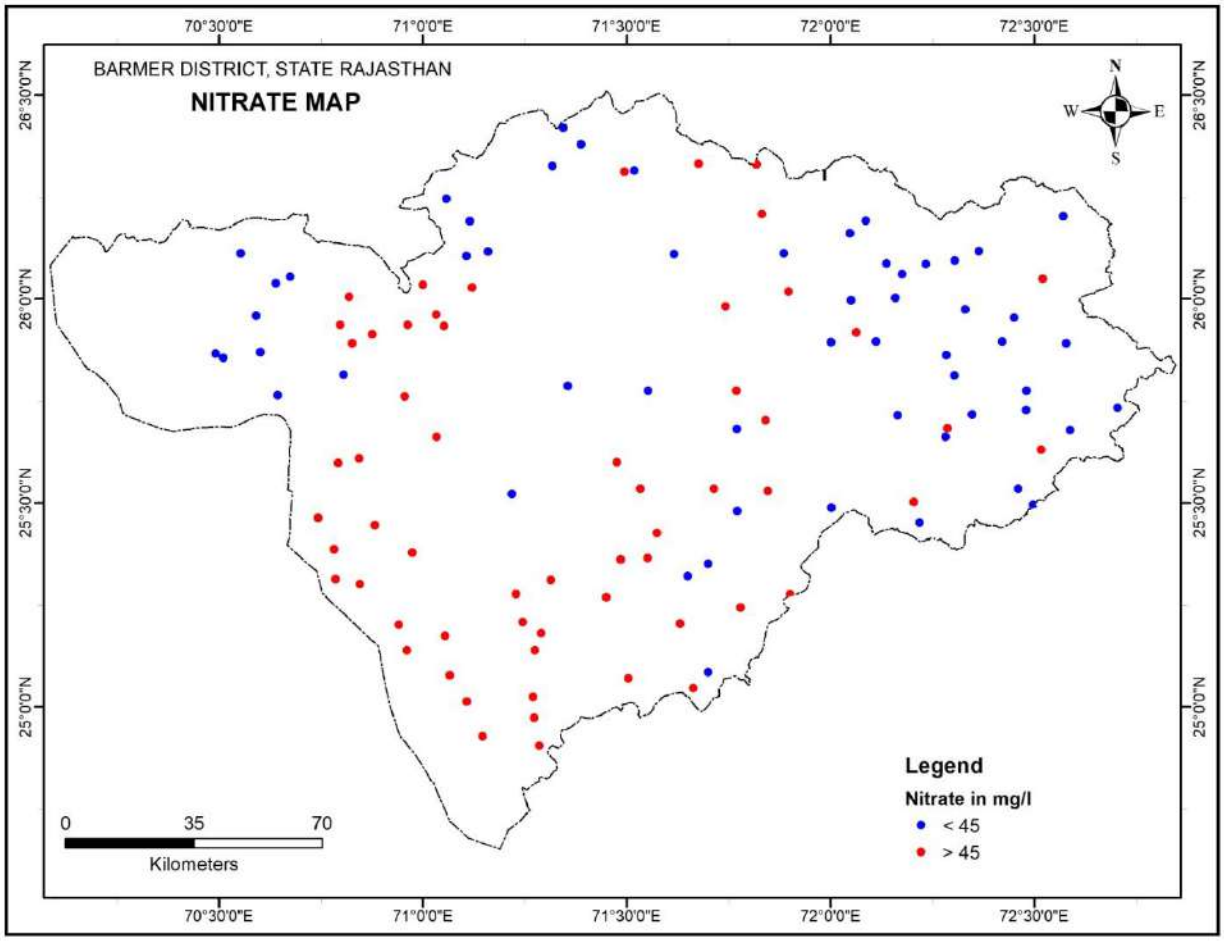
Electrical conductivity is a measure of total mineral contents of dissolved solids in water. It depends upon the ionic strength of the solution. An increase in dissolved solids causes a proportional increase in electrical conductivity. The electrical conductivity value of ground water in Barmer district found to vary from 510 to 33280 µS/cm at 25°C at Sitaram Ki Dhani in Sheo Block and Gol in Balotra Block respectively. Very high concentration of 11000 to 28000 µS/cm at 25°C has been reported at Sindhri, Baytuu, Gudamalani, Ramsar and Gadra Blocks of the district. The spatial variation of EC shows that in maximum area the groundwater has EC values more than 5000 µS/cm at 25°C. EC between 3000 to 5000 µS/cm at 25°C value has been observed in parts of Dhanau, Gadra, Barmer, Gira and Chohtan Blocks and EC between 750 to 1500 µS/cm at 25°C value has been observed in parts of Siwana, Sheo and Sindhri Blocks of the district.



Electrical Conductivity map of Barmer District

Nitrate

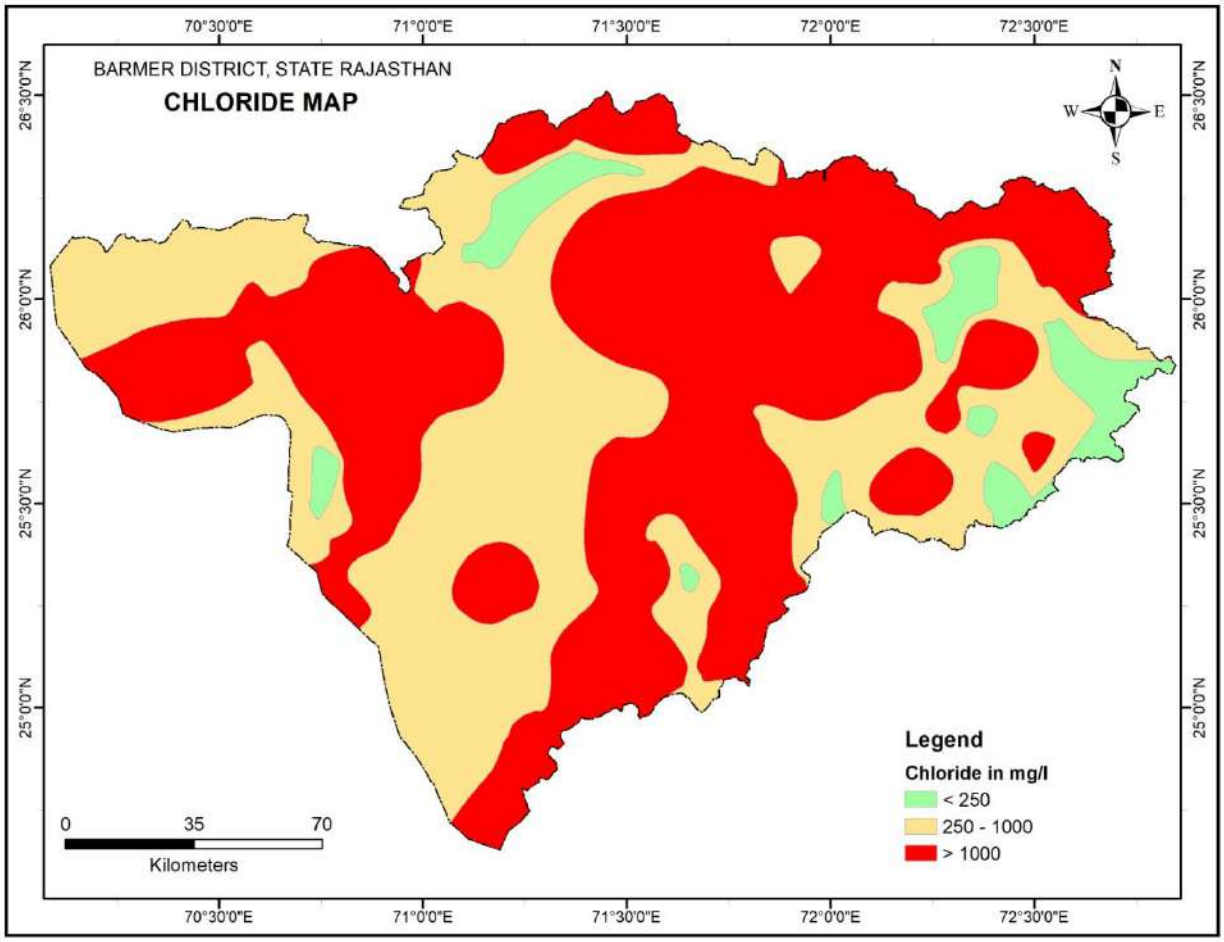
Concentration of nitrate (NO_3^-) has been found to vary from < 1 mg/l to 2010 mg/l. Nitrate concentration exceeds the maximum permissible limit of 45 mg/l in drinking water prescribed by BIS (IS-10500:2012) in around 51% of the total ground water samples. Nitrate in excess of maximum permissible limit has been reported mainly from localised pockets in Chohtan, Dhanau, Dhorimanna, Gadra, Ramsar, Serwa and Sheo Blocks. Higher concentrations of NO_3^- can be attributed to the sampling from application of more fertilizers and sewage carrying drains. Excess nitrate in drinking water can cause methaemoglobinaemia in infants, gastric cancer, goiter, birth malformations and hypertensions



Nitrate map of Barmer District

Chloride

Concentration of chloride has been found to vary from < 250 mg/l to 9050 mg/l. Chloride concentration exceeds the maximum permissible limit of 1000 mg/l in drinking water prescribed by BIS (IS-10500:2012) in around 44 % of the total ground water samples. Chloride in excess of maximum permissible limit has been reported mainly from localised pockets in Balotra, Barmer, Baytoo, Gadra, Gira, Guda Malani and Sindhri Blocks. Excess limit of chlorine in drinking water can affect the taste, corrosion, and palatability.



Chloride map of Barmer District

Suitability of Ground Water for Drinking Purposes

The suitability of ground water for drinking purpose is determined keeping in view the effects of various chemical constituents in water on the biological system of human being. The standards proposed by the Bureau of Indian Standards (BIS) for drinking water (IS-m10500-91, Revised 2012) were used to decide the suitability of ground water for drinking purpose. The overall classification of ground water samples falling below desirable limit (<DL) in the range of Desirable Limit and Maximum Permissible Limit (DL-MPL) and above maximum permissible limit (MPL) for drinking purpose is presented in table

Parameters	BIS ranges for drinking		Total number of Samples	Samples< DL		Samples between DL and PL		Samples > PL	
	DL	PL		Number of Samples	%	Number of Samples	%	Number of Samples	%
pH	6.5-8.5	No relaxation	118	0	0	116	98.30	02	1.70
TDS mg/l	500	2000	118	07	5.93	31	26.27	80	67.70
TH mg/l as $CaCO_3$	200	600	118	14	11.86	62	52.54	41	34.70
Ca^{++} mg/l	75	200	118	38	32.20	58	49.15	22	18.65
Mg^{++} mg/l	30	100	118	32	27.12	61	51.70	25	21.08
Cl^- mg/l	250	1000	118	19	16.10	46	38.98	53	44.92
SO_4^{--} mg/l	200	400	118	26	22.04	27	22.88	65	55.08
NO_3^- mg/l	45	No relaxation	118	56	47.45	--	--	62	52.55
F^- mg/l	1	1.5	118	29	24.57	25	21.18	64	54.25

DL Desirable Limit MPL Maximum Permissible Limit

Total Hardness (TH)

Classification of ground water samples based on Total Hardness (TH) is given in Table. TH has been found to vary between 105 mg/l and 3700 mg/l, indicating soft to very hard type of ground water. High hardness may cause precipitation of calcium carbonate and encrustation on water supply distribution systems. Long term consumption of extremely hard water might lead to an increased incidence of urolithiasis, anencephaly, parental mortality and cardio-vascular disorders. In Bikaner, Total Hardness exceeds the recommended maximum permissible limit of 600 mg/l (IS-10500: 2012) in 64.40% of total analysed ground water samples. Total hardness in excess of the maximum permissible limit has been reported from parts of Balotra, Siwana, Gira, Baytu and Gudamalani Blocks of the district.

Hardness Classification of water

Hardness (mg/l)	Water Class	No. of Samples	% Sample
0 – 75	Soft	0	0
75 – 150	Moderately Hard	7	5.94
150 – 300	Hard	28	23.72
>300	Very Hard	83	70.34

Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) in water include all dissolved materials in solution, whether ionized or not. It is numerical sum of all mineral constituents dissolved in water and is expressed in mg/l. The TDS contents of ground water are controlled by the mineral dissolution rate, chemical character of ground water and ionic saturation status of solution. The concentration of total dissolved solids in the ground water has been found to vary generally between 175 mg/l to 21632 mg/l. TDS of 50% of analyzed water samples falls in the category of fresh water, while 39% samples have TDS in the range of 3000 - 10,000 mg/l and fall in brackish water category.

Classification of water based on Total Dissolved Solids

Block	**Fresh % Samples**	**Brackish % Samples**	**Saline % Samples**	**Brine % Samples**
	0-3000 mg/l	**3000-10000 mg/l**	**>10000 mg/l**	**>35000 mg/l**
Baitu	0.00	50.00	50.00	0.00
Balotra	50.00	16.66	33.34	0.00
Barmer	40.00	40.00	20	0.00
Chohtan	42.85	57.15	0.00	0.00
Dhanau	100.00	0.00	0.00	0.00
Dhorimanna	16.66	83.34	0.00	0.00
Gadra Road	38.46	38.46	23.08	0.00
Gida	28.57	57.14	14.29	0.00
Gudamalani	28.57	42.86	28.57	0.00
Kalyanpur	60.00	40.00	0.00	0.00
Patodi	40.00	60.00	0.00	0.00
Ramsar	33.33	33.33	33.34	0.00
Samdari	100.00	0.00	0.00	0.00
Sedwa	0.00	100.00	0.00	0.00
Shiv	83.34	16.66	0.00	0.00
Sindhri	20.00	80.00	0.00	0.00
Siwana	50.00	50.00	0.00	0.00

Suitability of Ground Water for Irrigation Purposes

The ground water used for irrigation is an important factor in productivity of crop, its yield and quality of irrigated crops. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. The Electrical Conductivity (EC), Sodium Absorption Ratio (SAR) and Residual Sodium Carbonate (RSC) are the most important quality criteria,

which influence the water quality and its suitability for irrigation. The quality of groundwater based on EC and SAR is discussed in tables

Classification of Ground Water Samples based on EC

	Electrical Conductivity µS/cm at 25° C			**Classification of water**	**Activity required**
Type of Water	**Range**	**No. of Samples**	**% of Samples**		
Low Saline	>250	0	0	Excellent	• Good for all crops • little likelihood of development of salinity
Medium Saline	250-750	7	5.00	Good	• Plants with moderate salt tolerance • No special practices for salinity control required. • Moderate amount of leaching occurs.
Highly Saline	750-2250	20	16.94	Doubtful	• Cannot be used on soils with restricted drainage. • Even with adequate drainage, special management for salinity control may be required • Plants with good salt tolerance should be selected.
Very Highly saline	> 2250	92	77.96	Unsuitable	• Not suitable for irrigation under ordinary condition. • soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching • very salt tolerant crops should be selected
		118	100		

High saline water cannot be used on soils with restricted drainage and requires special management for salinity control. Plants with good salt tolerance should be selected for such areas. Very high saline water is not suitable for irrigation under ordinary conditions but may be used occasionally under very special circumstances. The soil must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching and salt tolerance crops/plants should be selected.

Classification of Ground Water Samples based on SAR

Type of Water	Sodium Adsorption Ratio			Classification of water
	Range	No. of samples	% of Samples	
Low Sodium Water	< 10	31	26.28	Excellent
Medium Sodium Water	10 to 18	33	27.96	Good
High Sodium Water	18 to 26	30	25.42	Doubtful
Very High Sodium Water	>26	24	20.34	Unsuitable
		118	100	

Classification of Ground Water Samples based on Na%

Water Class	Na%	
	Range	No. of samples
Excellent	< 20	02
Good	20 - 40	05
Medium	40 - 60	12
Bad	60 - 80	50
Very Bad	> 80	49

Low sodium (alkali) water can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium. Medium sodium water will present an appreciable sodium hazard in fine textured soils having high cation exchange capacity especially under low leaching conditions. This water can be used on coarse textured or organic soils with good permeability.

RSC values in 118 analysed samples of Barmer District were found to be <1.25, 1.25 - 2.0, 2.0 - 2.5, 2.5 - 3.0 samples becomes 95%. Only 05 % samples were found in which the RSC value exceeded 3.0 meq/l limits. The high RSC value makes the groundwater unsuitable for irrigation uses. The block-wise analysis for RSC values for assessing suitability of groundwater for irrigation is presented in table.

Classification of Ground Water Samples based on RSC

RSC (meq/l)		Baitu	Balotra	Barmer	Chohtan	Dhanau	Dhorimanna	Gadra Road	Gida	Gudamalani	Kalyanpur	Patodi	Ramsar	Samdari	Sedwa	Shiv	Sindhri	Siwana
Range	**No.of samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**	**% samples**
< 1.25	111	100	100	75	87.50	100	83.33	100	100	100	100	100	75	87.50	100	100	100	85.71
1.25 - 2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0 - 2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5 - 3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
> 3.0	07	0	0	25	12.50	0	16.66	0	0	0	0	0	25	12.50	0	0	0	14.29

Ground Water Resources

The ground water resource assessment as on March 2017 has been carried out and the salient features of the resources are given in Table

As per table- out of the total 2436174 ha area, recharge worthy areas are 1447172 ha in non-command areas.

Table : Area for Resource assessment (as on March 2017) in Barmer District

S.No	Blocks/Assessment Units	Total Geographical Area (ha)	Potential Area (ha)	Hilly Area (ha)	Command Area (ha)	Non Command Area (ha)
1.	Baitu	140758	25036	0	0	25036
2.	Balotra	156683	44860	0	0	44860
3.	Barmer	241209	151337	0	0	151337
4.	Chohtan	180275	115025	0	0	115025
5.	Dhanau	124474	124474	0	0	124474
6.	Dhorimanna	165986	141375	0	0	141375
7.	Gadra Road	392564	118750	0	0	118750
8.	Gida	155036	5156	0	0	5156
9.	Gudamalani	128265	118235	0	0	118235
10.	Kalyanpur	126304	31850	0	0	31850
11	Patodi	83162	35000	0	0	35000
12.	Ramsar	158707	36875	0	0	36875
13.	Samdari	83687	25600	0	0	25600
14.	Sedwa	170357	113750	0	0	113750
15.	Shiv	266379	148329	0	0	148329
16.	Sindhri	162984	70109	0	0	70109
17.	Siwana	120828	111500	0	0	111500
	Total	**2436174**	**1447172**	**0**	**0**	**1447172**

Recharge Component

During the monsoon season, the rainfall recharge is the main recharge parameter, which is estimated as the sum total of the change in storage and gross draft. The change in storage is computed by multiplying groundwater level fluctuation between pre and post monsoon

periods with the area of assessment and specific yield. Monsoon recharge can be expressed as:-

$R = h \times Sy \times A + DG$

Where h = rise in water level in the monsoon season, Sy = specific yield

A = area for computation of recharge, DG = gross ground water draft

The monsoon ground water recharge has two components- rainfall recharge and recharge from other sources. The other sources of groundwater recharge during monsoon season include seepage from canals, surface water irrigation, tanks and ponds, ground water irrigation, and water conservation structures.

During the non-monsoon season, rainfall recharge is computed by using Rainfall Infiltration Factor (RIF) method. Recharge from other sources is then added to get total non-monsoon recharge.

The season wise and block-wise wise assessment of recharge from various components such as rainfall and other sources for various units was done and presented in table. The recharge from rainfall contributes maximum component (26062.15 ham) during monsoon season and recharge from other sources (848.480 ham). The total annual ground water recharge is 30343.62 ham and net ground water availability after natural discharge is 1111.730 ham.

Recharge Components evaluated for Resource Estimation

Blocks/ Assessment Units	Accepted Value of Mon. Rainfall recharge Rrf (Normal)	Total Recharge from other sources	Recharge from Rainfall during non-monsoon	Recharge from other sources (Rgw+Rc+ Rsw+Rt)	Total Annual ground water Recharge	Environmental flows during Non Monsoon Season	Net GW Availability
	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)
BAITU	322.28	3.95	0.00	11.86	338.10	33.81	0.00
BALOTRA	909.79	59.09	0.00	59.09	1027.97	102.80	0.00
BARMER	1977.99	17.74	208.47	81.86	2286.06	228.61	513.09
CHOHTAN	2181.29	15.47	0.00	45.43	2242.19	224.22	543.49
DHANAU	2694.61	31.78	0.00	476.77	3203.16	320.32	9.77
DHORIMANA	205.65	48.41	214.22	211.80	680.08	68.01	0.00
GADRA ROAD	813.11	7.01	97.78	35.74	953.64	95.36	0.00

GIDA	66.37	2.29	0.00	6.86	75.52	7.55	0.00
GUDAMALANI	2948.94	230.27	0.00	399.20	3578.40	357.84	0.00
KALYANPUR	618.61	17.58	0.00	17.58	653.77	65.38	15.87
PATODI	765.28	14.81	0.00	22.73	802.82	80.28	0.00
RAMSAR	483.32	8.56	61.13	46.08	599.09	59.91	0.00
SAMADRI	1184.46	52.64	0.00	72.72	1309.82	130.98	0.00
SEDWA	2415.10	70.18	0.00	90.82	2576.10	257.61	29.52
SHIV	844.50	98.53	103.90	330.07	1377.01	137.70	0.00
SINDHARY	2737.65	86.20	0.00	177.19	3001.04	300.10	0.00
SIWANA	4893.21	83.96	409.83	251.88	5638.88	281.94	0.00
DISTRICT	**26062.15**	**848.480**	**1095.322**	**2337.668**	**30343.62**	**2752.418**	**1111.730**

The annual gross draft for all uses is estimated at 34284.64 ham with irrigation sector being the major consumer having a draft of 29153.67 ham. The annual draft for domestic and industrial uses was 5130.97 ham. The allocation for domestic & industrial requirement supply up to next 25 years is about 6926.82 ham.

Block wise GW Resources of Barmer (March 2017) (in ham)

Block	Potential Zone	Annual Extractable Ground Water Recharge	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground Water Domestic & Industrial Uses	Existing Gross Ground Water Draft for all uses	Stage of Ground Water Extraction %	Category
BAITU	25036	304.29	316.28	15.00	331.28	108.87	OE
BALOTRA	44860	925.18	1575.76	94.95	1670.71	180.58	OE
BARMER	151337	2057.45	677.10	642.42	1319.52	64.13	Safe
CHOHTAN	115025	2017.97	1211.52	194.79	1406.31	69.69	Safe
DHANAU	124474	2882.84	2542.76	244.68	2787.44	96.69	Critical
DHORIMANA	141375	612.07	1129.60	161.97	1291.57	211.02	OE
GADRA ROAD	118750	858.27	494.12	828.96	1323.08	154.16	OE
GIDA	5156	67.96	60.96	99.00	159.96	235.35	OE
GUDAMALANI	118235	3220.56	3888.10	422.22	4310.32	133.84	OE
KALYANPUR	31850	588.39	468.80	76.83	545.63	92.73	Critical
PATODI	35000	722.54	970.94	30.30	1001.24	138.57	OE

RAMSAR	36875	539.18	409.60	113.82	523.42	97.08	Critical
SAMADRI	25600	1178.84	1403.77	315.45	1719.22	145.84	OE
SEDWA	113750	2318.49	2054.88	173.40	2228.28	96.11	Critical
SHIV	148329	1239.31	2933.97	765.23	3699.19	298.49	OE
SINDHARY	70109	2700.94	2298.78	388.65	2687.43	99.50	Critical
SIWANA	111500	5356.93	6716.74	563.31	7280.05	135.90	OE
DISTRICT	**1447172**	**27591.20**	**29153.67**	**5130.97**	**34284.64**	**124.26**	OE

In-storage Resources

Ground water resource assessment of the zone below water level fluctuation is carried out is presented in table.

Table: Block wise In-storage Resources of Barmer District

Block	Total Area (Sq.Km)	Main aquifer	Sp yield	Utilizable Volume (mcm)	In storage Resources (mcm)
Baetu	1407.58	250.36	0.0100	17.03	42.64
Balotra	1566.83	448.60	0.0100	19.88	178.39
Barmer	2412.09	1513.37	0.0100	15.66	51.32
Chohtan	1802.75	1150.25	0.0150	25.13	237.30
Dhanau	1244.74	1244.74	0.0150	15.82	267.53
Dhorimanna	1659.86	1413.75	0.0150	71.44	717.97
Gadra Road	3925.64	1187.50	0.0100	24.60	292.12
Gida	1550.36	51.56	0.0100	27.34	14.09
Guda Malani	1282.65	1182.35	0.0150	18.87	334.66
Kalyanpur	1263.4	318.50	0.0150	14.23	60.31
Patodi	831.62	350.00	0.0150	26.85	140.96
Ramsar	1587.07	368.75	0.0150	21.36	34.01
Samdari	836.87	256.00	0.0150	12.02	46.15
Sedwa	1703.57	1137.50	0.0150	21.99	375.20
Sheo	2663.79	1483.29	0.0100	21.38	317.12
Sindhari	1629.84	701.09	0.0150	11.76	123.67
Siwana	1208.28	1115.00	0.0150	9.86	164.90
Total	27439.88	14172.61	0.013	375.22	3157.63

The total in-storage resources of the district, comes to 3157.63 mcm. The block-wise sustainability period of aquifers, if the present ground water draft for all uses continues to be same, is calculated after considering both dynamic resources and in-storage resources and presented in table

Block wise Sustainability of Aquifer in Barmer

Block	**Dynamic Resource** (mcm)	**In-Storage Resources** (mcm)	**Current annual gross ground water extraction for 'All Uses' (mcm)**	**Sustainability period of Aquifer** (years)
Baetu	3.04	42.64	3.31	13.8
Balotra	9.25	178.39	16.70	20.29
Barmer	20.57	51.32	13.19	3.495
Chohtan	20.17	237.30	14.06	12.76
Dhanau	28.82	267.53	27.87	10.28
Dhorimanna	6.12	717.97	12.91	118.3
Gadra Road	8.58	292.12	13.23	35.05
Gida	0.67	14.09	1.59	22.03
Guda Malani	32.20	334.66	43.10	11.39
Kalyanpur	5.88	60.31	5.45	11.26
Patodi	7.22	140.96	10.01	20.52
Ramsar	5.39	34.01	5.23	7.31
Samdari	11.78	46.15	17.19	4.918
Sedwa	23.18	375.20	22.28	17.19
Sheo	12.39	317.12	36.99	26.59
Sindhari	27.00	123.67	26.87	5.58
Siwana	53.56	164.90	72.80	4.079
Total	275.82	3157.63	337.33	12.44

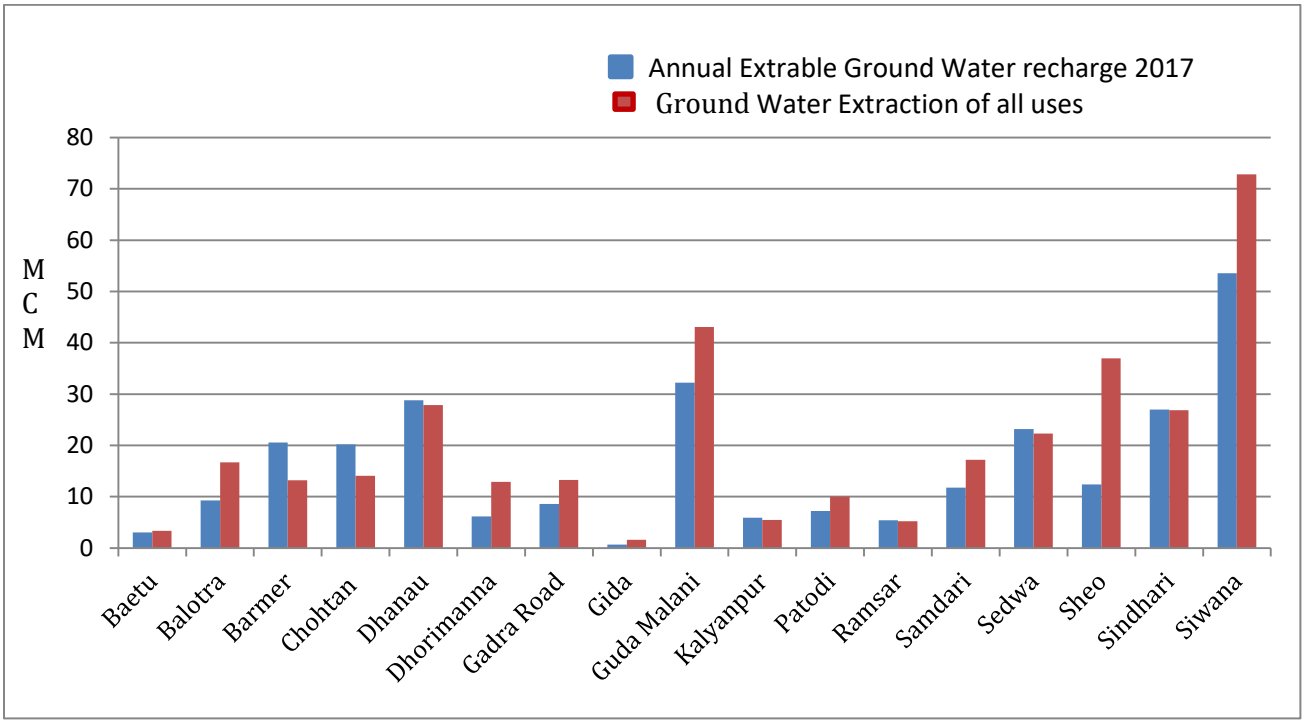
Aquifer Management Plan

8.1 Ground Water Related Issues

Over Exploitation of Groundwater

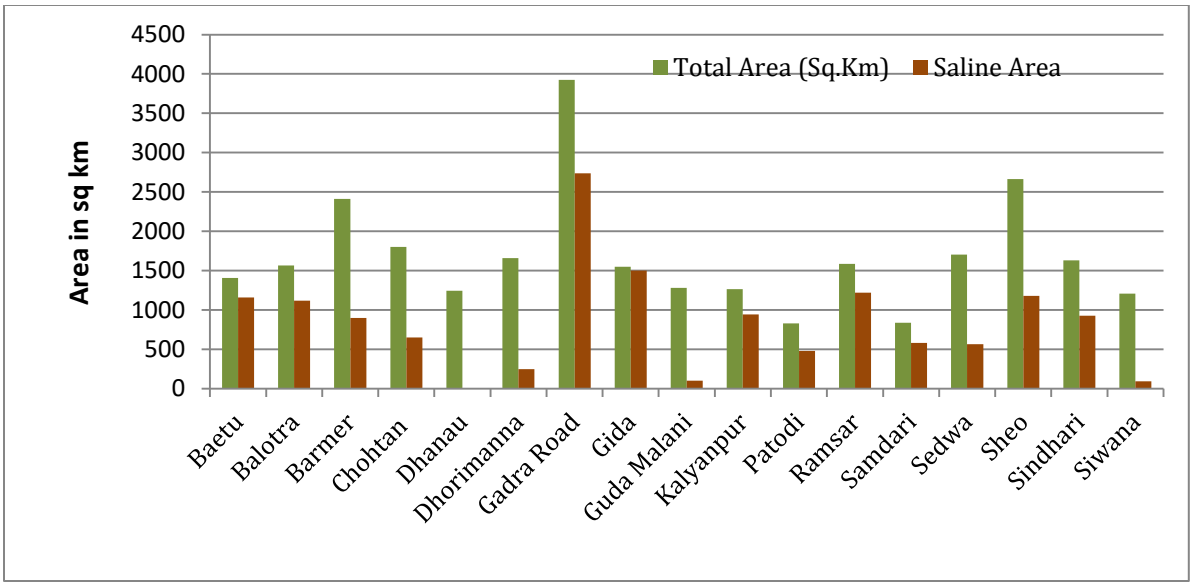
The ground water draft is more than net ground water availability in all the blocks The Stage of Ground Water is also increasing. This is due to over-exploitation of ground water for irrigation purposes. The groundwater resource estimation was done for all blocks of the district, stage of ground water development has increased over the period of time from 2009 to 2017 in almost all blocks of the District.

The ground water draft is more than net ground water availability in all the blocks



Inland Salinity

The parts of Baetu, Balotra, Barmer, Chohtan, Dhorimanna, Gadra, Gida, Guda Malani,Kalyanpur, Patodi, Ramsar, Samdari, Sedwa, Sheo, Sindhri Blocks covering an area of 14403.97 sq.km area has saline nature due to inland salinity problems with EC ranging from 3000 to 33,280 µS/cm at 25°C. The ground water in these areas is neither suitable for drinking nor for irrigation purposes. Figure depicts the ground water quality of aquifer



Distribution of Saline Area in Barmer District

Ground Water Management Plan

The management plan has been proposed to manage the ground water resources and to arrest further decline in water levels and improve the Stage of Ground Water Development in the district which is 124.26 % for the district and falls in Over-Exploited category. The management plan comprises two components namely supply-side management and demand side management. The management plan proposed in all the 17 blocks of Barmer District is discussed below

Supply Side Management

The supply side management of ground water resources is proposed based on availability of surplus surface water. 4.71 mcm surplus surface water is available during rainy season for which a total of 42117 Tanka (Nos.) (Capacity 50,000 liters) are proposed to be constructed in the district. After construction of water conservation structures, volume of 2.10 mcm surface water conserved.

Block-wise Proposal of Water Conservation Structures in Barmer District

Block	Geographical Area (sq km)	Hilly Area (sq km)	Potential Area (sq km)	Tanka (Nos.) (Capacity 50,000 liters)	Average cost (Rs) of Tanka	Total cost (Rs in crore) of Tanka
Baetu	1407.58	0	250.36	1999	200000	4.00
Balotra	1566.83	0	448.60	2316	200000	4.63
Barmer	2412.09	0	1513.37	4319	200000	8.64
Chohtan	1802.75	0	1150.25	3156	200000	6.31
Dhanau	1244.74	0	1244.74	2421	200000	4.84
Dhorimanna	1659.86	0	1413.75	2545	200000	5.09
Gadra Road	3925.64	0	1187.50	2370	200000	4.74
Gida	1550.36	0	51.56	2306	200000	4.61
Guda Malani	1282.65	0	1182.35	2458	200000	4.92
Kalyanpur	1263.4	0	318.50	2222	200000	4.44
Patodi	831.62	0	350.00	1487	200000	2.97
Ramsar	1587.07	0	368.75	2213	200000	4.43
Samdari	836.87	0	256.00	1972	200000	3.94
Sedwa	1703.57	0	1137.50	3382	200000	6.76
Sheo	2663.79	0	1483.29	1672	200000	3.34
Sindhari	1629.84	0	701.09	2601	200000	5.20
Siwana	1208.28	0	1115.00	2677	200000	5.35
Total	**27439.88**	**0**	**14172.61**	**42117**	**200000**	**84.21**

Demand Side Management

The Demand Side Management is proposed in all the blocks as the Stage of Ground Water Development is 124.26. Baytu, Balotra, Dhorimanna, Gadra, Gida, Gudamalani, Patodi, Samdari, Shiv and Shivana blocks fall in over exploited Category, Dhanau, Kalyanpur, Ramsar, Sedwa and Sindhry falls in Critical category. Even though after implementation of supply side management options in the current scenario, the water saving is still less to compensate the withdrawal. So, there is a need of adopting micro-irrigation techniques for water intensive crops or change in cropping pattern or both are required to save water.

The micro-irrigation techniques viz. sprinkler or drip irrigation, which is not in practice in the district till date is proposed to be adopted in 93194 ha. area of the district which can save a total of 74.55 mcm water. Similarly, if the 50% of cropping area of wheat be changed to gram crop it can save water up to 25.71 mcm (Figure 8.5).

Block-wise proposal for adopting Micro-Irrigation in Barmer District

Blocks	Net Irrigated Area through Ground Water (ha)				50% of area proposed for adopting Micro Irrigation Techniques (ha) (Sprinklers)	Water Saving through Micro Irrigation (mcm)
	Canals	TW	DW	Total		
Baetu	0	21002	26	21028	10514	8.4112
Barmer	0	7902	5253	13155	6577.5	5.262
Chohtan	0	0	27137	27137	13568.5	10.8548
Dhorimanna	8055	1127	32456	41638	20819	16.6552
Gadra Road	0	15893	0	15893	7946.5	6.3572
Gida	0	2725	0	2725	1362.5	1.09
Guda Malani	13534	0	47724	61258	30629	24.5032
Ramsar	0	4	485	489	244.5	0.1956
Samdari	0	4946	3537	8483	4241.5	3.3932
Sedwa	9395	17299	131042	157736	78868	63.0944
Sheo	0	76834	743	77577	38788.5	31.0308
Sindhari	0	12601	1079	13680	6840	5.472
Siwana	0	26687	4834	31521	15760.5	12.6084
Panchpadra	0	7088	543	7631	3815.5	3.0524
Total	**30984**	**194108**	**254859**	**479951**	**239975.5**	**191.9804**

Block-wise proposal for Crop Change and Water Saving in Barmer District

Blocks	Area Proposed for crop change from Wheat to Gram (ha)	Water Saving through Change in Crop (mcm)
Baetu	26	0.026
Barmer	194	0.194
Chohtan	37	0.037
Dhorimanna	1675	1.675
Gadra Road	1	0.001
Gida	27	0.027
Guda Malani	3000	3
Ramsar	1	0.001
Samdari	2323	2.323
Sedwa	1168	1.168
Sheo	142	0.142
Sindhari	650	0.65
Siwana	3664	3.664
Balotra	4140	4.14
Total	**17048**	**17.048**

Expected Benefits

The impact of groundwater management plans on the groundwater system in the district after its implementation is evaluated and the outcome shows significant improvement in groundwater scenario in all blocks as given in the table

After implementation of interventions the total Stage of Groundwater Extraction will improve from 145% to 70%.

Table : Ground Water Availability & Stage After Interventions in Barmer District

Block	Net G.W. Availability (mcm)	Additional Recharge from RWH & conservation (mcm)	Total Net G.W. Availability after intervention (mcm)	Existing G.W Draft for all purpose (mcm)	Saving of Ground water through projects (mcm)	Net GW draft after interventions (mcm)	Present stage of G.W. development (%)	Projected stage of G.W. Dev. (in %)
Baetu	3.04	0.00	3.04	3.31	1.68224	1.63	108.87	53.54
Barmer	20.57	0.00	20.57	13.19	5.466	7.72	64.13	37.55
Chohtan	20.17	0.00	20.17	13.06	10.8918	2.17	69.69	10.75
Dhorimanna	6.12	0.00	6.12	12.91	3.33104	9.58	211.02	156.52
Gadra Road	8.58	0.00	8.58	13.23	6.3582	6.87	154.16	80.09
Gida	0.67	0.00	0.67	1.59	1.117	0.47	235.35	70.60
Guda Malani	32.2	0.00	32.20	43.1	28.2332	14.87	133.84	46.17
Ramsar	5.39	0.00	5.39	5.23	0.1966	5.03	97.08	93.38
Samdari	11.78	0.00	11.78	17.19	6.3362	10.85	145.84	92.14
Sedwa	23.18	0.00	23.18	22.28	12.61888	9.66	96.11	41.68
Sheo	12.39	0.00	12.39	36.99	31.1728	5.82	298.49	46.95
Sindhari	27	0.00	27.00	17.19	7.202	9.99	99.5	36.99
Siwana	53.56	0.00	53.56	72.8	17.1224	55.68	135.9	103.95
Balotra	9.25	0.00	9.25	16.7	8.0024	8.70	180.58	94.03
Total	233.90	0.00	233.90	288.77	139.7308	149.04	145	70.00

Conclusions

The study was carried out based on data gap analysis, data generated in-house; data acquired from State Govt. departments and GIS maps prepared for various themes. All the available data was brought on GIS platform and an integrated approach was adopted for preparation of block wise aquifer maps and aquifer management plans of Barmer District.

Barmer district covering an area of 24361.74 sq.km. Geologically, the area is occupied by Alluvium, Tertiary Sandstone and Malani Rhyolites. The stage of ground water development is 145 %.The area witnessed Inland Salinity, Declining water level, Over-exploitation and low yield potential aquifers, being the major issues in the district.

Managing ground water is a grand challenging problem in its severity, pervasiveness and importance. To increase the water use efficiency, source sustainability plans of rain water harvesting and artificial recharge have been envisaged in the district.

The management plan has been proposed for all 17 blocks namely to manage the ground water resources and to arrest further decline in water levels.

The management plan comprises two components namely supply-side management and demand side management.

As a part of **Supply side Management**, a total of 42117 Tanka proposed for water conservation. After which an amount of 2.10 mcm surface water conserved.

As a part of **Demand side Management**, micro-irrigation techniques are to be adopted in 2399.75 sq. km area thereby saving a total of 191.9 mcm water. Change in cropping pattern is proposed in 17048 ha of area which will save 17.08 mcm water in the district and in turn bring down the Stage of Ground Water Development to 70%.

Recommendations

Awareness program to educate about conservation of precious ground water resources and training on rainwater harvesting will be beneficial to check decline in water level and justified use.

Ground water development in over-exploited, critical and semi-critical area should not be encouraged.

Use of water saving devices like sprinklers and close field distribution channels etc should be promoted.

Modern agricultural management techniques have to be adopted for effective and optimum utilization of the water resources. This can be achieved by maintaining irrigation through minimum pumping hours as per minimum requirement of water by the crop and also selecting most suitable cost effective crop pattern.

High water requirement crops to be discouraged. Proper agriculture extension services should be provided to the farmers so that they can go for alternate low water requirement economical crops.

Salt resistant crops can be sown in the area having brackish ground water.

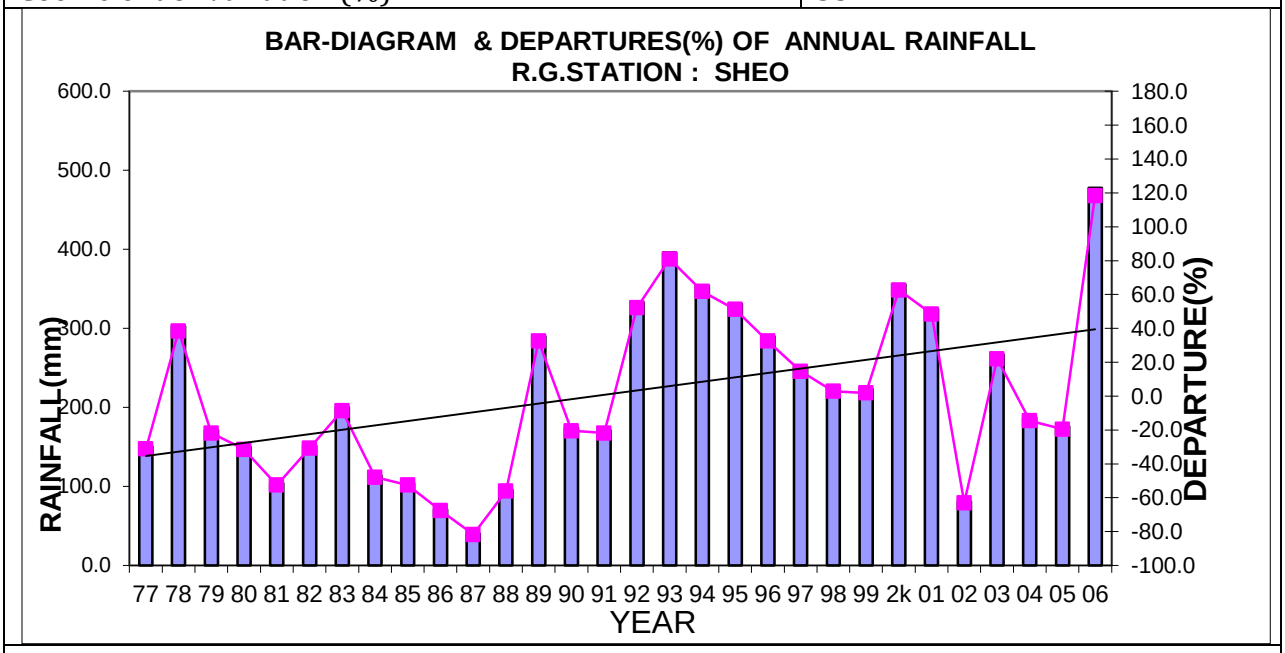
Traditional rainwater harvesting structures like tankas, roof top rain water storage should be encouraged for meeting day to day requirements which will reduce ground water withdrawal.

Large-scale recharge potentials exist in depleted aquifers. Implementation of artificial recharge in such areas through outside surface water sources like lift canal from IGNP system or floodwater during excess rainy years be promoted.

Conjunctive use of ground water and surface water should be encouraged in canal command areas to prevent further water logging in the CCA. Anti water logging measures have to be adopted in the canal command areas.

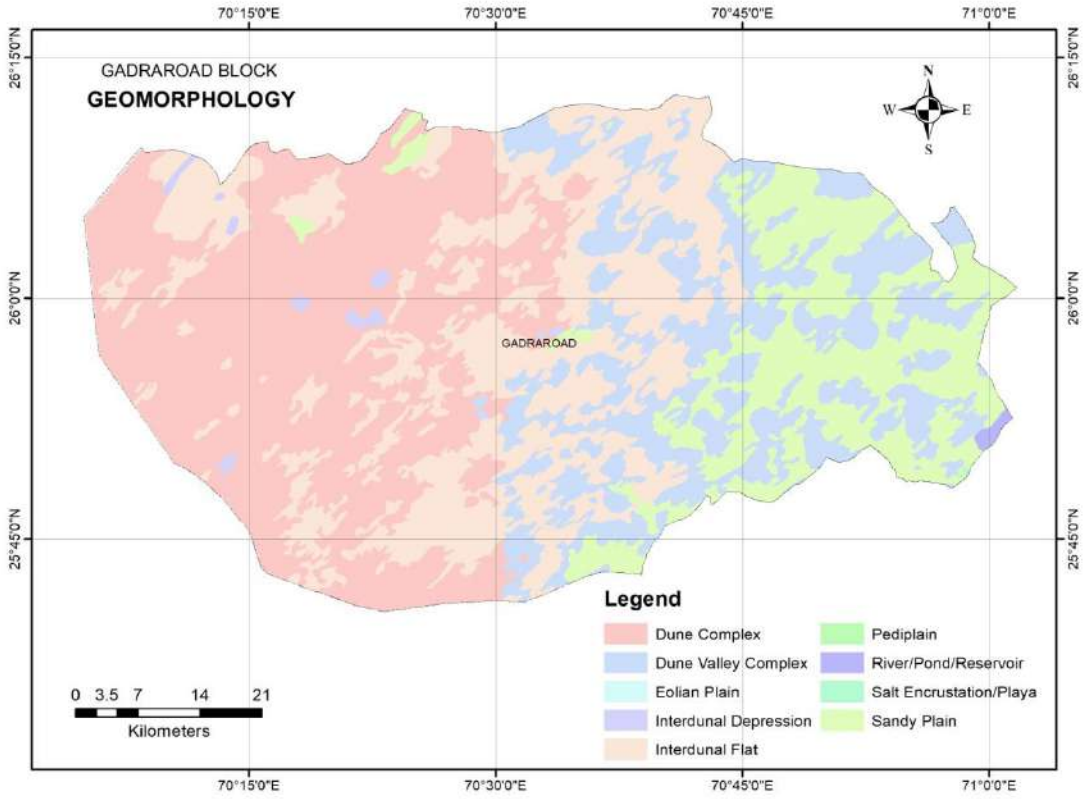
GADRA ROAD

SALIENT INFORMATION	
Block Name	**GADRA ROAD**
Longitude	70°04'55" to 71°01'45"
Latitude	25°40'25" to 26°12'39"
Geographical Area Sq.km	3925.64
Hilly Area (Sq.km)	Nil
Population (2011)	108710
Climate	
Average Temperature range (°C)	02 to 48
Rainfall Analysis	
Normal Rainfall (mm)	249.2
Mean Annual rainfall (mm)	245.7
Highest annual rainfall with year (mm)	746.2 (1976)
Lowest annual rainfall (mm) with year	40 (1987)
Standard deviation (mm)	131.9
Coefficient of Variation (%)	53.7

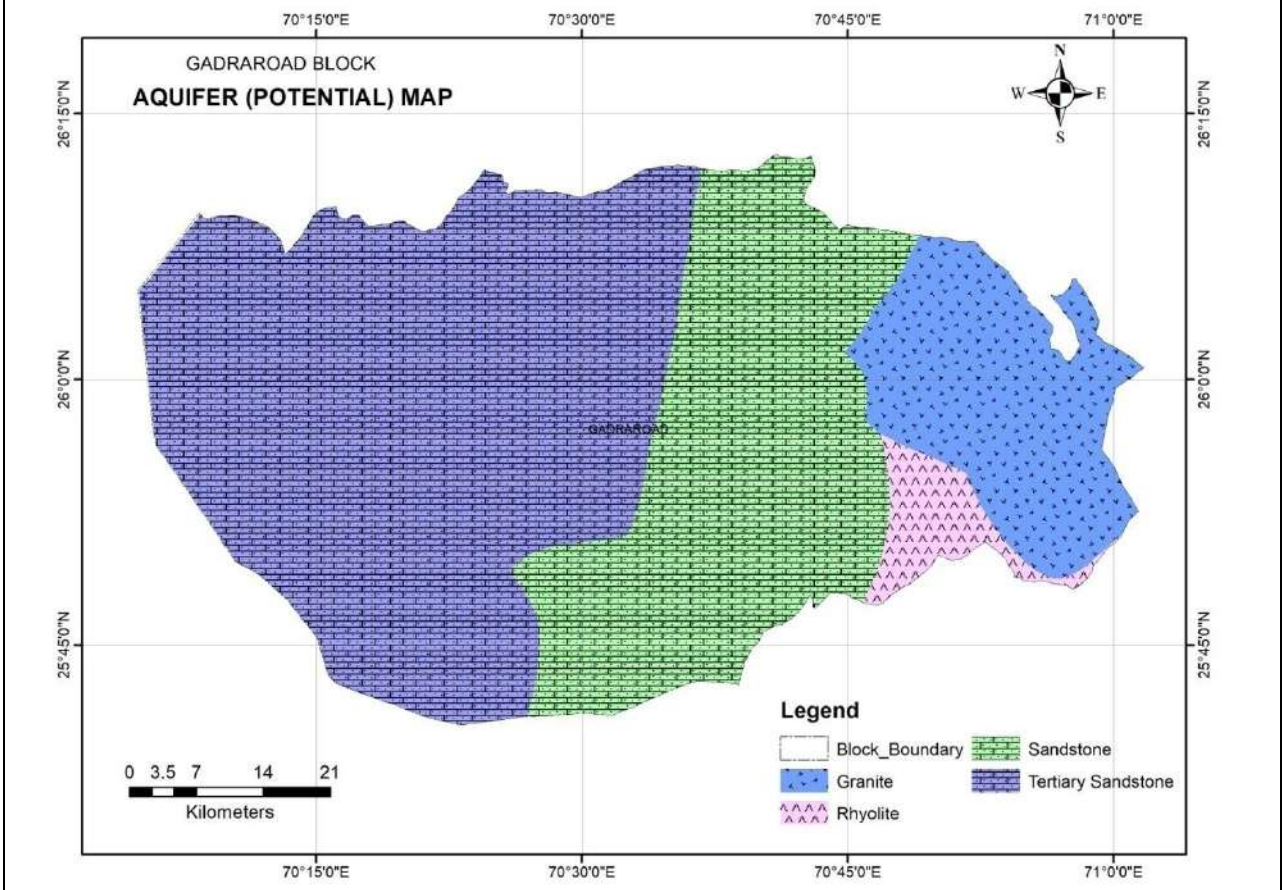


Drought Analysis	
Mild (0 to -25%)	08
Normal (-25% to -50%)	06
Severe (-50% to -75%)	07
Most severe (-75% to -100%)	01
Probability of Normal Rainfall	27%
Geomorphology	
Geomorphic Unit	Sand Dunes, Aeolian & Alluvial plains, Ridges and Hillocks.

Elevation (m amsl)	107- 232

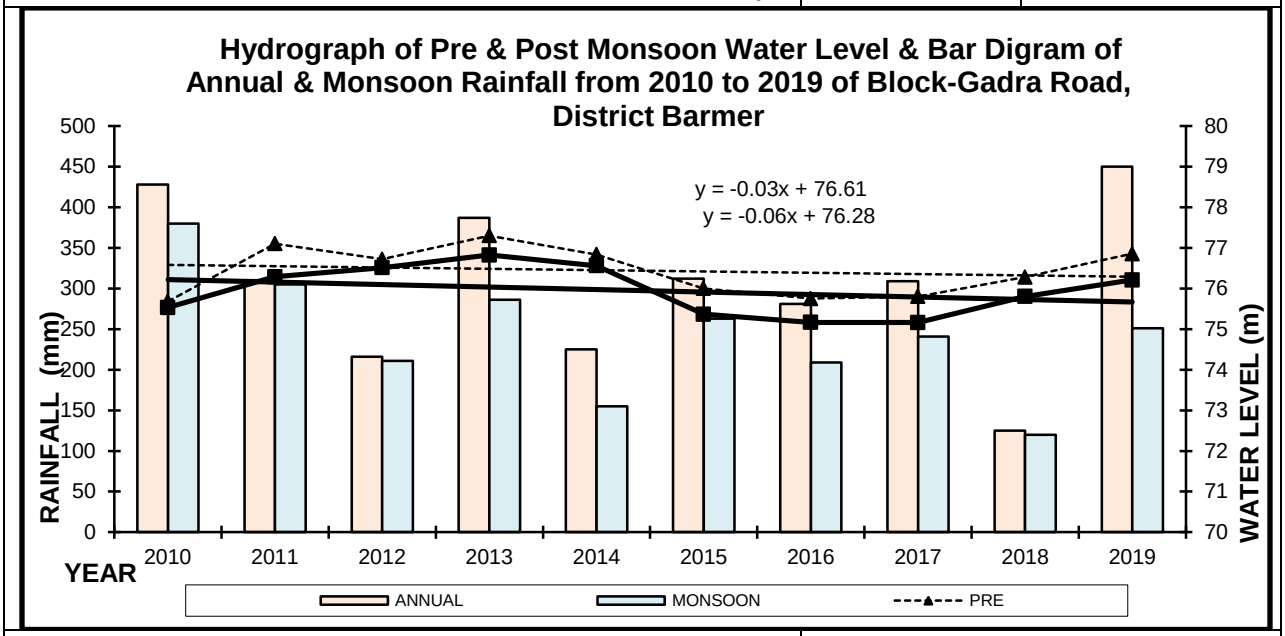


Geology	
Aeolian Sand, Alluvium, Tertiary Sandstone, Malani Rhyolite, Granite and Jalore Siwana Granite (Post Delhi)	



Drainage & Hydrology			
Drainage/Basin/Sub Basin		No Major drainage except few ephemerals streamlets and inter dunal area	
Hydrology			
Ponds		10	
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		392564	
Forest Area in ha.		12430	
Net Sown Area in ha.		135529	
Area sown more than once in ha.		2530	
Rainfed Crop		Bajra in 61202 hect area	
Area under Irrigation (Net) in ha			
Surface Water		0	
Ground Water		15893	
Other sources		0	
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
sown	136615	14014	0
Irrigated	2112	13717	0

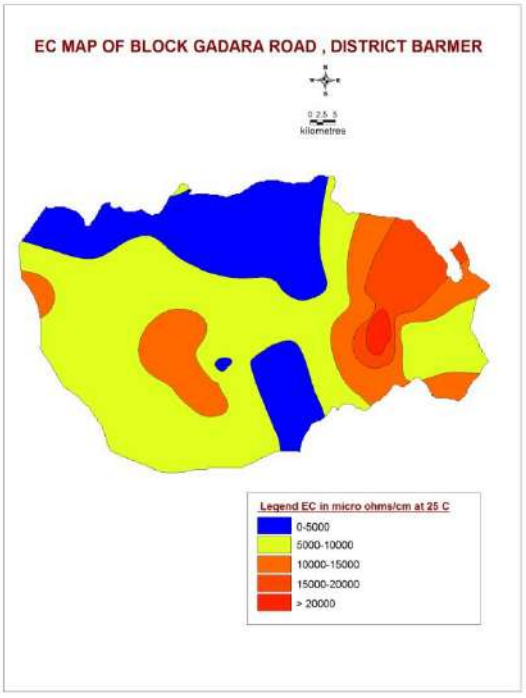
Principal Crop Area (ha)		
Crop Type		
Cereals	1584	
Oil Seeds	540	
Hydrogeology		
Monitoring Stations (May 2019)		
CGWB	05	
SGWD	02	
NAQUIM Key Wells	14	
WATER LEVEL BEHAVIOUR		
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019)Water level	
8.65 to 104.50 m bgl	8.33 to 96.20 m bgl	
Water Level Trend (2010-2019)	Pre-monsoon	Post-monsoon
Average Trend (m/year)	Declining 0.28	Declining 0.27
	Pre-monsoon	Post-monsoon
Rise	-0.03 – (0)	-0.06- (0)
Fall	NA	NA

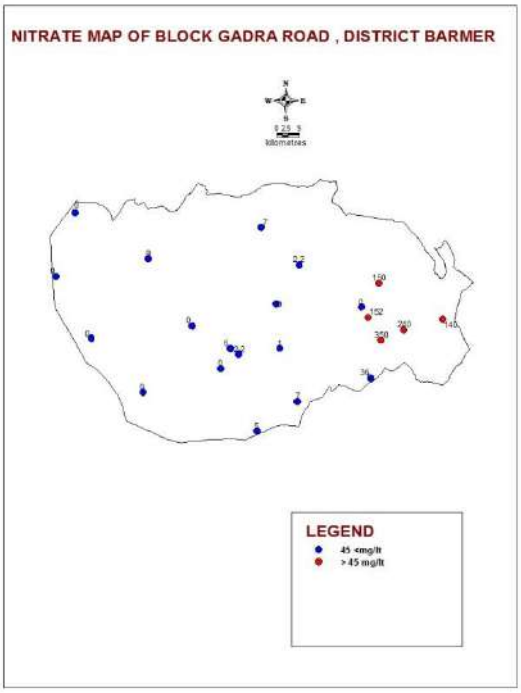
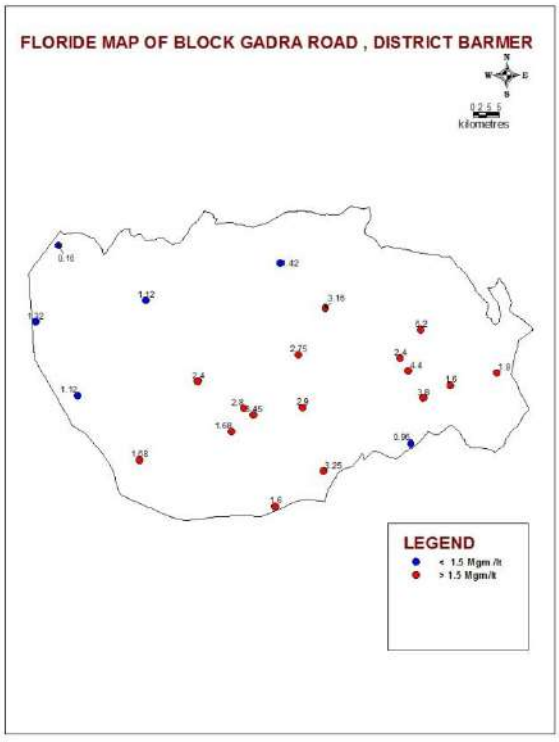


AQUIFER DISPOSITION	
Number of Aquifers (Major)	Two
I	Alluvium followed by tertiary Sand Stone
II	Tertiary Sandstone

Major Aquifer System	CGWB	GWD
Status of GW Exploration	15	02

BASIC AQUIFER CHARACTERISTICS			
Type of Aquifer	Aquifer-I	Aquifer-II	Aquifer-III
Depth of Occurrence (mbgl)	47-107	120-193	223-281
Yield Potential(lpm)	130-396	340-1440	634-822
Drawdown(m)	7.6-9.66	2.55-7.28	7.28-10.0
EC µS/cm at 25°C	5700-11500	6900-11400	6900-7900

CHEMICAL QUALITY OF GROUND WATER		
Suitability for Drinking		
TDS(mg/l)	**Range**	**% Samples**
Fresh	0-3000	40%
Brackish	>-3000	60%
Hardness (mg/l)as $CaCO_3$	**Range**	**% Samples**
Soft	0 – 75	0%
Moderately Hard	75 – 150	0%
Hard	150 – 300	20%
Very Hard	>300	80%
CHEMICAL QUALITY MAP	VARIATION IN MAJOR & MINOR ELEMENTS	
	EC < 2000 µS/cm at 25°C	0%

	NO3 in mg/l>45 mg/l	60%
	F in mg/l – 1 to 1.5 mg/l >1.5 mg/l	27% 63%

Suitability for Irrigation

EC		**RSC (meq/l)**		
Type of Water	**Classification**	**% Samples**	**Range**	**% Samples**
			< 1.25	0

Low Saline< 250 mg/l	Excellent	0.00	1.25 - 2.0	13
Medium Saline 250 – 750 mg/l	Good	33.00	2.0 - 2.5	6
Highly Saline 750 – 2250 mg/l	Permissible	06.00	2.5 - 3.0	0
Very Highly saline> 2250 mg/l	Doubtful	61.00	> 3.0	81

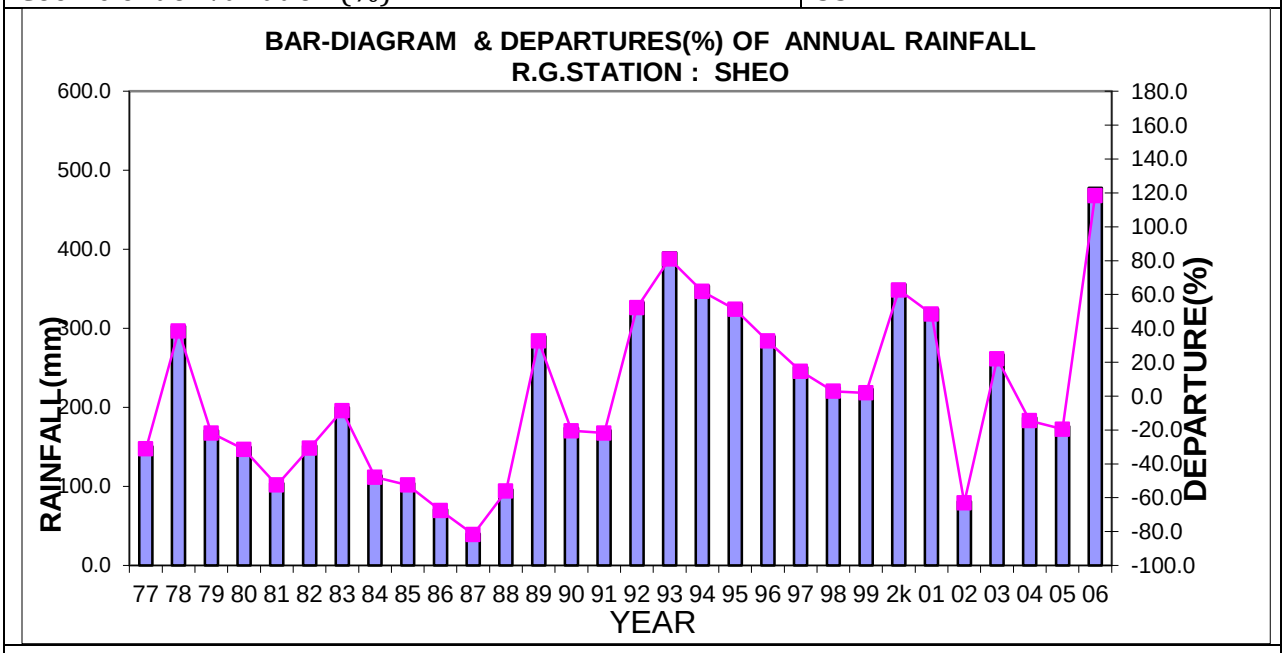
Na%			**SAR**		
Water Class	**Range**	**% Samples**	**Water Class**	**Range**	**% Samples**
Excellent	< 20	0.00	Excellent	<10	20.0
Good	20 - 40	0.00	Good	10 to 18	40.0
Medium	40 - 60	13.00	Medium	18 to 26	26.0
Bad	60 - 80	66.0	Bad	>26	14.0
Very Bad	> 80	21			

GROUND WATER ISSUES	
1. Over-Exploitation – Resource Availability	At present the Ground water Draft 13.23 is more than Annual Availability 11.19 mcm
2. Rainfall and Drought	• Normal Droughts in 6.00% years • Severe Drought in 1.00% years
3. Decadal Water Level Trend (2009-2019)	Declining
GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)	
Ground Water Recharge Worthy Area (sq. km.)	1187.50
Total Annual Ground Water Recharge (mcm)	09.53
Natural Discharge (mcm)	9.5
Net Annual Ground Water Availability (mcm)	54.62
Existing Gross Ground Water Draft for All uses(mcm)	13.23
Provision for domestic and industrial requirement supply to 2025(mcm)	11.19
Stage of Ground Water Development %	154.16
Category	Over Exploited
In-Storage Resource	
Total Area (Sq.Km)	1187.50
Specific yield	0.06
Total Resource (mcm)	813.75
Utilizable Volume (mcm)	36

Total In-storage Resource (mcm)	813.75
Total Resource Dynamic + In-storage(Fresh)	822.33
Sustainability Period with existing draft	62
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	541
Water Harvesting Structure	07
Contour Continuous Trench (CCT)	01
Talai (Talab)	15
Tankas	515
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Tanks (Nos) Capacity 50.000 lts	2370
Volume of water to be conserved (mcm)	0.1185
Type of Aquifer	
Soft Rock Area (sq.km)	1. Tertiary Sand Stone : 968.75
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	858.27
Surplus Surface water Availability (mcm)	0.00
Volume of Water expected to be conserved (mcm)	0.1185
DEMAND SIDE MANAGEMENT	
DEMAND SIDE MANAGEMENT	
Micro irrigation techniques	
Use of Sprinklers for Irrigation	
Irrigation Area (ha) proposed for irrigation through Sprinkler	9538.8
Water Saving by use of Sprinklers (mcm)	7.628
Cropping Pattern change	
Cropping Area (ha) proposed for change in crop	1
Water Saving by Change in Cropping Pattern(mcm)	0.001
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	54.62
Existing Ground Water Draft for All Purposes (mcm)	13.23
GW draft after Demand Side Interventions (mcm)	5.60
Present stage of Ground Water Development (%)	243.84
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	65.26
Total Ground Water Resources (In-storage & Availability after all interventions) mcm	822.23
Sustainability of GW Resources with existing Draft (in years)	70

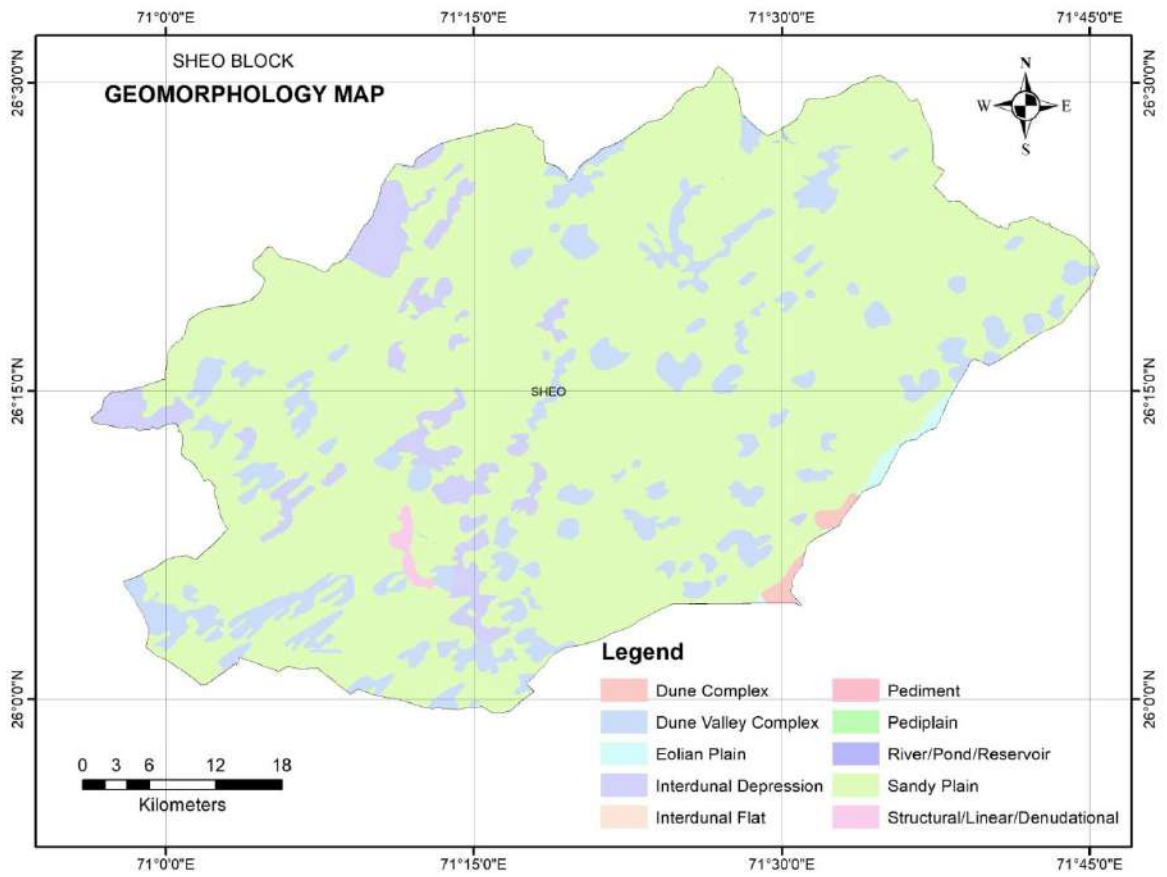
SHEO

SALIENT INFORMATION	
Block Name	**SHEO**
Longitude	70°56'21" to 71°45'28"
Latitude	25°59'20" to 26°30'45"
Geographical Area Sq.km	2663.79
Hilly Area (Sq.km)	Nil
Population (2011)	128370
Climate	
Average Temperature range (°C)	02 to 48
Rainfall Analysis	
Normal Rainfall (mm)	248.9
Mean Annual rainfall (mm)	245.7
Highest annual rainfall with year (mm)	396 (1993)
Lowest annual rainfall (mm) with year	40 (1987)
Standard deviation (mm)	131.9
Coefficient of Variation (%)	53.7

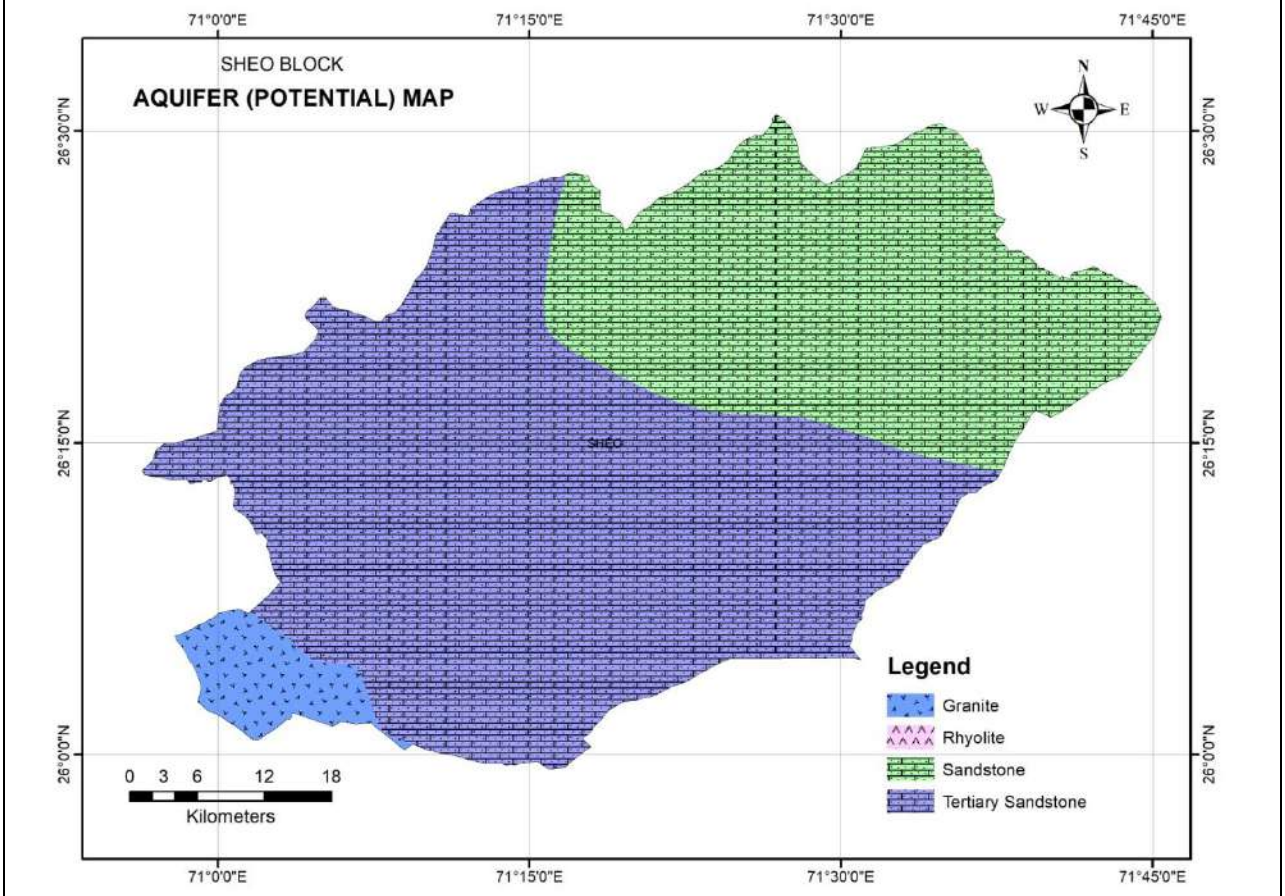


Drought Analysis	
Mild (0 to -25%)	07
Normal (-25% to -50%)	03
Severe (-50% to -75%)	04
Most severe (-75% to -100%)	01
Probability of Normal Rainfall	20%
Geomorphology	
Geomorphic Unit	Sand Dunes, Aeolian & Alluvial plains, Ridges and Hillocks.

Elevation (m amsl)	105- 238

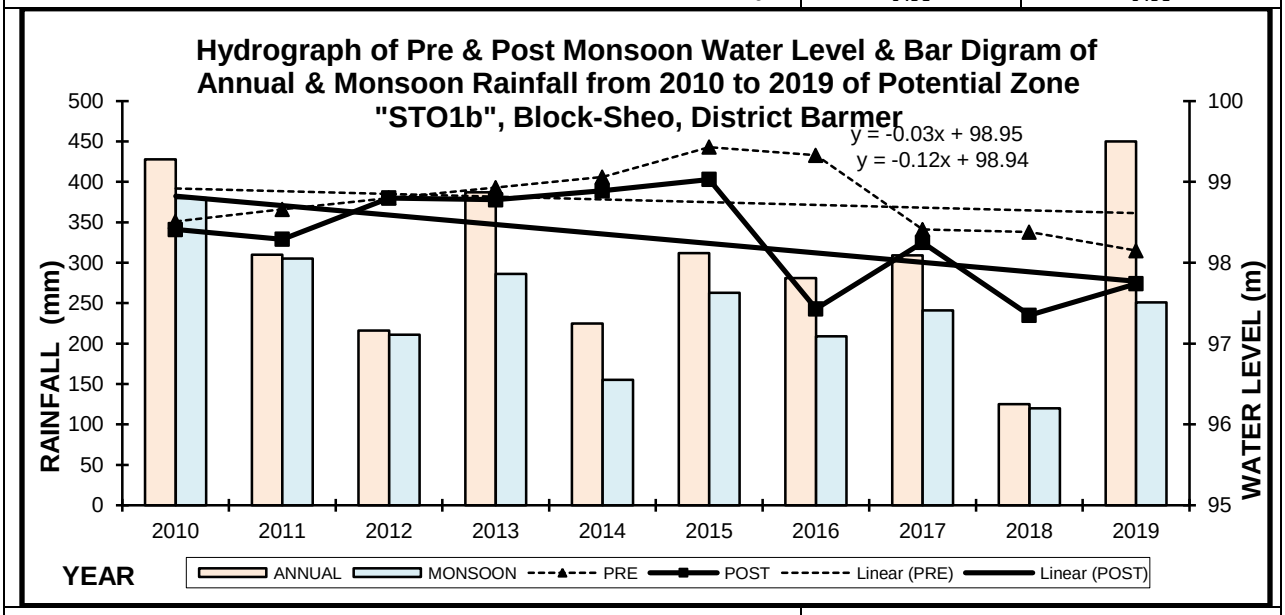


Geology	
Aeolian Sand, Alluvium, Tertiary Sandstone, Malani Rhyolite, Granite and Jalore Siwana Granite (Post Delhi)	



Drainage & Hydrology			
Drainage/Basin/Sub Basin		No Major drainage except few ephemerals streamlets and inter dunal area	
Hydrology			
Ponds		00	
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		266379	
Forest Area in ha.		1679	
Net Sown Area in ha.		77577	
Area sown more than once in ha.		28351	
Rainfed Crop		Bajra in 74467 hect area	
Area under Irrigation (Net) in ha			
Surface Water		0	
Ground Water		77577	
Other sources		0	
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
Sown	160680	57567	0

Irrigated	28490	48465	0
Principal Crop Area (ha)			
Crop Type			
Cereals		679	
Oil Seeds		4331	
Hydrogeology			
Monitoring Stations (May 2019)			
CGWB		04	
SGWD		02	
NAQUIM Key Wells		13	
WATER LEVEL BEHAVIOUR			
Pre-Monsoon (May-2019) Water level		Post-Monsoon (November-2019) Water level	
13.67 to 98.50 m bgl		16.20 to 99.60 m bgl	
Water Level Trend (2010-2019)		Pre-monsoon	Post-monsoon
Average Trend (m/year)		Declining 0.28	Declining 0.27
		Pre-monsoon	Post-monsoon
Rise		-0.03 – (0)	-0.06- (0)
Fall		NA	NA

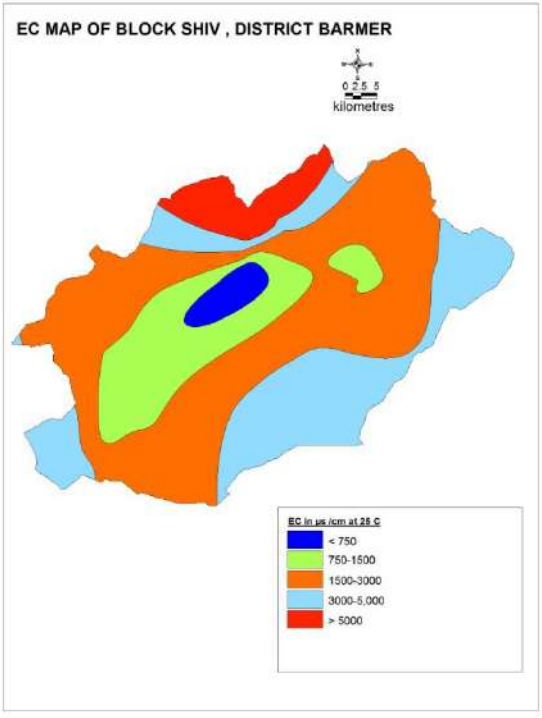


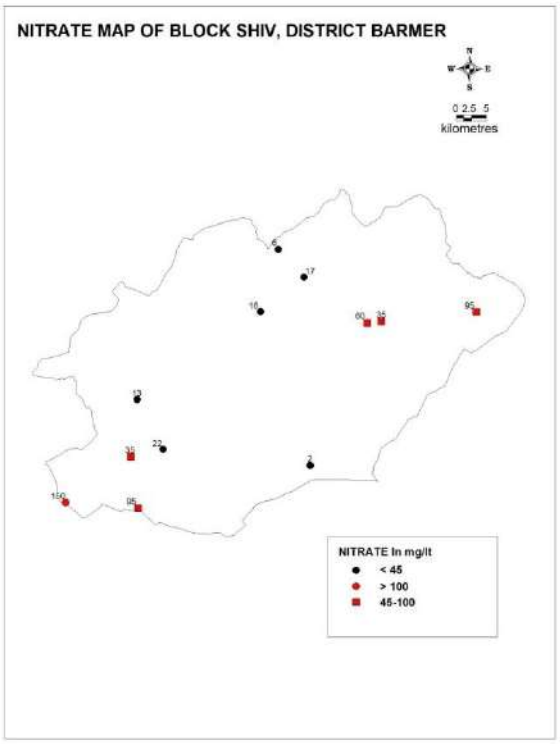
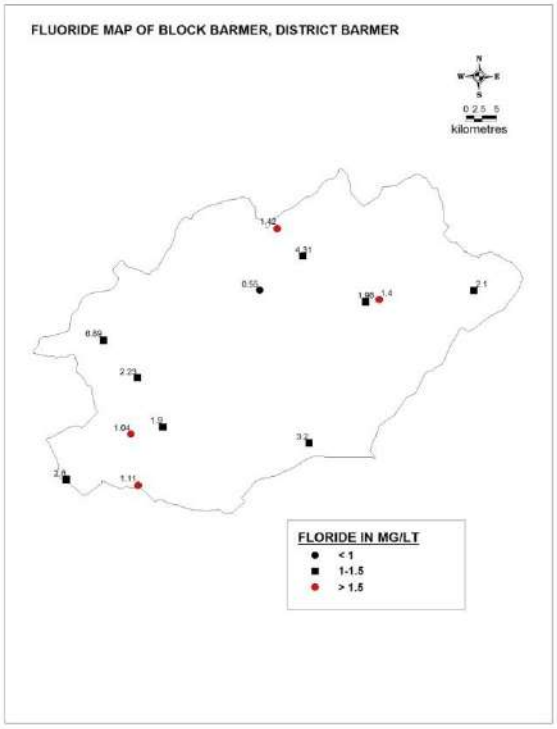
AQUIFER DISPOSITION		
Number of Aquifers (Major)		Two
I		Alluvium followed by tertiary Sand Stone
II		Tertiary Sandstone
Major Aquifer System	CGWB	GWD
Status of GW Exploration	09	05
BASIC AQUIFER CHARACTERISTICS		

Type of Aquifer	Aquifer-I	Aquifer-II	Aquifer-III
Depth of Occurrence (mbgl)	44-73	106-171	203-288
Yield Potential(lpm)	Meager-279	158-634	279-664
Drawdown(m)	13.46-21.96	8.28-12.7	6.3-9.47
EC µS/cm at 25°C	1810-7500	7800-10000	11300-12900

CHEMICAL QUALITY OF GROUND WATER

Suitability for Drinking

TDS(mg/l)	**Range**	**% Samples**
Fresh	0-3000	85%
Brackish	>-3000	15%
Hardness (mg/l)as $CaCO_3$	**Range**	**% Samples**
Soft	0 – 75	0%
Moderately Hard	75 – 150	0%
Hard	150 – 300	30%
Very Hard	>300	70%
CHEMICAL QUALITY MAP	VARIATION IN MAJOR & MINOR ELEMENTS	
	EC < 2000 µS/cm at 25°C	38%

	NO3 in mg/l>45 mg/l	30%
	F in mg/l – 1 to 1.5 mg/l >1.5 mg/l	38% 62%

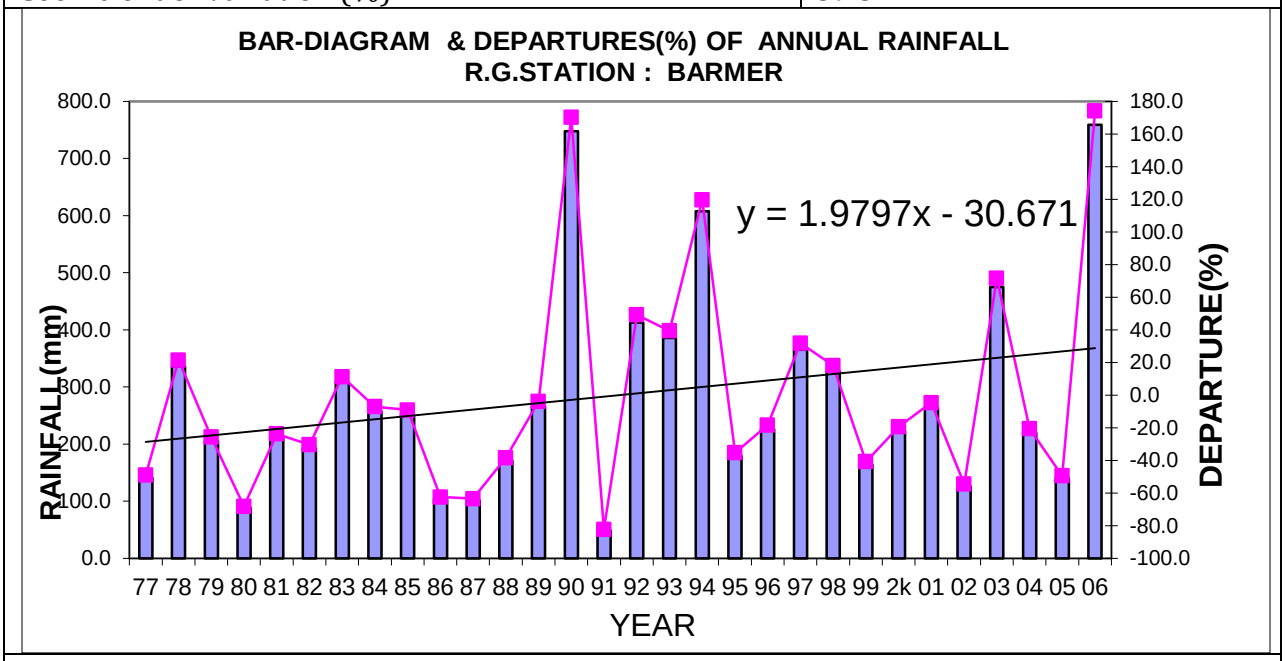
Suitability for Irrigation				
EC		**RSC (meq/l)**		
Type of Water	**Classification**	**% Samples**	**Range**	**% Samples**

				< 1.25	92
Low Saline< 250 mg/l		Excellent	0.00	1.25 - 2.0	8
Medium Saline 250 – 750 mg/l		Good	07.00	2.0 - 2.5	0
Highly Saline 750 – 2250 mg/l		Permissible	46.00	2.5 - 3.0	0
Very Highly saline> 2250 mg/l		Doubtful	47.00	> 3.0	0
Na%			**SAR**		
Water Class	**Range**	**% Samples**	**Water Class**	**Range**	**% Samples**
Excellent	< 20	84	Excellent	<10	53.0
Good	20 - 40	16	Good	10 to 18	30.0
Medium	40 - 60	0.00	Medium	18 to 26	17.0
Bad	60 - 80	0.00	Bad	>26	0
Very Bad	> 80	0.00			
GROUND WATER ISSUES					
1. Over-Exploitation – Resource Availability			At present the Ground water Draft 36.99 is more than Annual Availability 12.39 mcm		
2. Rainfall and Drought			• Normal Droughts in 3 % years • Severe Drought in 4% years		
3. Decadal Water Level Trend (2009-2019)			Declining		
GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)					
Ground Water Recharge Worthy Area (sq. km.)			1483.29		
Total Annual Ground Water Recharge (mcm)			13.77		
Natural Discharge (mcm)			1.377		
Net Annual Ground Water Availability (mcm)			12.39		
Existing Gross Ground Water Draft for All uses(mcm)			36.99		
Provision for domestic and industrial requirement supply to 2025(mcm)			10.33		
Stage of Ground Water Development %			298.49		
Category			Over Exploited		
In-Storage Resource					
Total Area (Sq.Km)			2663.79		
Specific yield			0.06		
Total Resource			3203.91		

Utilizable Volume (mcm)	36
Total In-storage Resource (mcm)	3203
Total Resource Dynamic + In-storage(Fresh)	3216
Sustainability Period with existing draft	87
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	451
Farm Ponds	07
Check Dam	01
Contour Continuous Trench (CCT)	01
Tankas	442
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Tanks (Nos) Capacity 50.000 lts	1672
Volume of water to be conserved (mcm)	0.0836
Type of Aquifer	
Soft Rock Area (sq.km)	2. Tertiary Sand Stone : 2643.79
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	1644.53
Surplus Surface water Availability (mcm)	0.00
Volume of Water expected to be conserved (mcm)	0.0836
DEMAND SIDE MANAGEMENT	
Micro irrigation techniques	
Use of Sprinklers for Irrigation	
Irrigation Area (ha) proposed for irrigation through Sprinkler	38788.5
Water Saving by use of Sprinklers (mcm)	31.03
Cropping Pattern change	
Cropping Area (ha) proposed for change in crop	142
Water Saving by Change in Cropping Pattern(mcm)	31.17
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	12.39
Existing Ground Water Draft for All Purposes (mcm)	36.99
GW draft after Demand Side Interventions (mcm)	5.84
Present stage of Ground Water Development (%)	204.44
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	47.10
Total Ground Water Resources (In-storage & Availability after all interventions) mcm	3216
Sustainability of GW Resources with existing Draft (in years)	99

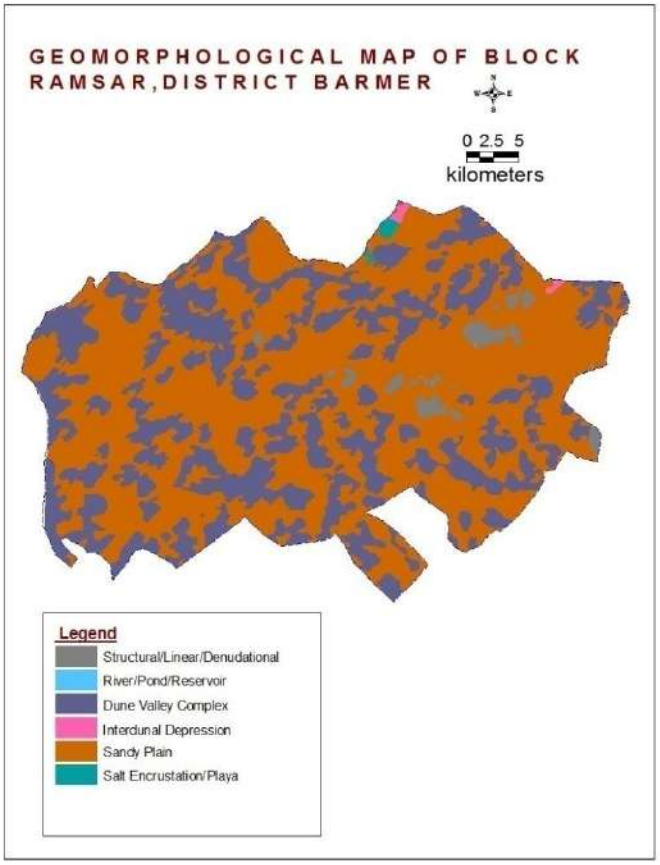
RAMSAR

SALIENT INFORMATION	
Block Name	**RAMSAR**
Longitude	70°39'11" to 71°13'54"
Latitude	25°30'16" to 25°51'55"
Geographical Area Sq.km	1587.07
Hilly Area (Sq.km)	Nil
Population (2011)	163786
Climate	
Average Temperature range (°C)	02 to 48
Rainfall Analysis	
Normal Rainfall (mm)	299.5
Mean Annual rainfall (mm)	285.8
Highest annual rainfall with year (mm)	748 (1990)
Lowest annual rainfall (mm) with year	49 (1991)
Standard deviation (mm)	170.1
Coefficient of Variation (%)	59.5

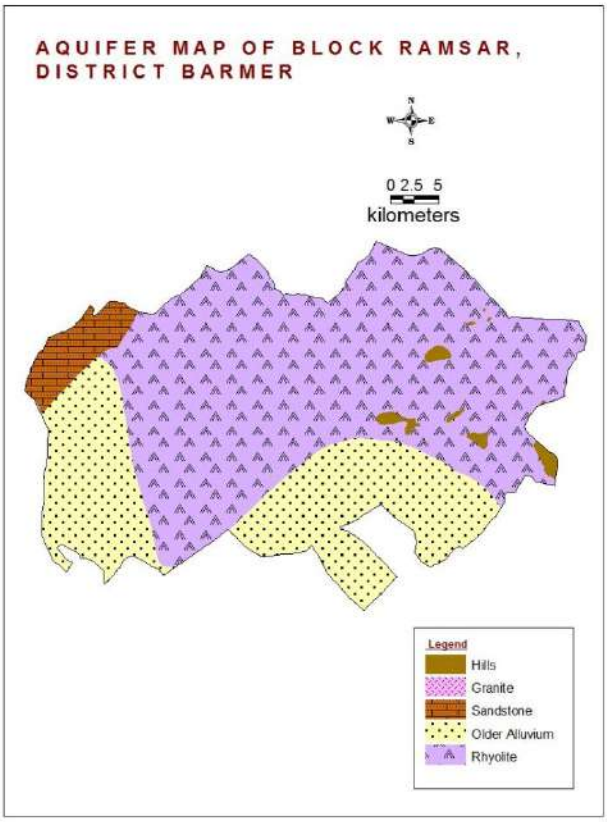


Drought Analysis	
Mild (0 to -25%)	10
Normal (-25% to -50%)	08
Severe (-50% to -75%)	07
Most severe (-75% to -100%)	02
Probability of Normal Rainfall	29%
Geomorphology	
Geomorphic Unit	Sand Dunes, Aeolian & Alluvial plains, Ridges and Hillocks.

Elevation (m amsl)	155-262



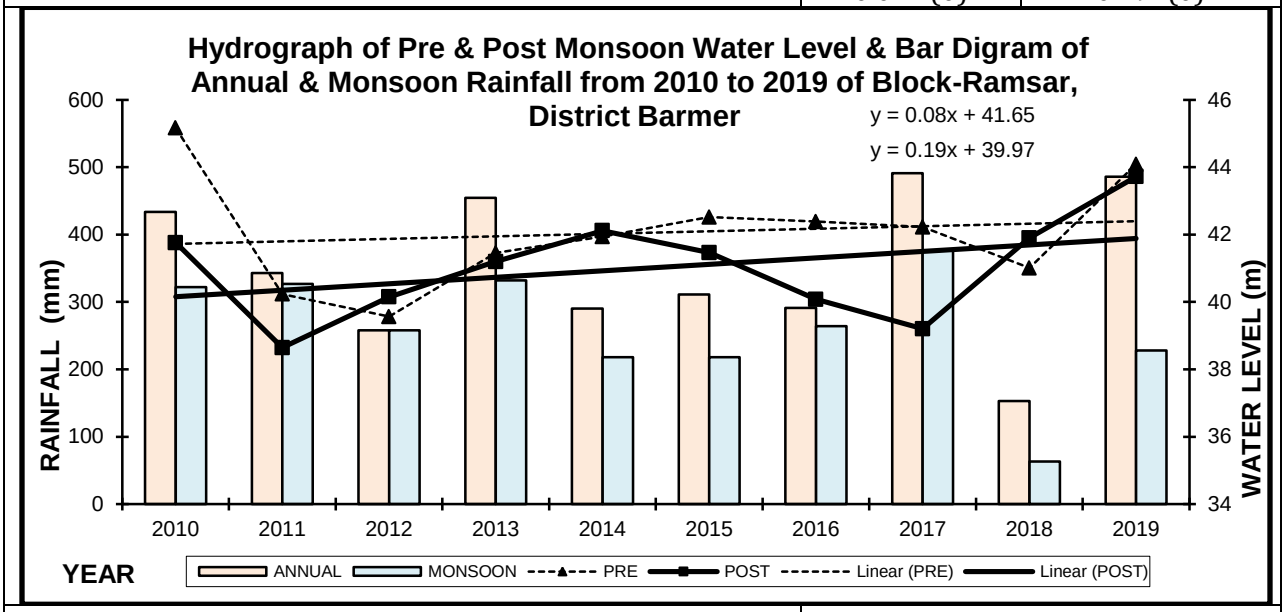
Geology	
Aeolian Sand, Alluvium, Tertiary Sandstone, Malani Rhyolite, Granite and Jalore Siwana Granite (Post Delhi)	



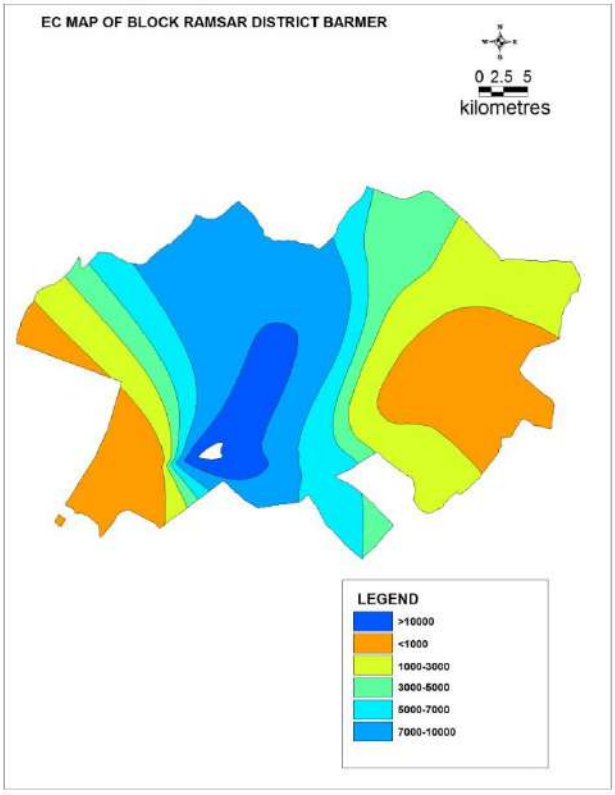
Drainage & Hydrology			
Drainage/Basin/Sub Basin		No Major drainage except few ephemerals streamlets and inter dunal area	
Hydrology			
Ponds		00	
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		158707	
Forest Area in ha.		507	
Net Sown Area in ha.		89755	
Area sown more than once in ha.		2737	
Rainfed Crop		Bajra in 54881 hect area	
Area under Irrigation (Net) in ha			
Surface Water		0	
Ground Water		489	
Other sources		0	
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
Sown	89346	3146	0
Irrigated	0	489	0
Principal Crop Area (ha)			
Crop Type			

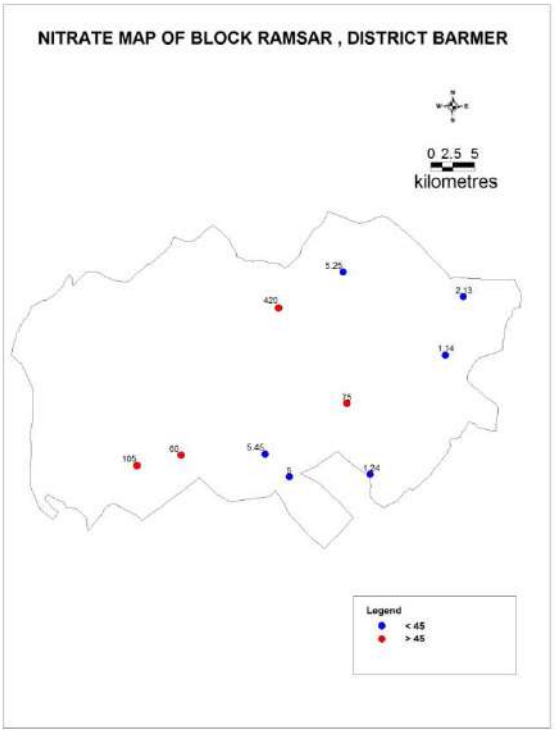
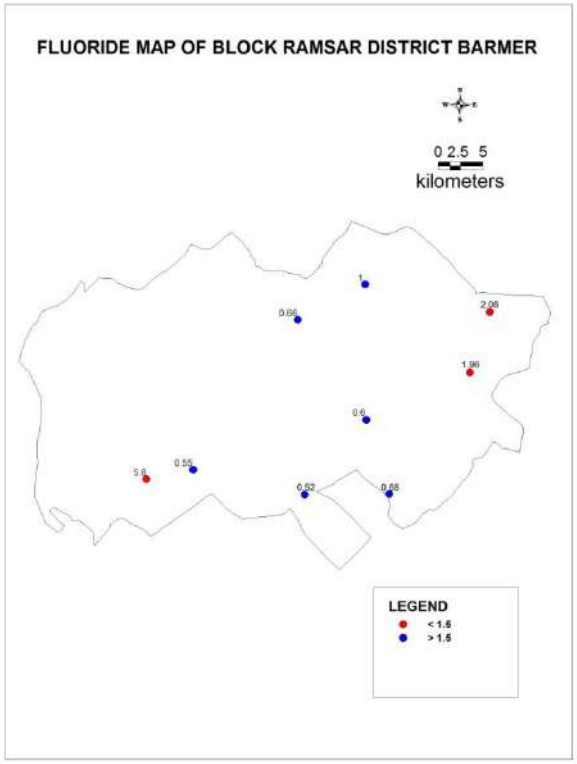
Cereals	14240
Oil Seeds	2
Hydrogeology	
Monitoring Stations (May 2019)	
CGWB	04
SGWD	07
NAQUIM Key Wells	04

WATER LEVEL BEHAVIOUR		
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019) Water level	
13.67 to 98.50 m bgl	16.20 to 99.60 m bgl	
Water Level Trend (2010-2019)	Pre-monsoon	Post-monsoon
Average Trend (m/year)	Declining	Declining
	Pre-monsoon	Post-monsoon
	0.07– (0)	0.19- (0)



AQUIFER DISPOSITION			
Number of Aquifers (Major)		Three	
I		Alluvium	
II		Tertiary Sandstone	
III			
Status of GW Exploration	CGWB	GWD	
	07	05	
BASIC AQUIFER CHARACTERISTICS			
Type of Aquifer	Aquifer-I	Aquifer-II	
Depth of Occurrence (mbgl)	27-140	189-296	
Yield Potential(lpm)	Meager	-	

CHEMICAL QUALITY OF GROUND WATER		
Suitability for Drinking		
TDS(mg/l)	**Range**	**% Samples**
Fresh	**< 500**	**0%**
Brackish	500-1000	0%
Saline	>1000	100%
Hardness (mg/l)as $CaCO_3$	**Range**	**% Samples**
Soft	0 – 75	0%
Moderately Hard	75 – 150	25%
Hard	150 – 300	25%
Very Hard	>300	50%
CHEMICAL QUALITY MAP	VARIATION IN MAJOR & MINOR ELEMENTS	
	EC < 2000 µS/cm at 25°C	25%

	NO3 in mg/l>45 mg/l	40%
	F in mg/l – 1 to 1.5 mg/l >1.5 mg/l	70% 30%

Suitability for Irrigation				
EC		**RSC (meq/l)**		
Type of Water	**Classification**	**%**	**Range**	**% Samples**

		Samples		
			< 1.25	80
Low Saline< 250 mg/l	Excellent	0.00	1.25 - 2.0	0
Medium Saline 250 – 750 mg/l	Good	00.00	2.0 - 2.5	0
Highly Saline 750 – 2250 mg/l	Permissible	20.00	2.5 - 3.0	0
Very Highly saline> 2250 mg/l	Doubtful	80.00	> 3.0	20

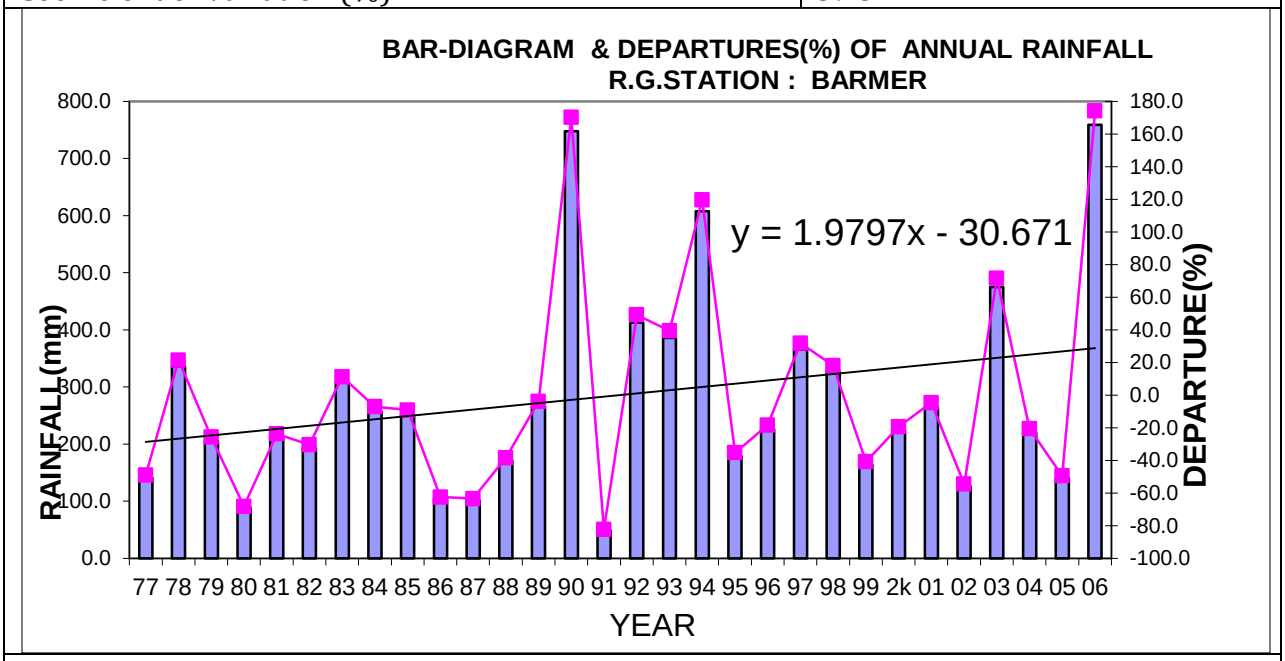
Na%			**SAR**		
Water Class	**Range**	**% Samples**	**Water Class**	**Range**	**% Samples**
Excellent	< 20	0	Excellent	<10	0
Good	20 - 40	0	Good	10 to 18	40
Medium	40 - 60	0	Medium	18 to 26	20
Bad	60 - 80	30	Bad	>26	40
Very Bad	> 80	70			

GROUND WATER ISSUES	
1. Over-Exploitation – Resource Availability	At present the Ground water Draft 52.34 mcm is more than Annual Availability 13.92 mcm
2. Rainfall and Drought	• Normal Droughts in 8 % years • Severe Drought in 7% years
3. Decadal Water Level Trend (2009-2019)	Declining
GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)	
Ground Water Recharge Worthy Area (sq. km.)	368.75
Total Annual Ground Water Recharge (mcm)	5.990
Natural Discharge (mcm)	0.5991
Net Annual Ground Water Availability (mcm)	13.92
Existing Gross Ground Water Draft for All uses(mcm)	52.34
Provision for domestic and industrial requirement supply to 2025(mcm)	1.5366
Stage of Ground Water Development %	97.08
Category	Critical
In-Storage Resource	
Total Area (Sq.Km)	1587.07
Specific yield	0.06
Total Resource	374.14
Utilizable Volume (mcm)	35.80
Total In-storage Resource (mcm)	792.08
Total Resource Dynamic + In-storage(Fresh)	374.1418

Sustainability Period with existing draft	71
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	438
Farm Ponds	01
Talai	01
Water Harvesting Structure	01
Tankas	430
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Tanks (Nos) Capacity 50.000 lts	2213
Volume of water to be conserved (mcm)	0.11065
Type of Aquifer	
Alluvium (sq.km)	300.80
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	244.45
Surplus Surface water Availability (mcm)	0.00
Volume of Water expected to be conserved (mcm)	0.11065
DEMAND SIDE MANAGEMENT	
Micro irrigation techniques	
Use of Sprinklers for Irrigation	
Irrigation Area (ha) proposed for irrigation through Sprinkler	244.5
Water Saving by use of Sprinklers (mcm)	0.1956
Cropping Pattern change	
Cropping Area (ha) proposed for change in crop	01
Water Saving by Change in Cropping Pattern(mcm)	0.001
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	13.92
Existing Ground Water Draft for All Purposes (mcm)	52.34
GW draft after Demand Side Interventions (mcm)	5.04
Present stage of Ground Water Development (%)	99.87
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	43.43
Total Ground Water Resources (In-storage & Availability after all interventions) mcm	374.14
Sustainability of GW Resources with existing Draft (in years)	76

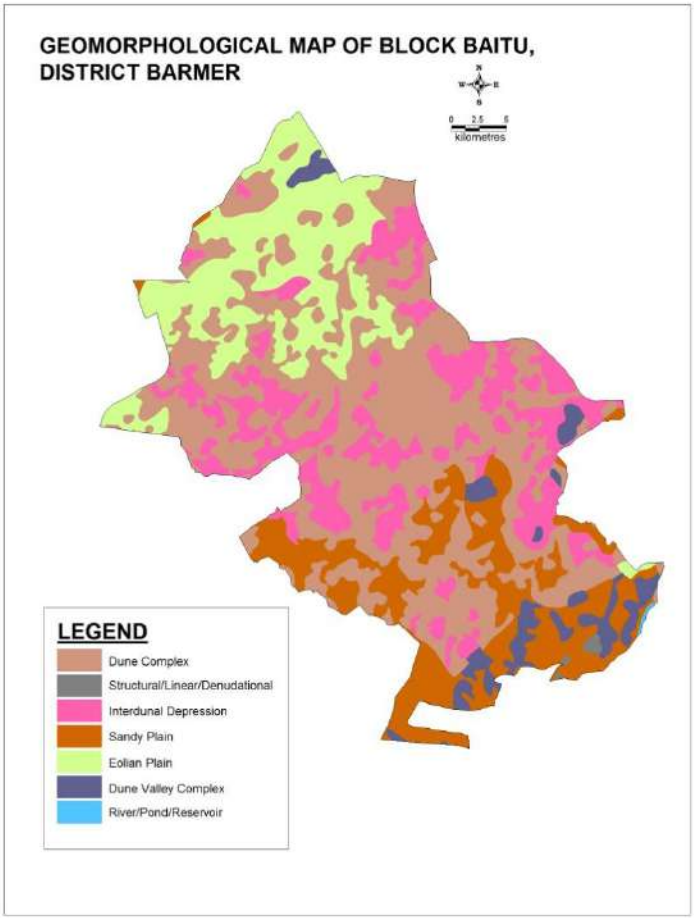
BAYTU

SALIENT INFORMATION	
Block Name	**BAYTU**
Longitude	71°26'24" to 71°56'44"
Latitude	25°41'20" to 26°13'16"
Geographical Area Sq.km	1407.58
Hilly Area (Sq.km)	Nil
Population (2011)	294237
Climate	
Average Temperature range (°C)	02 to 48
Rainfall Analysis	
Normal Rainfall (mm)	299.5
Mean Annual rainfall (mm)	285.8
Highest annual rainfall with year (mm)	748 (1990)
Lowest annual rainfall (mm) with year	49 (1991)
Standard deviation (mm)	170.1
Coefficient of Variation (%)	59.5

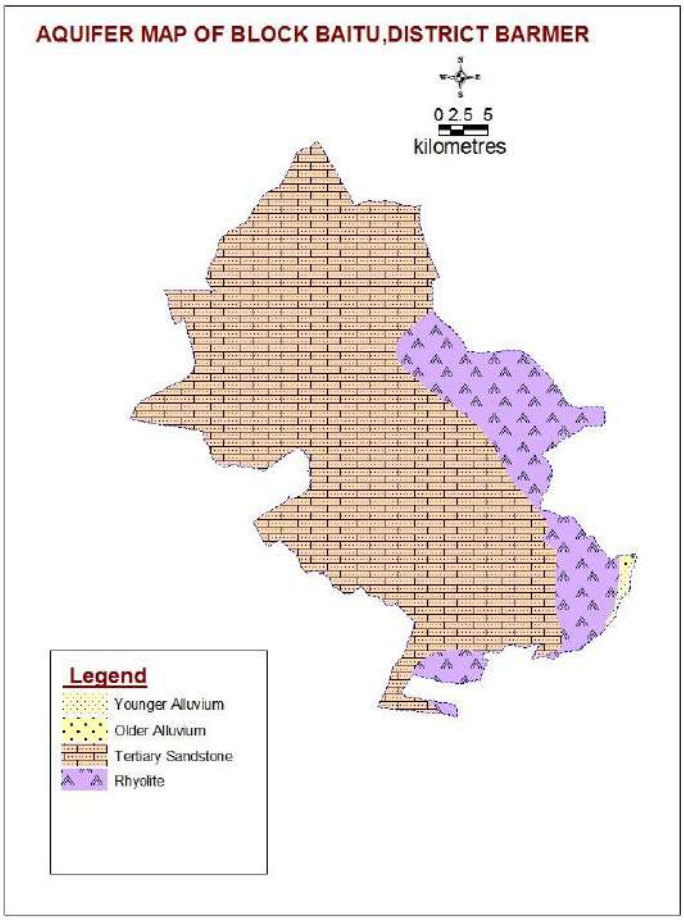


Drought Analysis	
Mild (0 to -25%)	10
Normal (-25% to -50%)	08
Severe (-50% to -75%)	07
Most severe (-75% to -100%)	02
Probability of Normal Rainfall	29%
Geomorphology	
Geomorphic Unit	Sand Dunes, Aeolian & Alluvial plains, Ridges and Hillocks.

Elevation (m amsl)	110-257

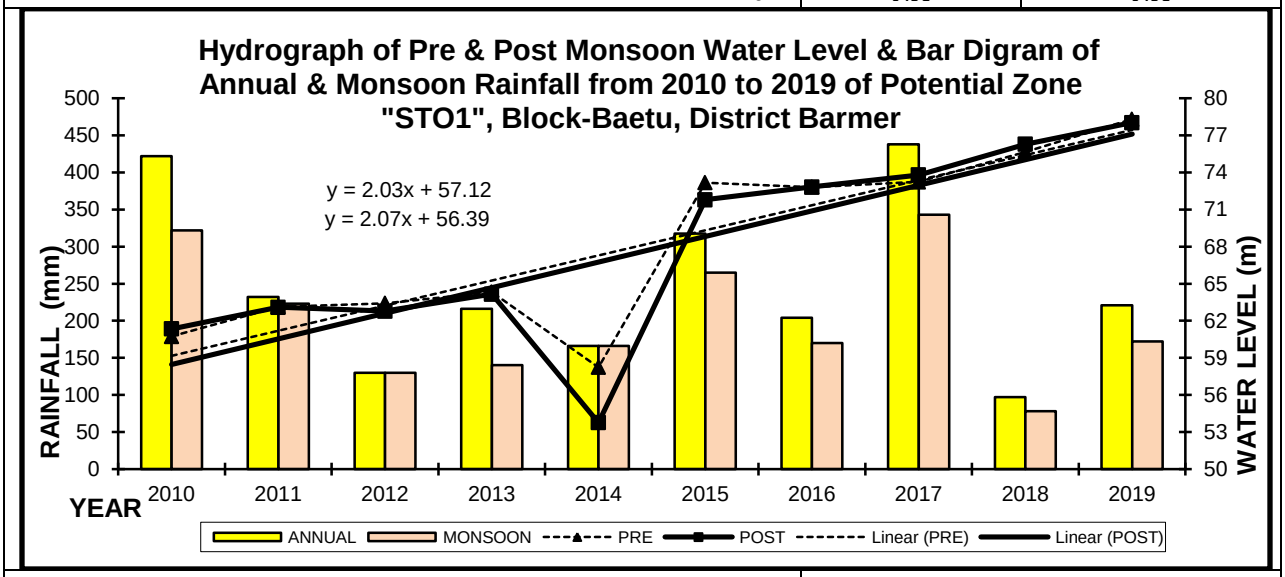


Geology	
Aeolian Sand, Alluvium, Tertiary Sandstone, Malani Rhyolite.	



Drainage & Hydrology			
Drainage/Basin/Sub Basin		No Major drainage except few ephemerals streamlets and inter dunal area	
Hydrology			
Ponds		00	
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		140758	
Forest Area in ha.		02	
Net Sown Area in ha.		89197	
Area sown more than once in ha.		11857	
Rainfed Crop		Bajra in 16893 hect area	
Area under Irrigation (Net) in ha			
Surface Water		0	
Ground Water		21002	
Other sources		26	
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
Sown	59575	15663	0

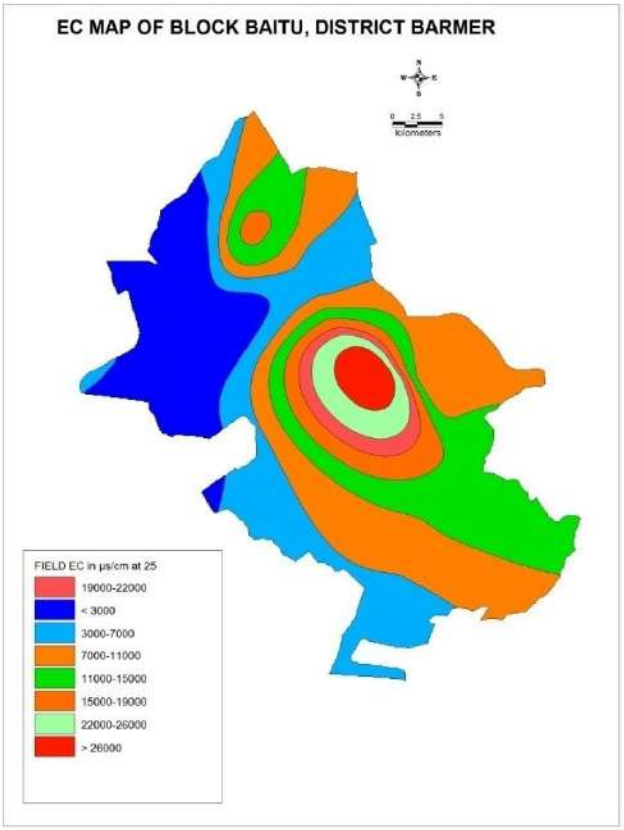
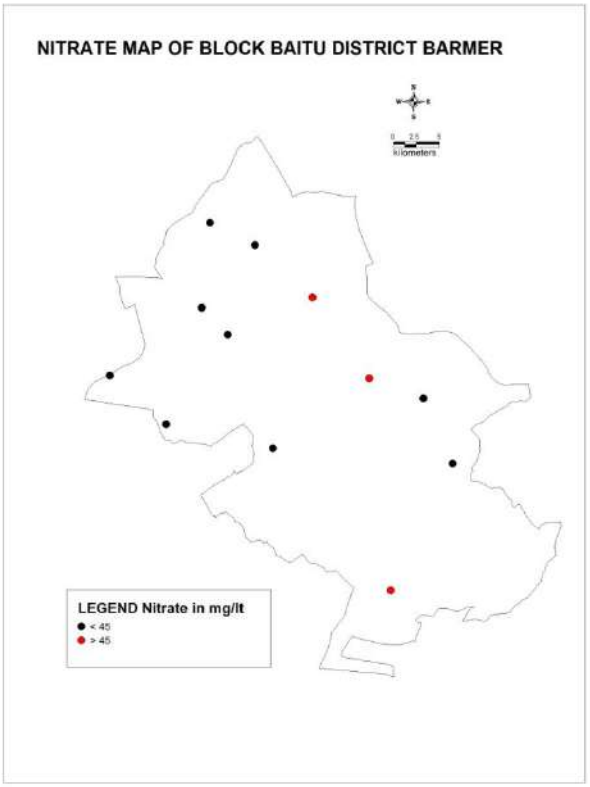
Irrigated	5745	15212	0
Principal Crop Area (ha)			
Crop Type			
Cereals		18517	
Oil Seeds		807	
Hydrogeology			
Monitoring Stations (May 2019)			
CGWB		10	
SGWD		15	
NAQUIM Key Wells		04	
WATER LEVEL BEHAVIOUR			
Pre-Monsoon (May-2019) Water level		Post-Monsoon (November-2019) Water level	
13.67 to 98.50 m bgl		16.20 to 99.60 m bgl	
Water Level Trend (2010-2019)		Pre-monsoon	Post-monsoon
Average Trend (m/year)		Declining	Declining
		Pre-monsoon	Post-monsoon
Rise		2.03 – (0)	2.07(0)
Fall		NA	NA

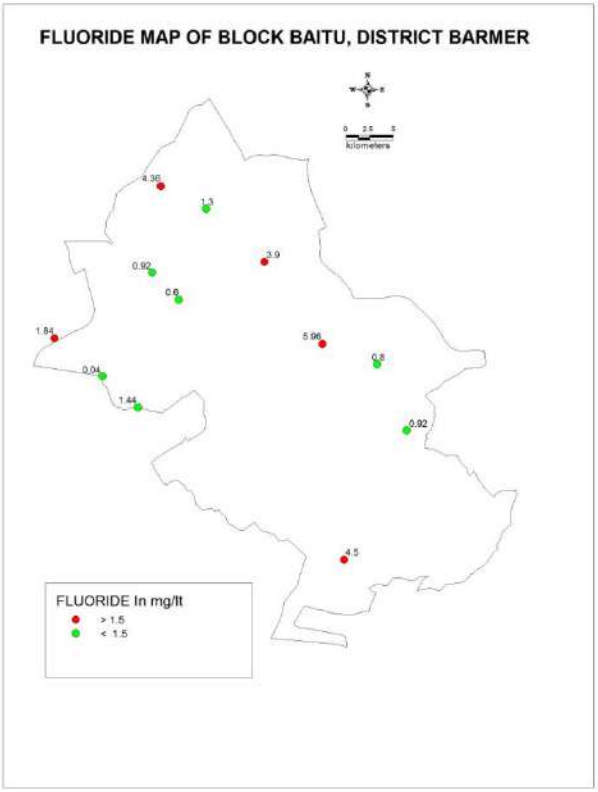


AQUIFER DISPOSITION			
Number of Aquifers (Major)		Three	
I		Alluvium	
II		Lathi Sandstone	
III		Tertiary Sandstone	
Status of GW Exploration	CGWB	GWD	
	06	07	
BASIC AQUIFER CHARACTERISTICS			
Type of Aquifer	Aquifer-I	Aquifer-II	

Depth of Occurrence (mbgl)	60-139	148-155	
Yield Potential(lpm)	146	108-275	
Drawdown(m)	04	02-06	
EC µS/cm at 25°C	1570	19000-26300	

CHEMICAL QUALITY OF GROUND WATER		
Suitability for Drinking		
TDS(mg/l)	**Range**	**% Samples**
Fresh	**< 500**	**0%**
Brackish	500-1000	0%
Saline	>1000	100%
Hardness (mg/l)as $CaCO_3$	**Range**	**% Samples**
Soft	0 – 75	0%
Moderately Hard	75 – 150	0%
Hard	150 – 300	0%
Very Hard	>300	100%
CHEMICAL QUALITY MAP	VARIATION IN MAJOR & MINOR ELEMENTS	

	EC < 2000 µS/cm at 25°C	0%
	NO3 in mg/l>45 mg/l	25%



F in mg/l – 1 to 1.5 mg/l	66%
>1.5 mg/l	34%

Suitability for Irrigation

EC		**RSC (meq/l)**		
Type of Water	**Classification**	**% Samples**	**Range**	**% Samples**
			< 1.25	84
Low Saline< 250 mg/l	Excellent	0.00	1.25 - 2.0	8
Medium Saline 250 – 750 mg/l	Good	16.00	2.0 - 2.5	0
Highly Saline 750 – 2250 mg/l	Permissible	16.00	2.5 - 3.0	0
Very Highly saline> 2250 mg/l	Doubtful	68.00	> 3.0	8

Na%			**SAR**		
Water Class	**Range**	**% Samples**	**Water Class**	**Range**	**% Samples**
Excellent	< 20	0	Excellent	<10	42
Good	20 - 40	16	Good	10 to 18	25
Medium	40 - 60	8	Medium	18 to 26	25
Bad	60 - 80	34	Bad	>26	8
Very Bad	> 80	42			

GROUND WATER ISSUES

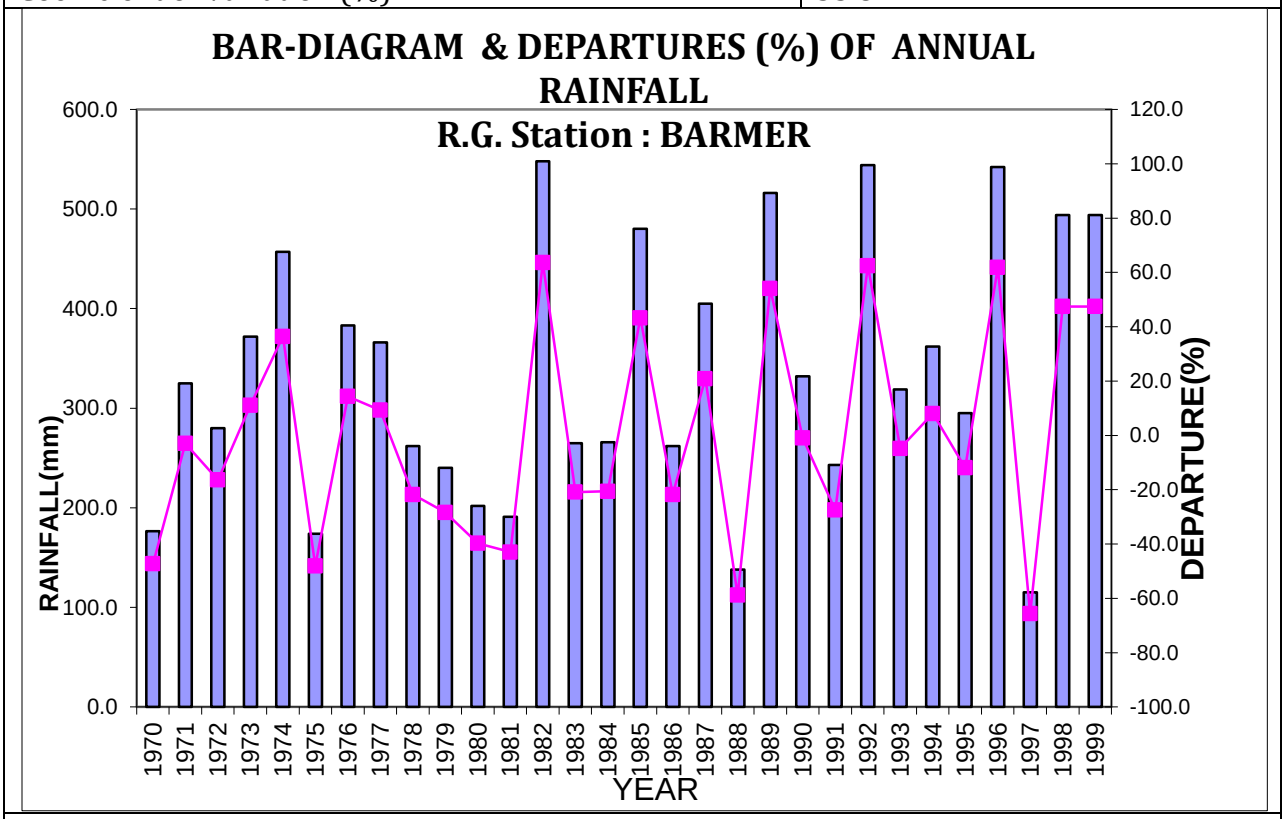
1. Over-Exploitation – Resource Availability	At present the Ground water

	Draft 33.12 mcm is more than Annual Availability 21.17 mcm
2. Rainfall and Drought	• Normal Droughts in 8 % years • Severe Drought in 7% years
3. Decadal Water Level Trend (2009-2019)	Declining
GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)	
Ground Water Recharge Worthy Area (sq. km.)	350.00
Total Annual Ground Water Recharge (mcm)	8.028
Natural Discharge (mcm)	0.802
Net Annual Ground Water Availability (mcm)	21.17
Existing Gross Ground Water Draft for All uses(mcm)	33.12
Provision for domestic and industrial requirement supply to 2025(mcm)	0.2525
Stage of Ground Water Development %	108.87
Category	Over Explo.
In-Storage Resource	
Total Area (Sq.Km)	1407.58
Specific yield	0.06
Total Resource	28.402
Utilizable Volume (mcm)	26
Total In-storage Resource (mcm)	390.56
Total Resource Dynamic + In-storage(Fresh)	28.402
Sustainability Period with existing draft	09
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	527
Water Harvesting Structures	14
Piezometer	01
Tanka	512
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Tanks (Nos) Capacity 50.000 lts	1999
Volume of water to be conserved (mcm)	0.9995
Type of Aquifer	
Soft Rock Area (sq.km)	3. Tertiary Sand Stone : 1182.58
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	288.99
Surplus Surface water Availability (mcm)	0.03
Volume of Water expected to be conserved (mcm)	0.1136

DEMAND SIDE MANAGEMENT	
Micro irrigation techniques	
Use of Sprinklers for Irrigation	
Irrigation Area (ha) proposed for irrigation through Sprinkler	10514
Water Saving by use of Sprinklers (mcm)	8.4112
Cropping Pattern change	
Cropping Area (ha) proposed for change in crop	26
Water Saving by Change in Cropping Pattern(mcm)	0.026
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	21.17
Existing Ground Water Draft for All Purposes (mcm)	33.12
GW draft after Demand Side Interventions (mcm)	-5.13
Present stage of Ground Water Development (%)	0
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	-168
Total Ground Water Resources (In-storage & Availability after all interventions) mcm	28.40
Sustainability of GW Resources with existing Draft (in years)	11

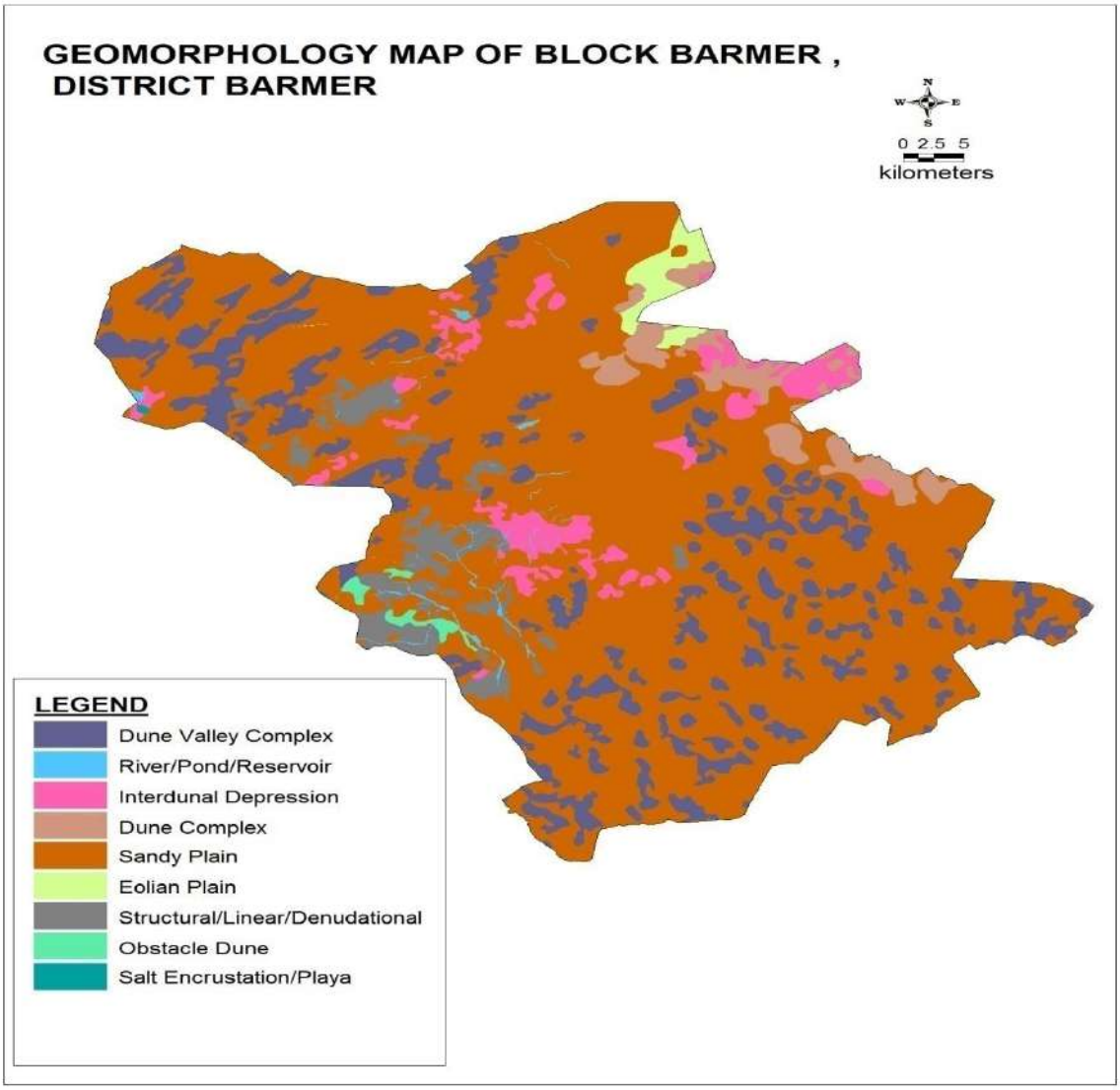
BARMER BLOCK

SALIENT INFORMATION	
Block Name	**BARMER**
Longitude	70˚ 59’ 21” to 71˚ 48’ 37”
Latitude	25˚ 24’ 47” to 26˚ 4’ 39”
Geographical Area Sq.km	2412.09
Hilly Area (Sq.km)	106.95
Population (2011)	370721
Climate	
Average Temperature range (°C)	03 to 48
Rainfall Analysis	
Normal Rainfall (mm)	272.7
Mean Annual rainfall (mm)	275.9
Highest annual rainfall with year (mm)	739 (1981)
Lowest annual rainfall (mm) with year	73 (2002)
Standard deviation (mm)	154.00
Coefficient of Variation (%)	55.8



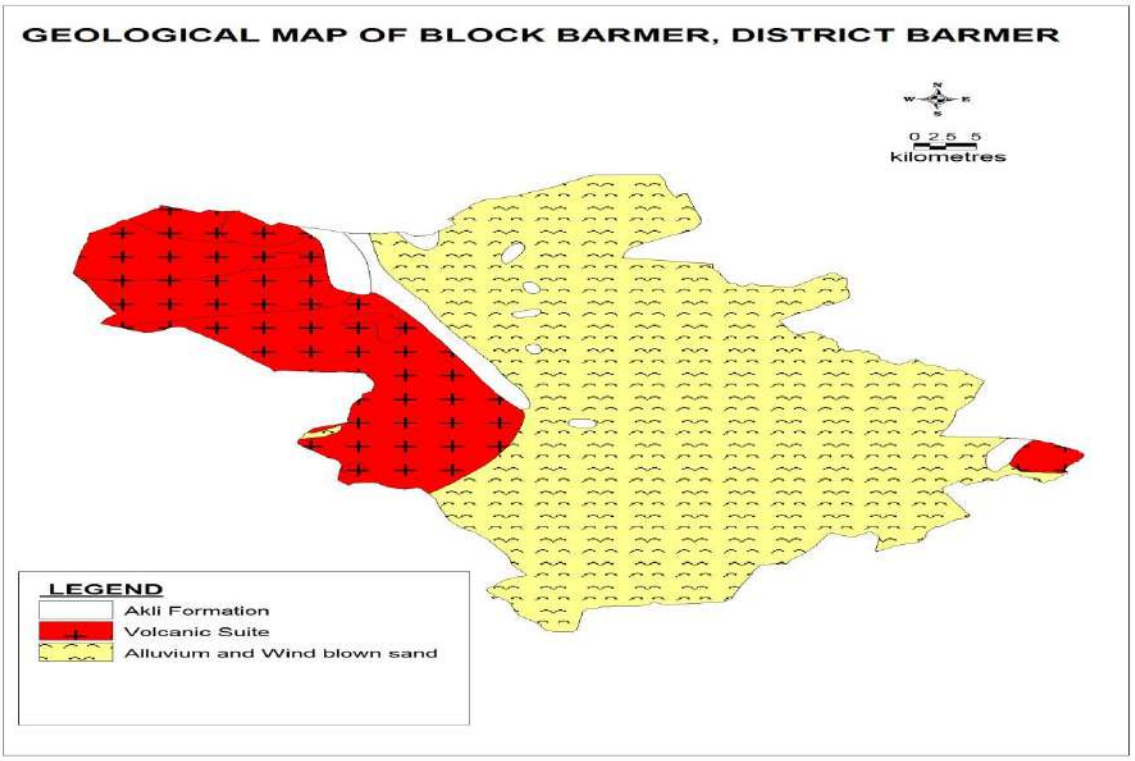
Drought Analysis	
Mild (0 to -25%)	09
Normal (-25% to -50%)	03
Severe (-50% to -75%)	06
Most severe (-75% to -100%)	00

Geomorphology	
Geomorphic Unit	undulating planes, sand dunes and abruptly rising hills of rhyolite and granites
Elevation (m amsl)	

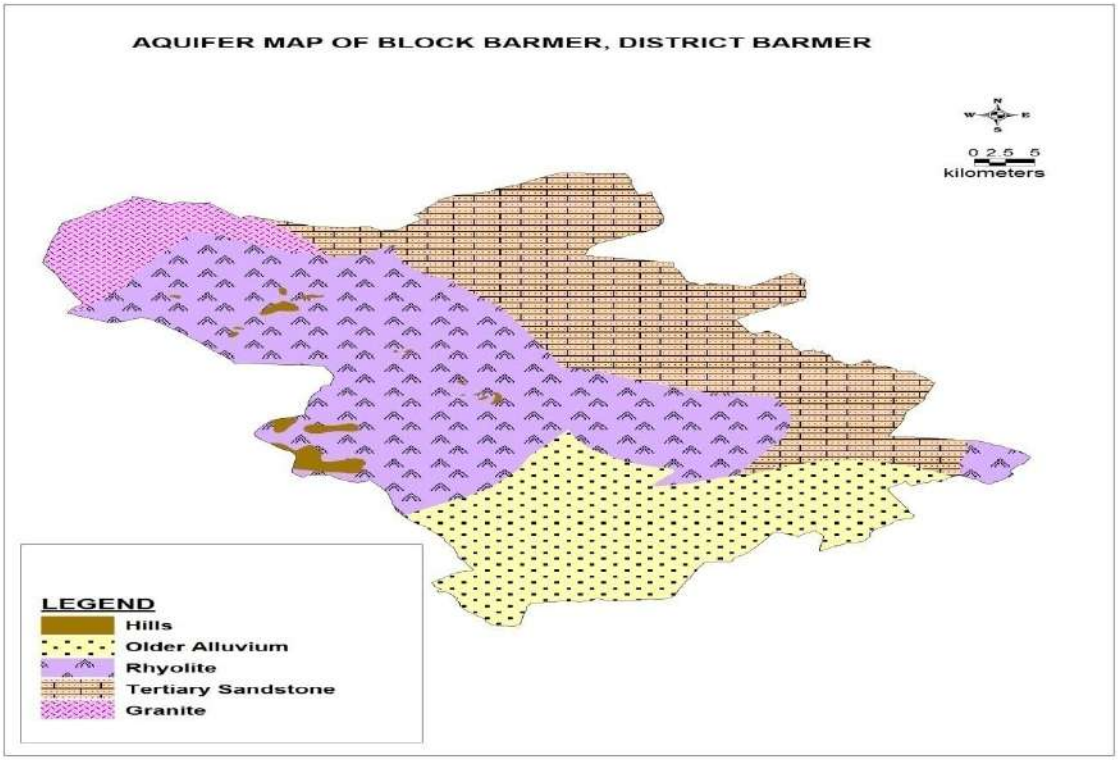


Geology	

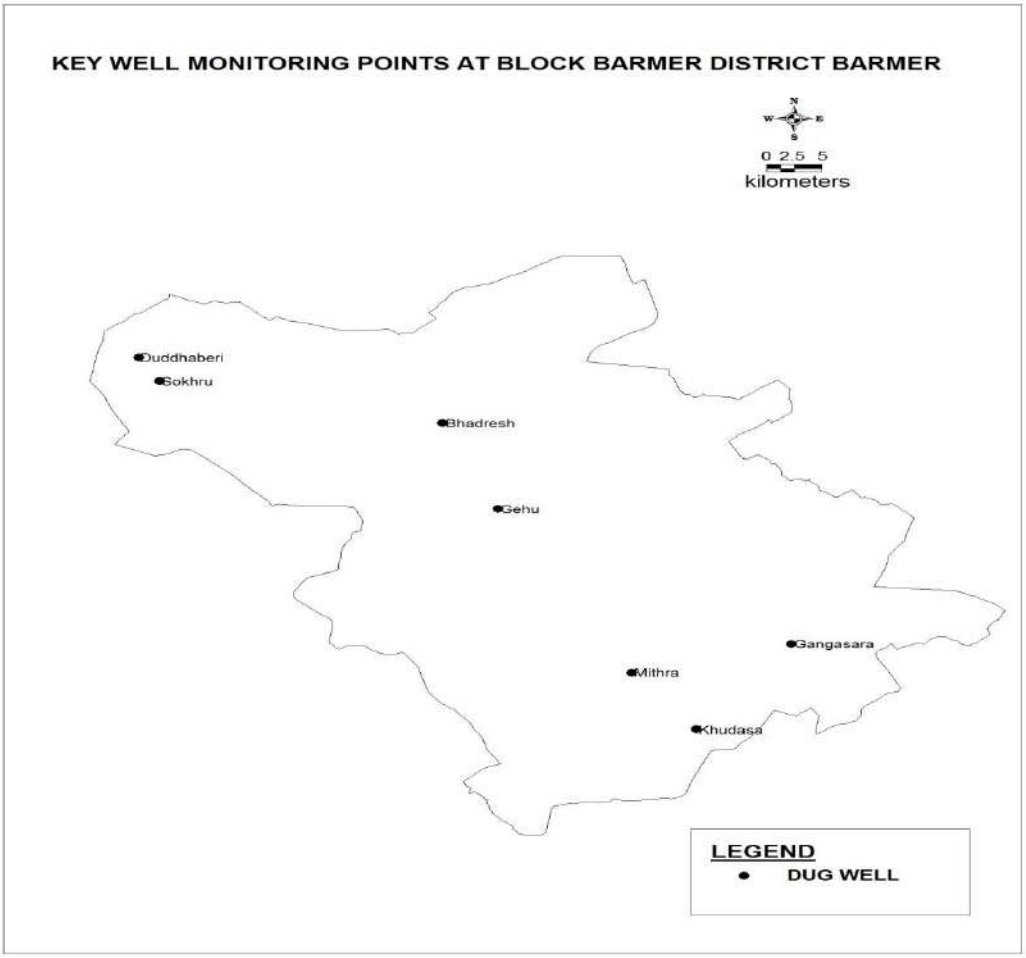
GEOLOGICAL MAP OF BLOCK BARMER, DISTRICT BARMER



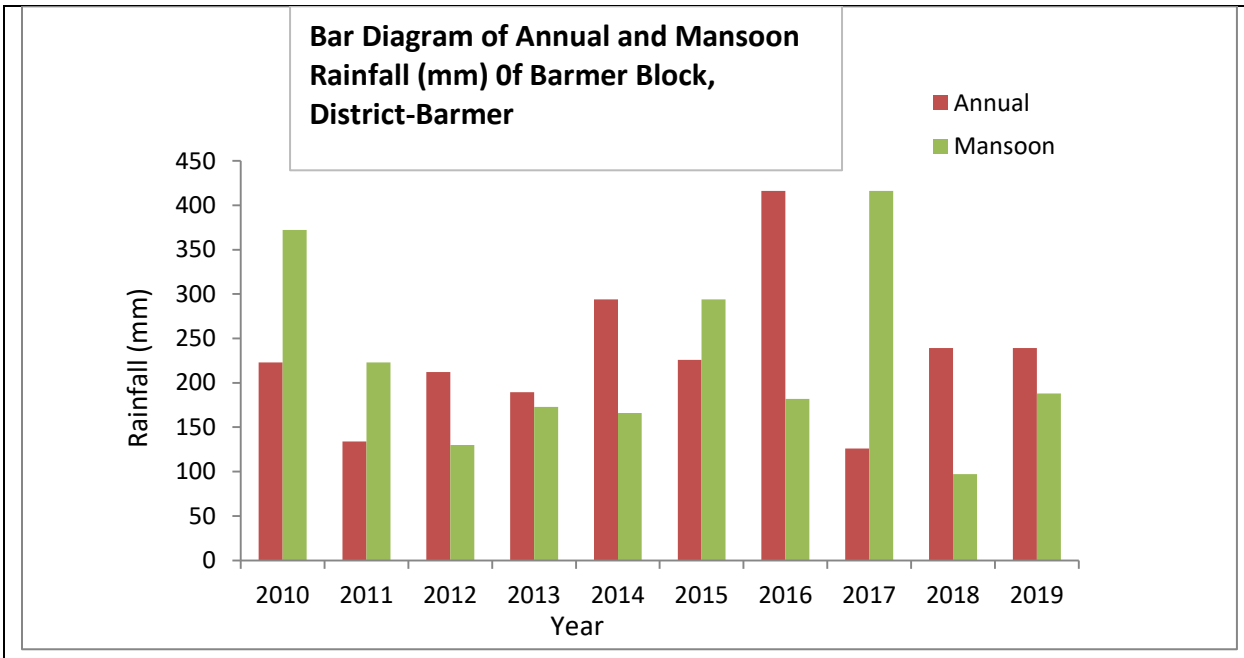
AQUIFER MAP OF BLOCK BARMER, DISTRICT BARMER



Drainage & Hydrology			
Drainage/Basin/Sub Basin		No Major drainage except few ephemerals streamlets	
Hydrology			
Ponds		0	
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		241209	
Forest Area in ha.		4461	
Net Sown Area in ha.		161840	
Area sown more than once in ha.		8886	
Rainfed Crop		Bajra in 61202 hect area	
Area under Irrigation (Net) in ha			
Surface Water		0	
Ground Water		12803	
Other sources		352	
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
sown	144699	17124	0
Irrigated	1558	11580	17
Principal Crop Area (ha)			
Crop Type			
Cereals		103832	
Oil Seeds		13230	
Pulses		27620	
Hydrogeology			
Monitoring Stations (May 2019)			
CGWB		14	
SGWD		25	
NAQUIM Key Wells		07	



WATER LEVEL BEHAVIOUR	
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019)Water level
6.20 to 86.72 m bgl	6.00 to 87.72 m bgl
Trend (m/yr)	-0.21



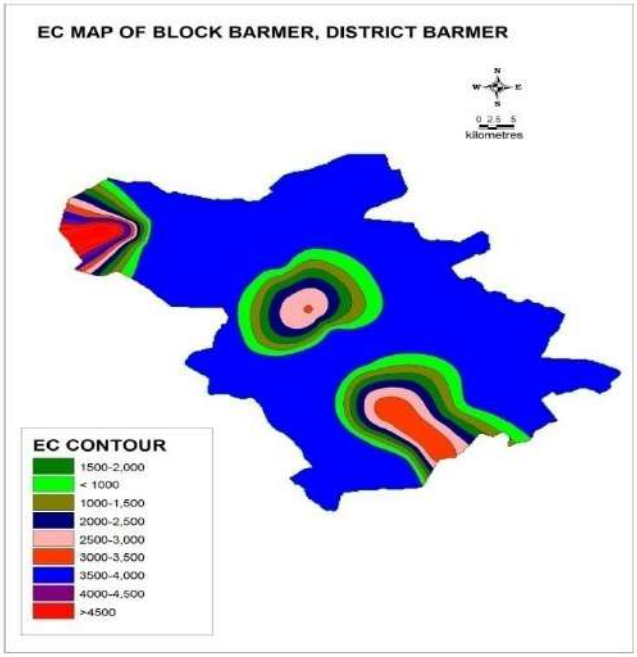
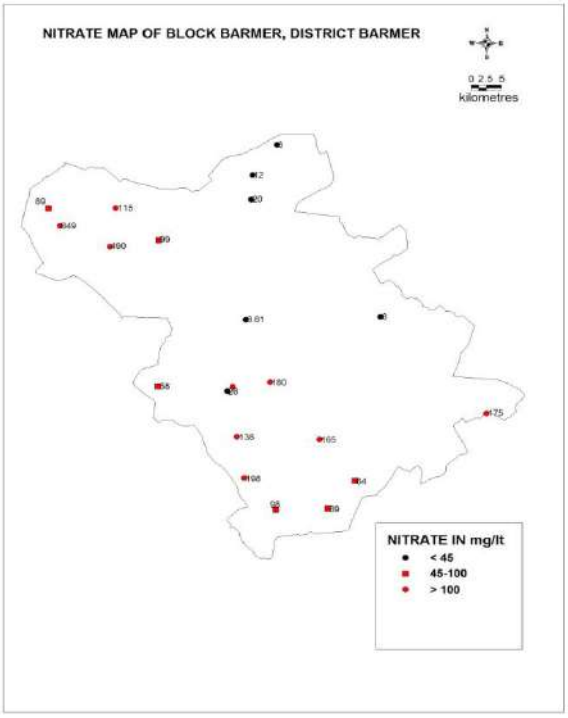
AQUIFER DISPOSITION

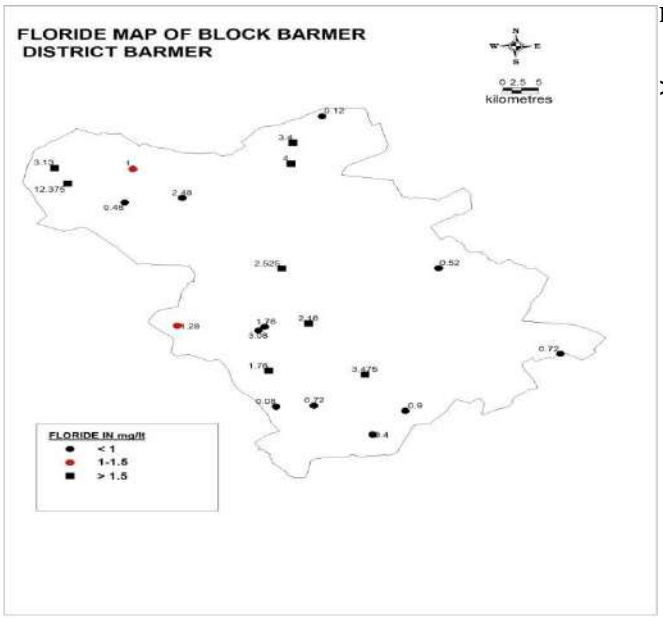
Status of GW Exploration	Exploratory Wells-0 Observation Wells-0 Piezometers - 00 Slim hole -00
Aquifer Characteristics	The Alluvium, Tertiary Sandstone and Granite forms the most important aquifer in the block, Specific Yeild value in the range of 0.015 to 0.06.
GW Quality	EC varies from 380 µS/cm to 17990 µS/cm
Aquifer Potential	Static Water level varies from 6.20 to 86.72 m, Area is yet unexplored

CHEMICAL QUALITY OF GROUND WATER

Suitability for Drinking

TDS(mg/l)	**Range**	**% Samples**
Fresh	0-3000	48%
Brackish	>-3000	52%
Total Hardness (mg/l)	**Range**	**% Samples**
Soft	0 – 75	13.63 %
Moderately Hard	75 – 150	13.63 %
Hard	150 – 300	4.54 %
Very Hard	>300	68.18 %

CHEMICAL QUALITY MAP	VARIATION IN MAJOR & MINOR ELEMENTS	
	EC < 2000 µS/cm at 25°C	20%
	NO3 in mg/l>45 mg/l	76%
	F in mg/l – 1 to 1.5	8%

	mg/l >1.5 mg/l	 40%

Suitability for Irrigation

EC

Type of Water	Classification	% Samples
Low Saline< 250 mg/l	Excellent	0.00
Medium Saline 250 – 750 mg/l	Good	8.00
Highly Saline 750 – 2250 mg/l	Permissible	12.00
Very Highly saline> 2250 mg/l	Doubtful	80.00

Na%

Water Class	Range	% Samples
Excellent	< 20	0.00
Good	20 - 40	8.00
Medium	40 - 60	0.00
Bad	60 - 80	00.0
Very Bad	> 80	92.00

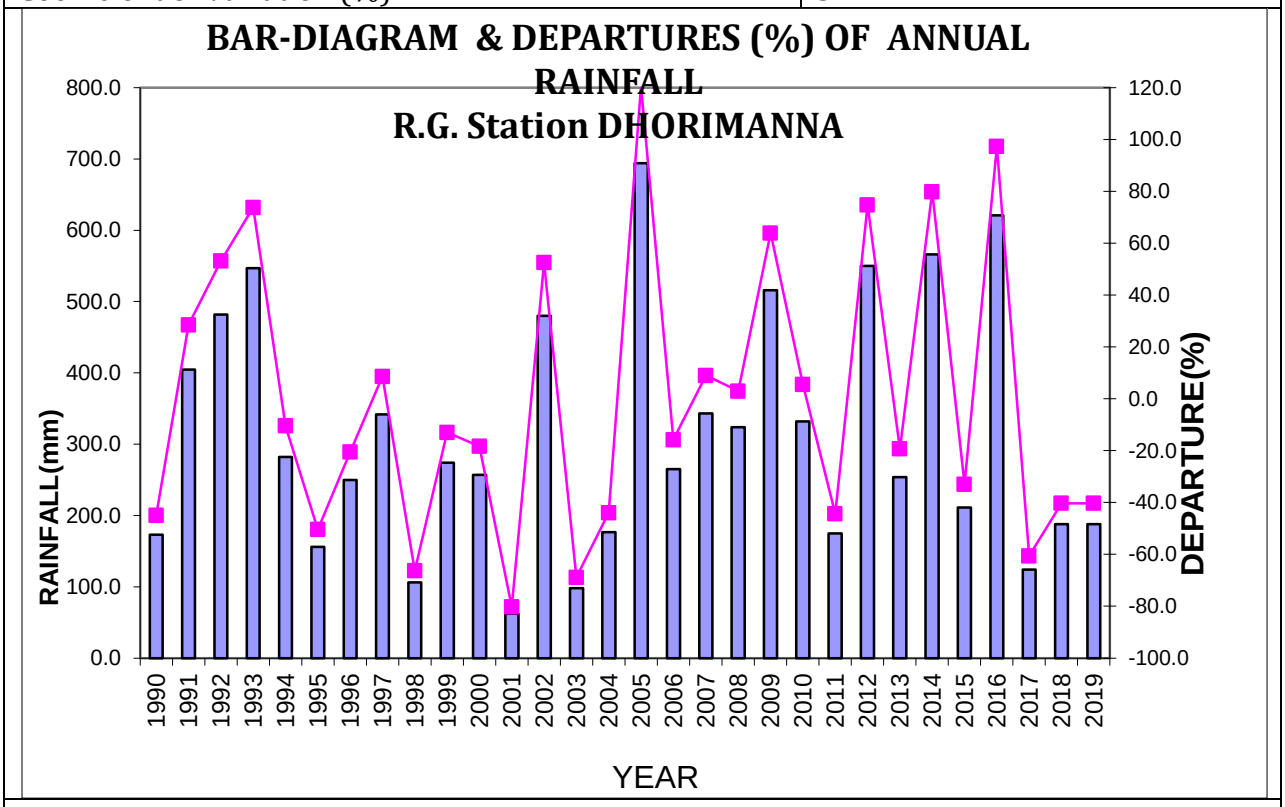
GROUND WATER ISSUES

1. Salinity	High EC and Na%
2. Rainfall and Drought	• Normal Droughts in 10% years • Severe Drought in 20% years
3. Decadal Water Level Trend (2009-2019)	Declining

GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)	
Ground Water Recharge Worthy Area (sq. km.)	1513.37
Total Annual Ground Water Recharge (mcm)	22.86
Natural Discharge (mcm)	2.28
Net Annual Ground Water Availability (mcm)	20.57
Existing Gross Ground Water Draft for All uses(mcm)	13.19
Provision for domestic requirement supply to 2025(mcm)	8.67
Stage of Ground Water Development %	64.13
Category	Safe
In-Storage Resource	
Total Area (Sq.Km)	151.337
Specific yield	STO1:0.06 ALO3:0.06 GRO2a:0.015 GRO2b:0.015
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	475
Water Harvesting Structure	06
Farm Pond / Khet Talai	05
Talai (Talab)	01
Tankas	463
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Tanks (Nos) Capacity 50.000 lts	4319
Volume of water to be conserved (mcm)	0.2160
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	697.34
Surplus Surface water Availability (mcm)	0.00
DEMAND SIDE MANAGEMENT:	
DEMAND SIDE MANAGEMENT	
Irrigitation by permitted TW almost already using Micro irrigation techniques like irrigation through Sprinkler. No more scope is feasible	
Cropping Pattern change: The sown crops are already less water consuming crops like Bajra, Mung etc. The change in cropping pattern is not feasible.	
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	20.57
Existing Ground Water Draft for All Purposes (mcm)	13.19
Present stage of Ground Water Development (%)	64.13
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	63.46

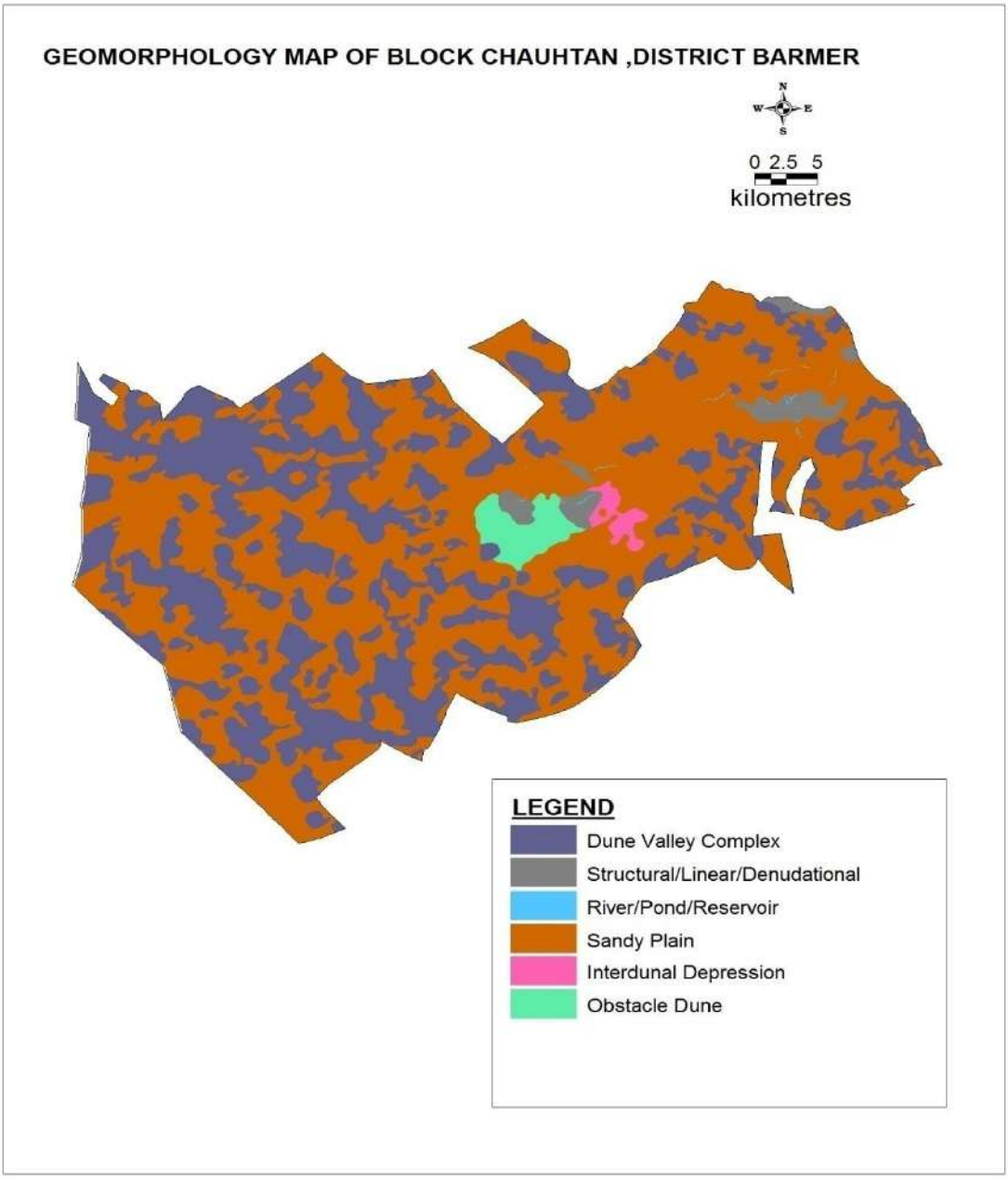
CHOHTAN BLOCK

SALIENT INFORMATION	
Block Name	**CHOHTAN**
Longitude	70˚ 40’ to 71˚ 21’ 26”
Latitude	25˚ 11’ 18” to 25˚ 38’ 34”
Geographical Area Sq.km	1802.79
Hilly Area (Sq.km)	10.51
Population (2011)	203797
Climate	
Average Temperature range (°C)	02 to 48
Rainfall Analysis	
Normal Rainfall (mm)	266.1
Mean Annual rainfall (mm)	314.7
Highest annual rainfall with year (mm)	694 (1983)
Lowest annual rainfall (mm) with year	62 (1989)
Standard deviation (mm)	171.20
Coefficient of Variation (%)	54.4

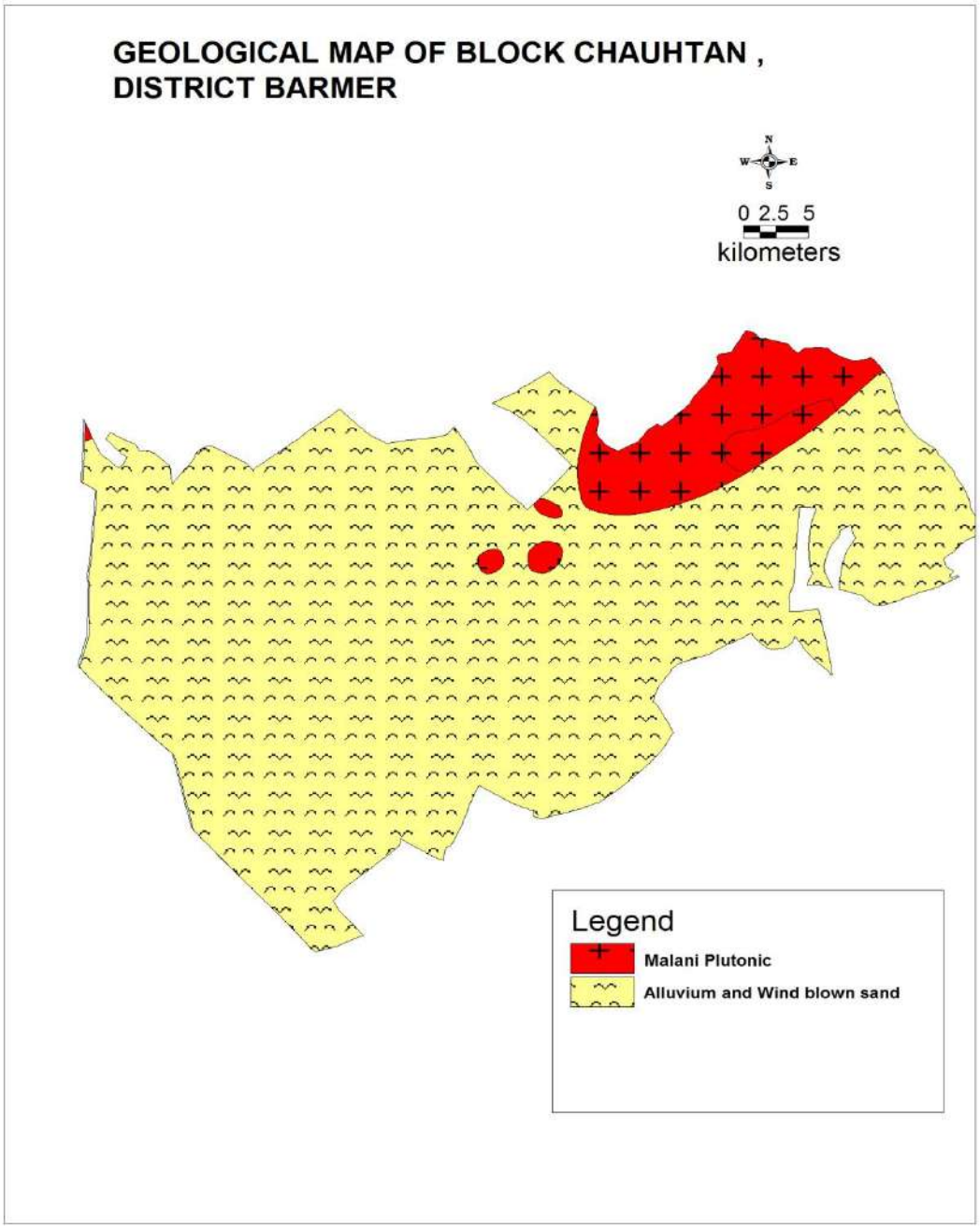


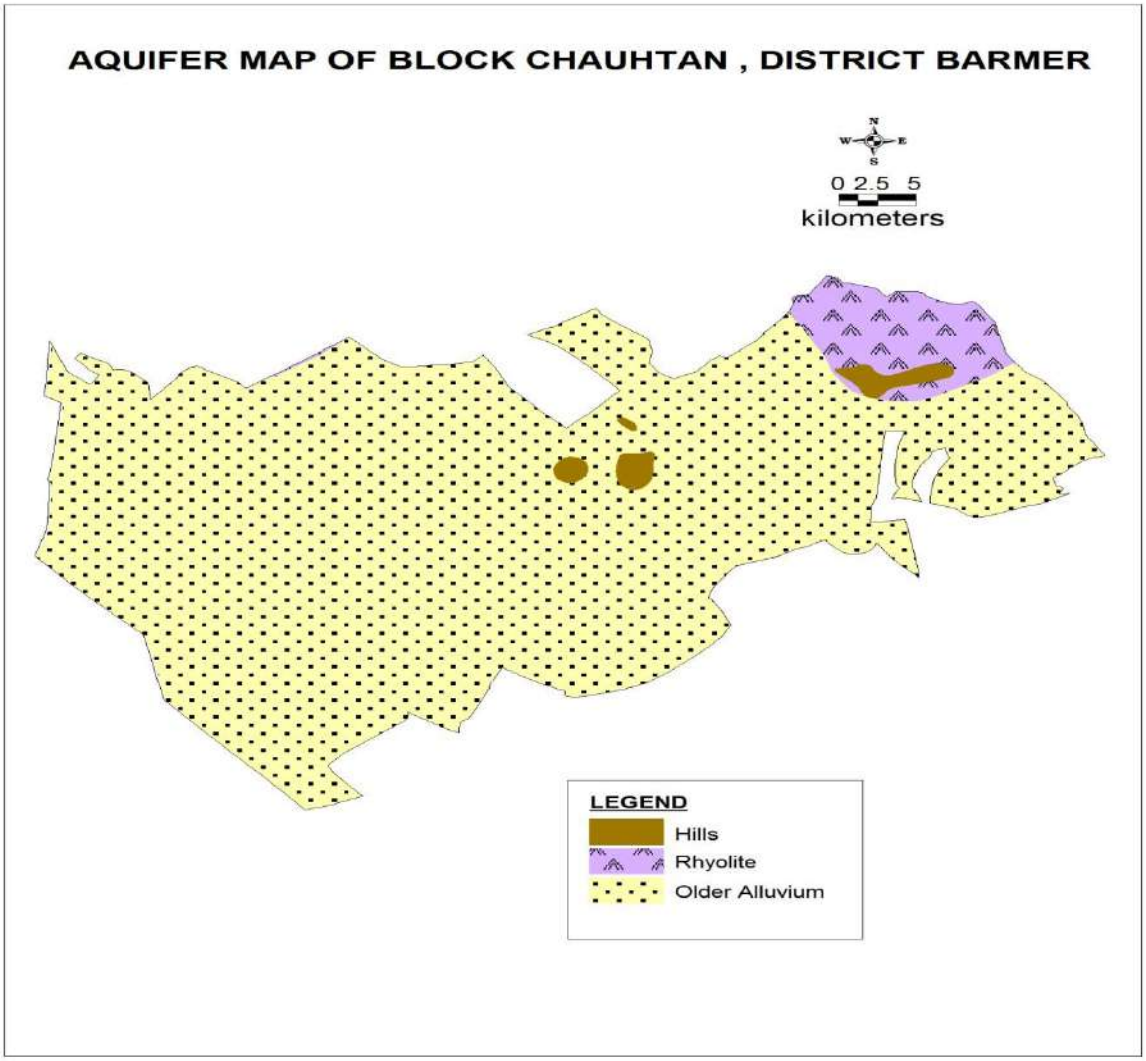
Drought Analysis	
Mild (0 to -25%)	06
Normal (-25% to -50%)	06
Severe (-50% to -75%)	04
Most severe (-75% to -100%)	01

Geomorphology	
Geomorphic Unit	Older alluvium with undulating planes, abruptly rising hills of rhyolite, sand dunes slightly with obstacle dune
Elevation (m amsl)	



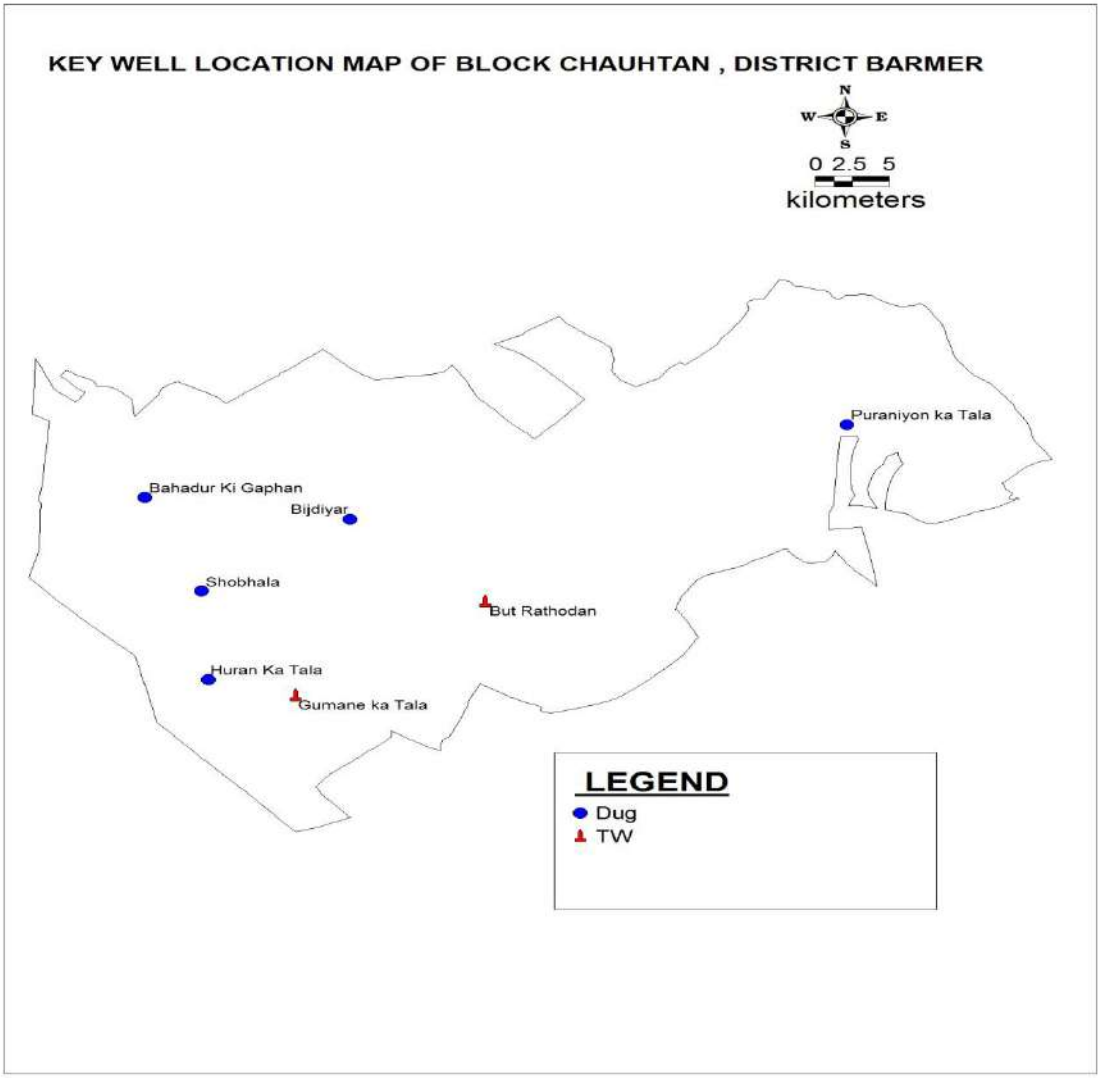
Geology	


GEOLOGICAL MAP OF BLOCK CHAUHTAN ,
DISTRICT BARMER
N
W
E
S
0 2.5 5
kilometers
Legend
Malani Plutonic
Alluvium and Wind blown sand

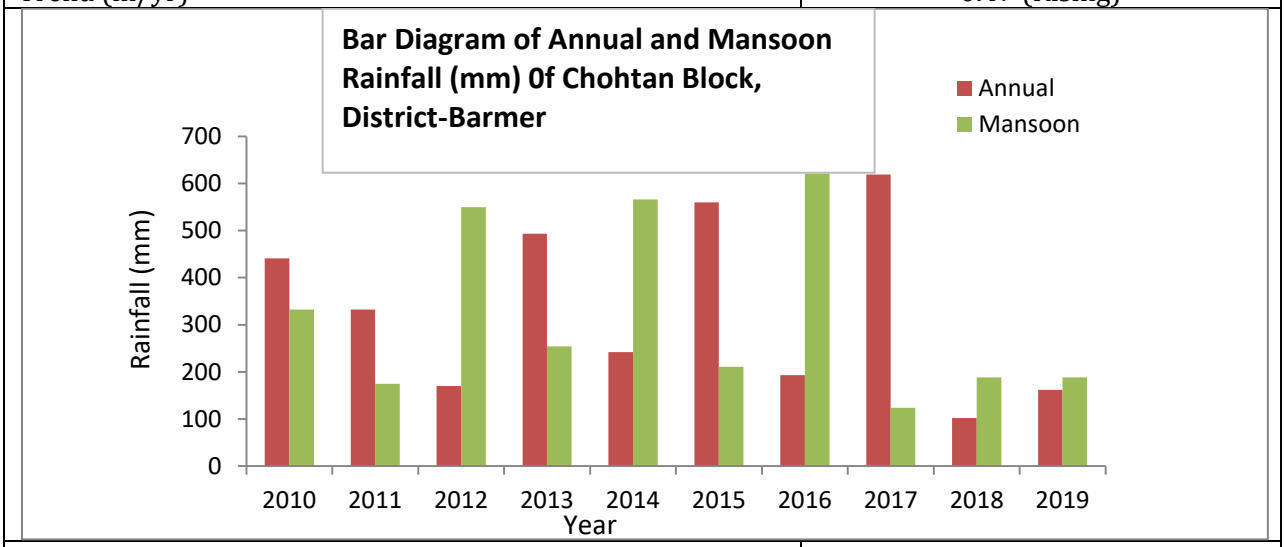


Drainage & Hydrology	
Drainage/Basin/Sub Basin	No Major drainage except few ephemerals streamlets
Hydrology	
Ponds	0
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN	
Geographical Area in ha.	180279
Forest Area in ha.	1382
Net Sown Area in ha.	143839
Area sown more than once in ha.	14474
Rainfed Crop	Bajra in 73815 hect area
Area under Irrigation (Net) in ha	
Surface Water	0
Ground Water	27137
Other sources	0

Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
sown	121623	20418	1798
Irrigated	5377	19962	1798
Principal Crop Area (ha)			
Crop Type			
Cereals		78581	
Oil Seeds		26581	
Pulses		16461	
Hydrogeology			
Monitoring Stations (May 2019)			
CGWB		07	
SGWD		12	
NAQUIM Key Wells		08	



WATER LEVEL BEHAVIOUR	
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019)Water level
3.90 to 90.00 m bgl	4.06 to 88.79 m bgl
Trend (m/yr)	0.47 (Rising)



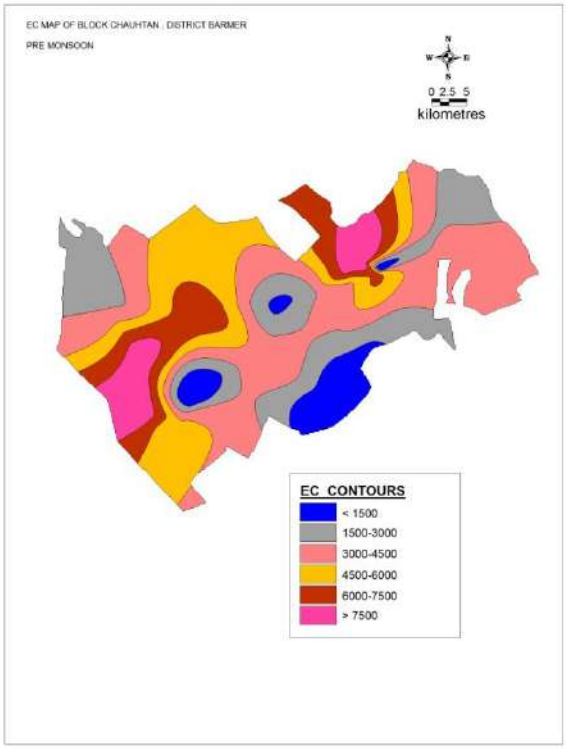
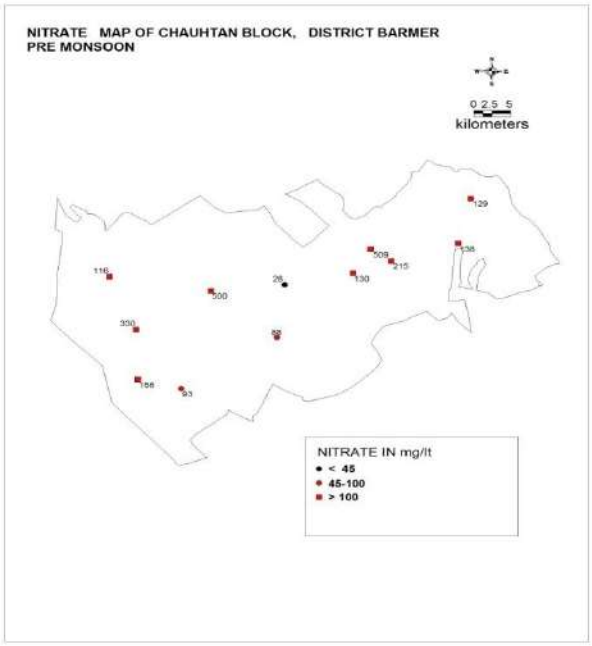
AQUIFER DISPOSITION

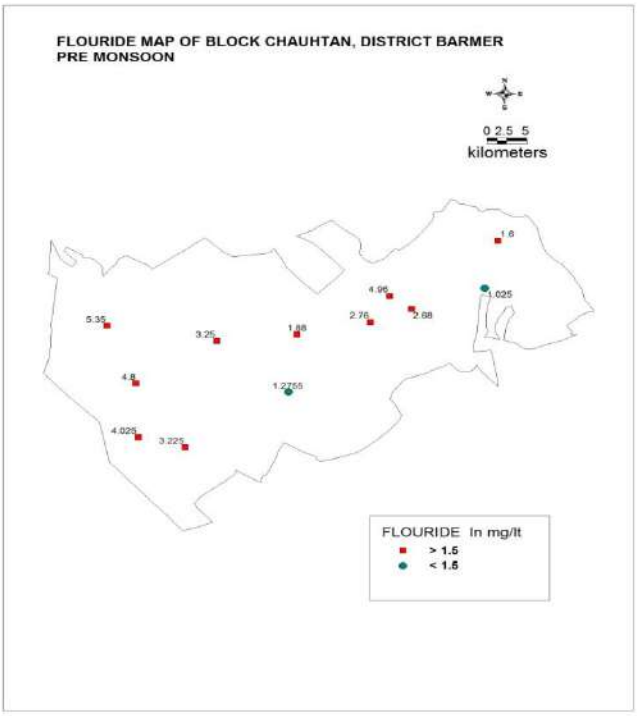
Status of GW Exploration	Exploratory Wells-10 Observation Wells-07 Piezometers - 03 Slim hole -00
Aquifer Characteristics	The Alluvium, and Granite forms the most important aquifer in the block, Specific Yeild value in the range of 0.015 to 0.08.
GW Quality	EC varies from 1250 µS/cm to 8700 µS/cm
Aquifer Potential	Static Water level varies from 3.90 to 90.00 m, Discharge varies from 89 to 471 lpm and Transmissivity varies from 123.60 to 698.6.

CHEMICAL QUALITY OF GROUND WATER

Suitability for Drinking

TDS(mg/l)	**Range**	**% Samples**
Fresh	0-3000	53.85%
Brackish	>-3000	46.15%
Total Hardness (mg/l)	**Range**	**% Samples**
Soft	0 – 75	0 %
Moderately Hard	75 – 150	0%
Hard	150 – 300	30.77 %
Very Hard	>300	69.23 %

CHEMICAL QUALITY MAP	VARIATION IN MAJOR & MINOR ELEMENTS	
	EC < 2000 µS/cm at 25°C	7.69%
	NO3 in mg/l>45 mg/l	84.62%



	F in mg/l – 1 to 1.5 mg/l	15.38%
	>1.5 mg/l	76.92%

Suitability for Irrigation

EC

Type of Water	Classification	% Samples
Low Saline< 250 mg/l	Excellent	0.00
Medium Saline 250 – 750 mg/l	Good	8.00
Highly Saline 750 – 2250 mg/l	Permissible	7.69
Very Highly saline> 2250 mg/l	Doubtful	92.31

Na%

Water Class	Range	% Samples
Excellent	< 20	0.00
Good	20 - 40	0.00
Medium	40 - 60	0.00
Bad	60 - 80	00.0
Very Bad	> 80	100.00

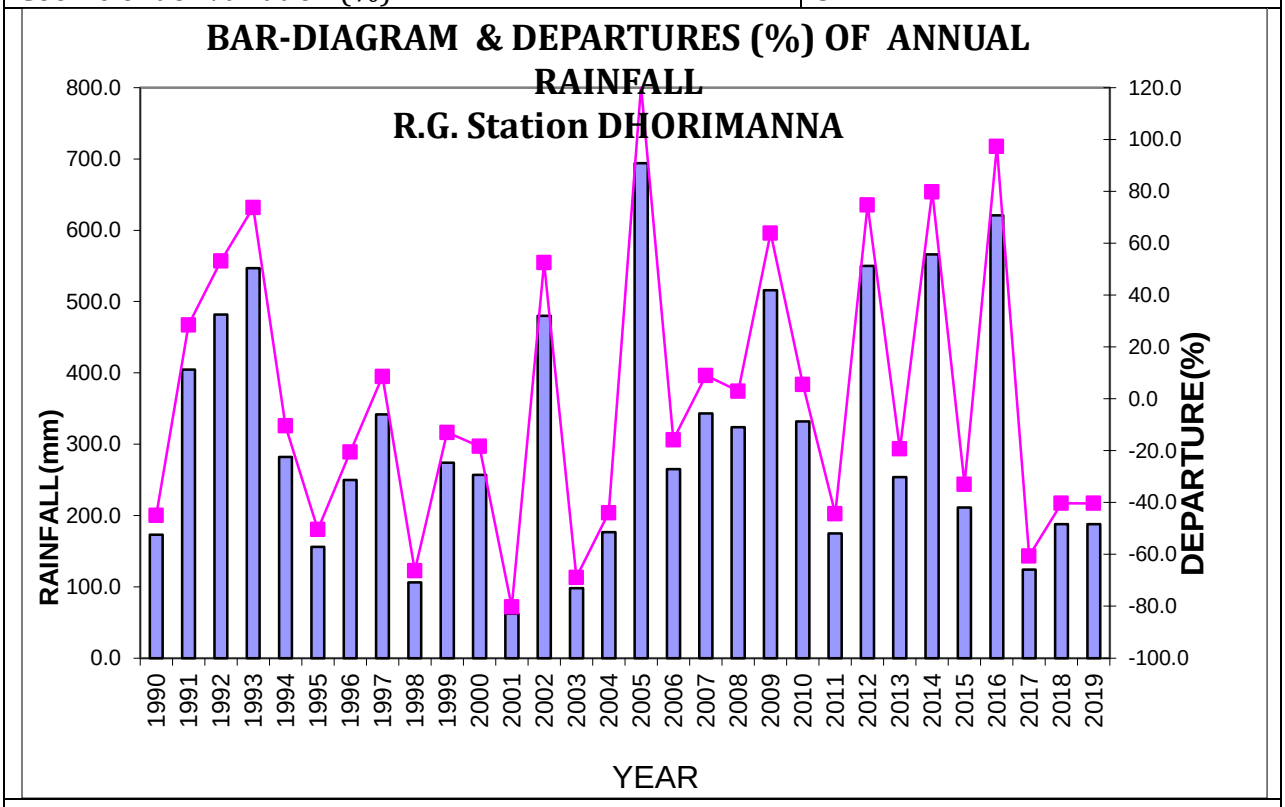
GROUND WATER ISSUES

1. Salinity	High EC and Na%
2. Rainfall and Drought	• Normal Droughts in 20% years • Severe Drought in 13.33% years
3. Decadal Water Level Trend (2009-2019)	Rising

GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)	
Ground Water Recharge Worthy Area (sq. km.)	1150.25
Total Annual Ground Water Recharge (mcm)	22.42
Natural Discharge (mcm)	2.24
Net Annual Ground Water Availability (mcm)	20.17
Existing Gross Ground Water Draft for All uses(mcm)	14.06
Provision for domestic requirement supply to 2025(mcm)	2.62
Stage of Ground Water Development %	69.69
Category	Safe
In-Storage Resource	
Total Area (Sq.Km)	115.025
Specific yield	ALO3a :0.08 ALO3b :0.08 GRO2 :0.015
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	652
Water Harvesting Structure	08
Farm Pond / Khet Talai	04
Sub Surface barrier	02
Tankas	638
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Tanks (Nos) Capacity 50.000 lts	3156
Volume of water to be conserved (mcm)	0.1578
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	595.15
Surplus Surface water Availability (mcm)	0.00
DEMAND SIDE MANAGEMENT:	
DEMAND SIDE MANAGEMENT	
Irrigitation by permitted TW almost already using by Micro irrigation techniques like irrigation through Sprinkler. No more scope is feasible	
Cropping Pattern change: The sown crops are already less water consuming crops like Bajra, Mung etc. The change in cropping pattern is not feasible.	
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	20.17
Existing Ground Water Draft for All Purposes (mcm)	14.06
Present stage of Ground Water Development (%)	69.69
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	69.22

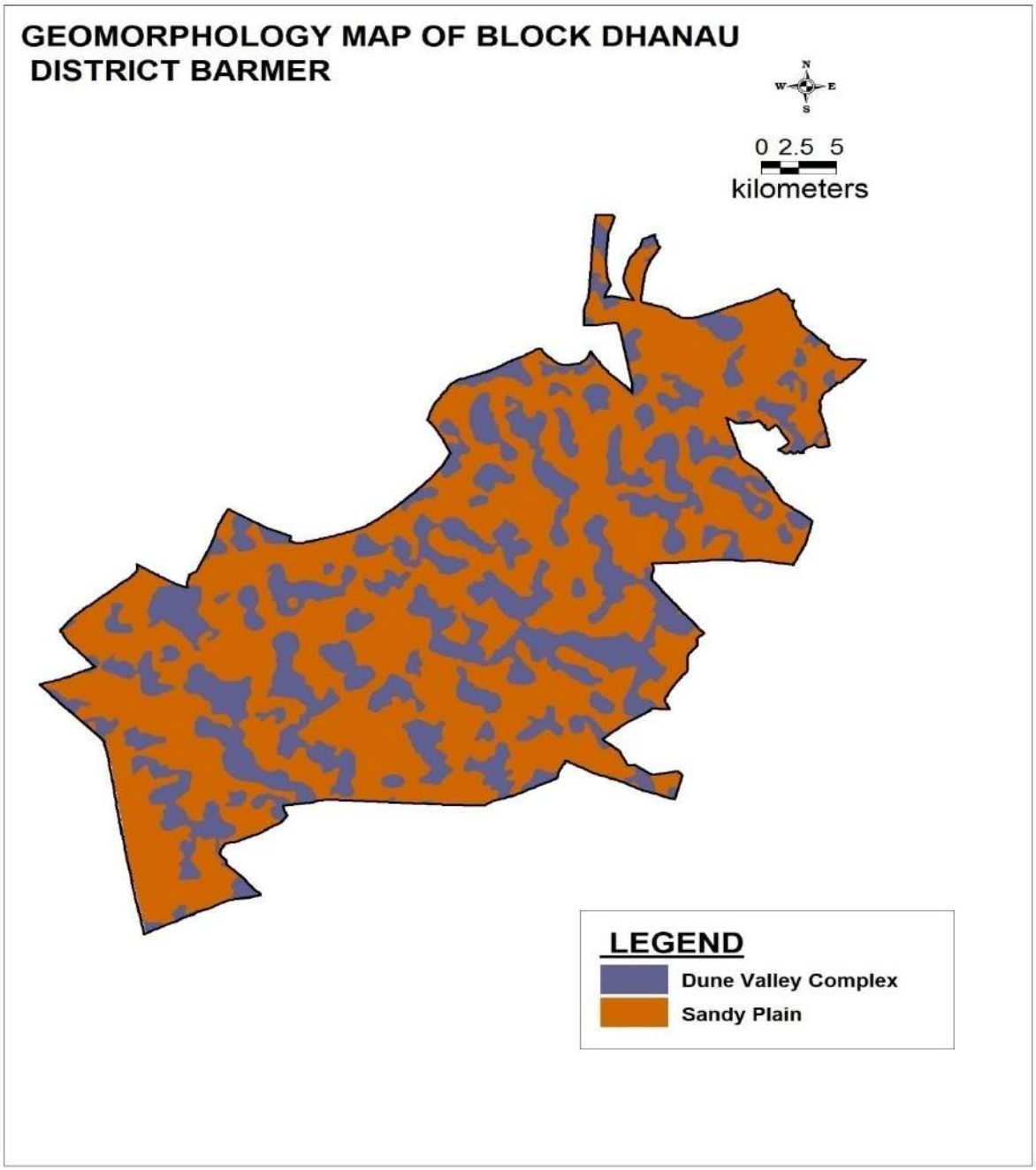
DHANAU BLOCK

SALIENT INFORMATION	
Block Name	**DHANAU**
Longitude	70˚ 50’5” to 71˚ 24’ 7”
Latitude	25˚ 1’ 24” to 25˚ 30’ 28”
Geographical Area Sq.km	1244.74
Hilly Area (Sq.km)	0
Population (2011)	No census available
Climate	
Average Temperature range (°C)	02 to 48
Rainfall Analysis	
Normal Rainfall (mm)	275.2
Mean Annual rainfall (mm)	314.7
Highest annual rainfall with year (mm)	694 (1983)
Lowest annual rainfall (mm) with year	62 (1989)
Standard deviation (mm)	171.20
Coefficient of Variation (%)	54.4

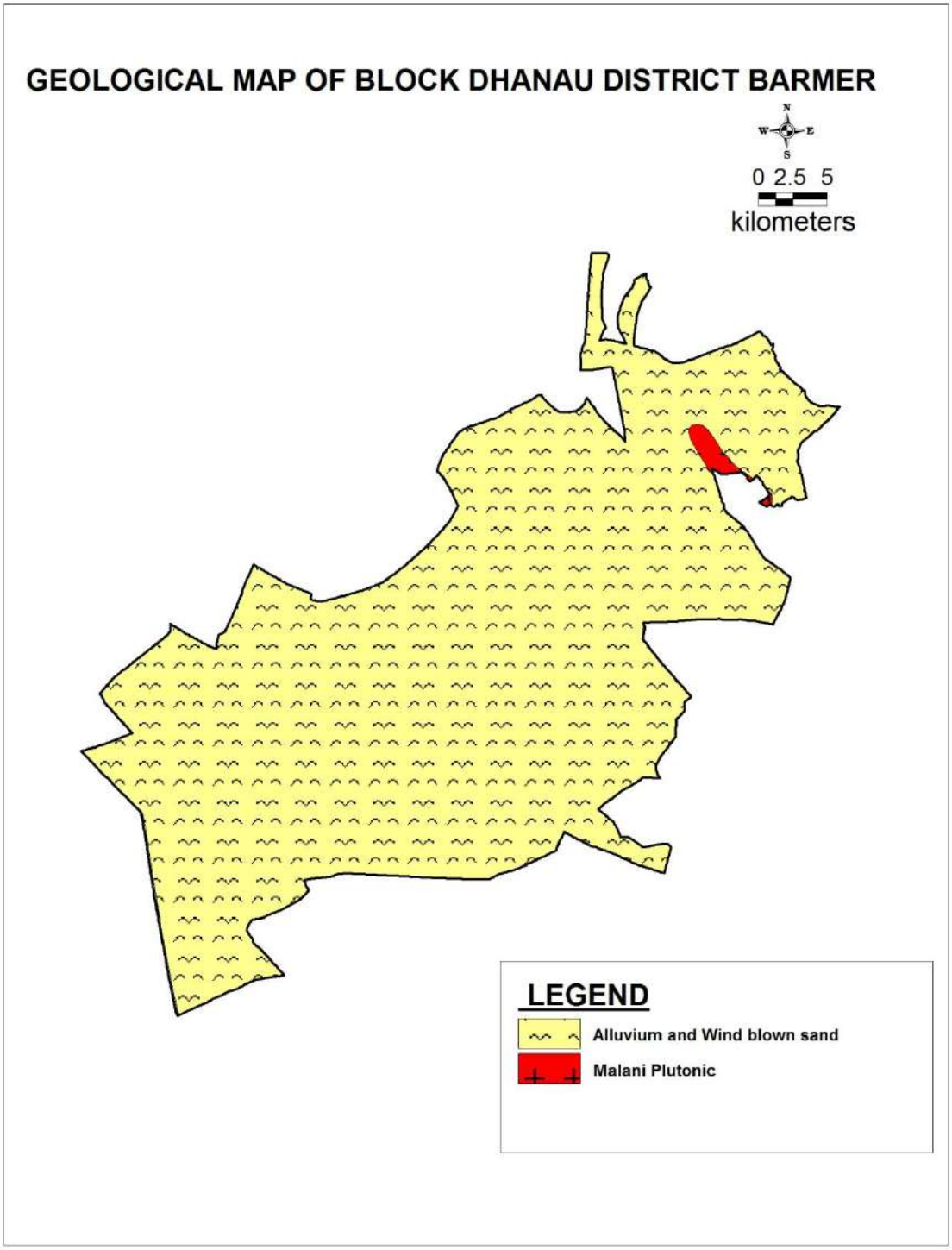


Drought Analysis	
Mild (0 to -25%)	06
Normal (-25% to -50%)	06
Severe (-50% to -75%)	04
Most severe (-75% to -100%)	01

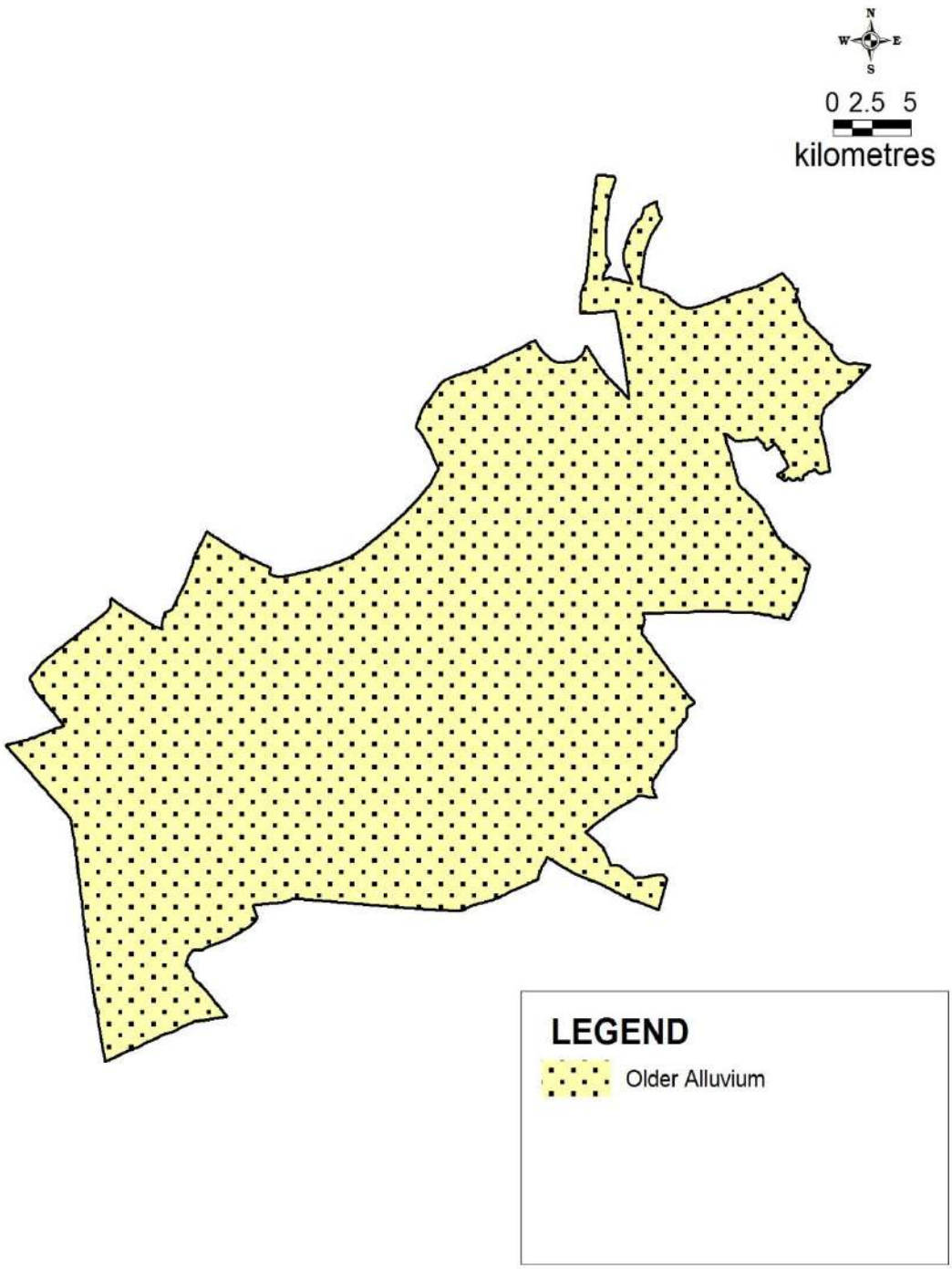
Geomorphology	
Geomorphic Unit	Older alluvium with undulating planes, sand dunes slightly with obstacle dune
Elevation (m amsl)	



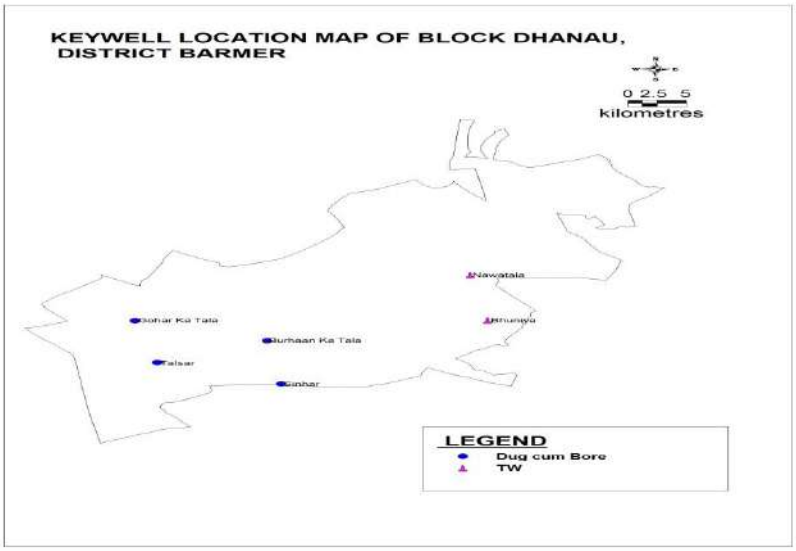
Geology	


GEOLOGICAL MAP OF BLOCK DHANAU DISTRICT BARMER
N
W
E
S
0 2.5 5
kilometers
LEGEND
Alluvium and Wind blown sand
Malani Plutonic

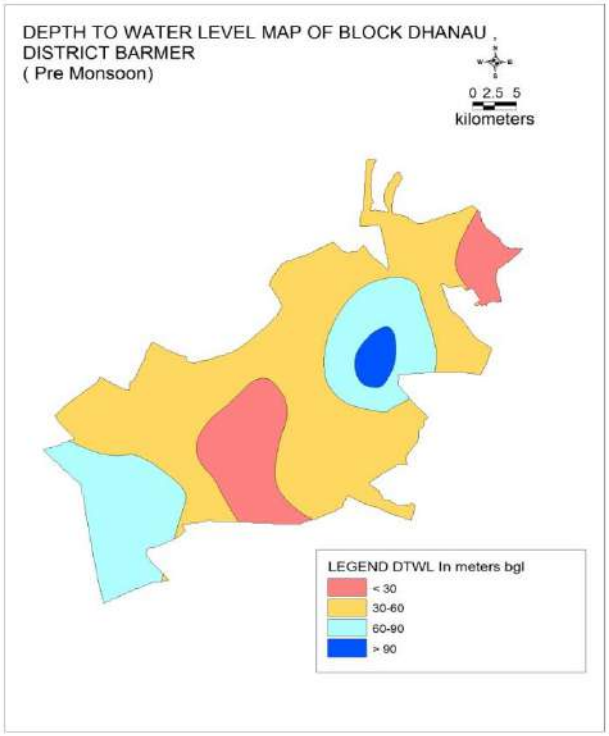
AQUIFER MAP OF DHANAU BLOCK , DISTRICT BARMER

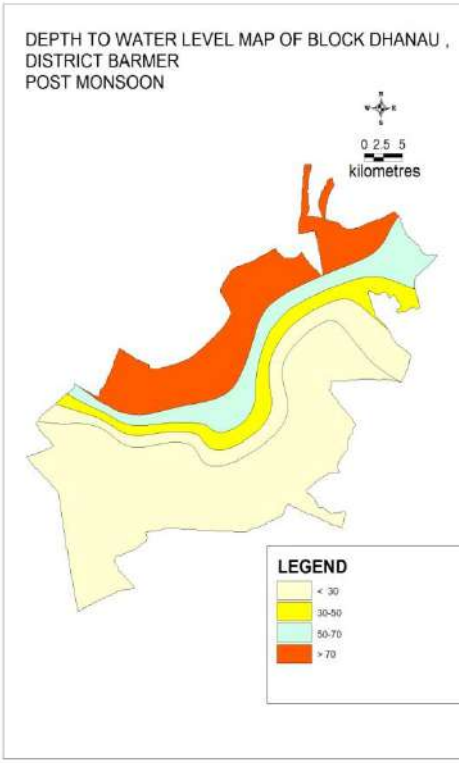


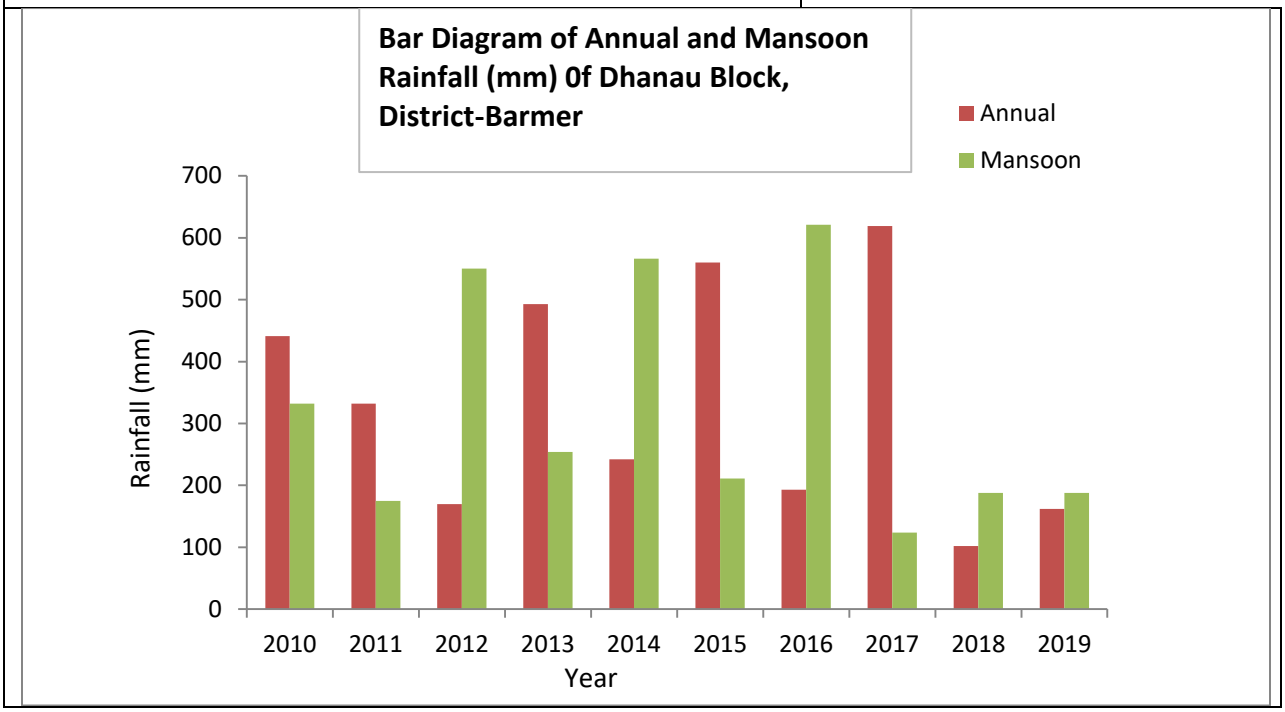
Drainage & Hydrology			
Drainage/Basin/Sub Basin		No Major drainage except few ephemerals streamlets	
Hydrology			
Ponds		0	
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		124474	
Forest Area in ha.		2	
Net Sown Area in ha.		101054	
Area sown more than once in ha.		11857	
Rainfed Crop		Bajra in 50162 hect area	
Area under Irrigation (Net) in ha			
Surface Water		0	
Ground Water		21002	
Other sources		26	
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
sown	85320	15663	71
Irrigated	5745	15212	71
Principal Crop Area (ha)			
Crop Type			
Cereals		26955	
Oil Seeds		12893	
Pulses		18517	
Hydrogeology			
Monitoring Stations (May 2019)			
CGWB		01	
SGWD		05	
NAQUIM Key Wells		06	



WATER LEVEL BEHAVIOUR	
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019)Water level
52.10 to 76.03 m bgl	50.92 to 75.70 m bgl
Trend (m/yr)	-0.14 (Declining)



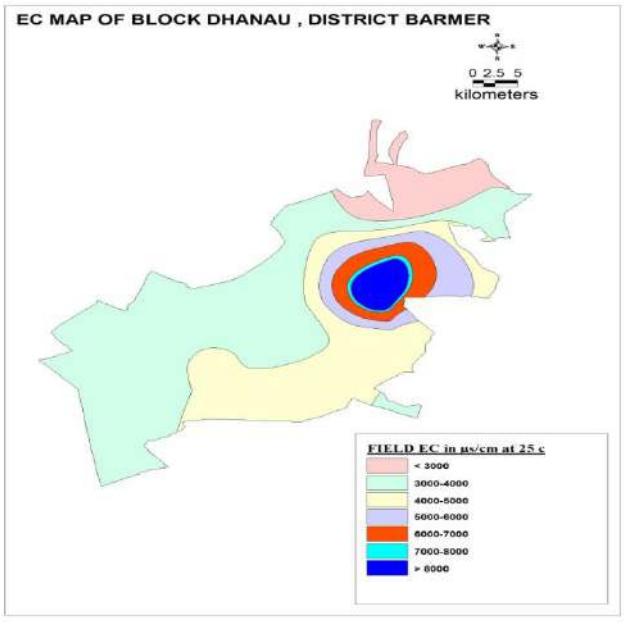


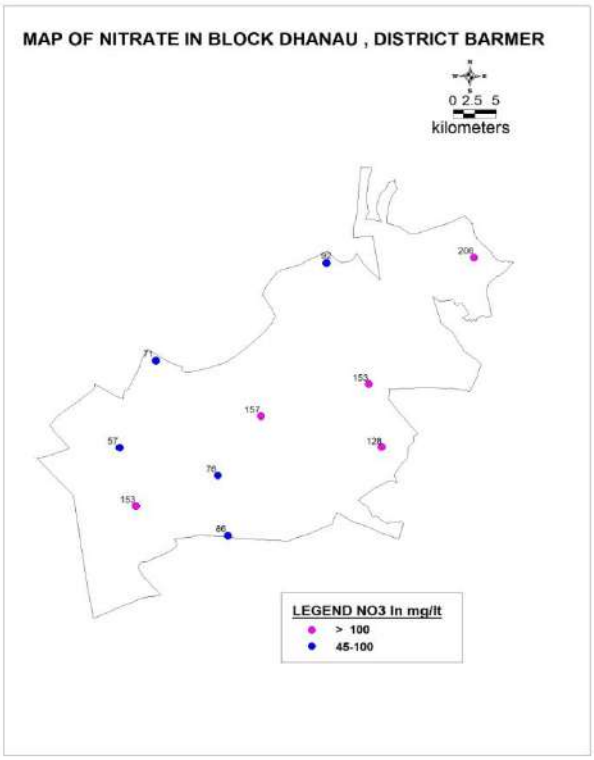
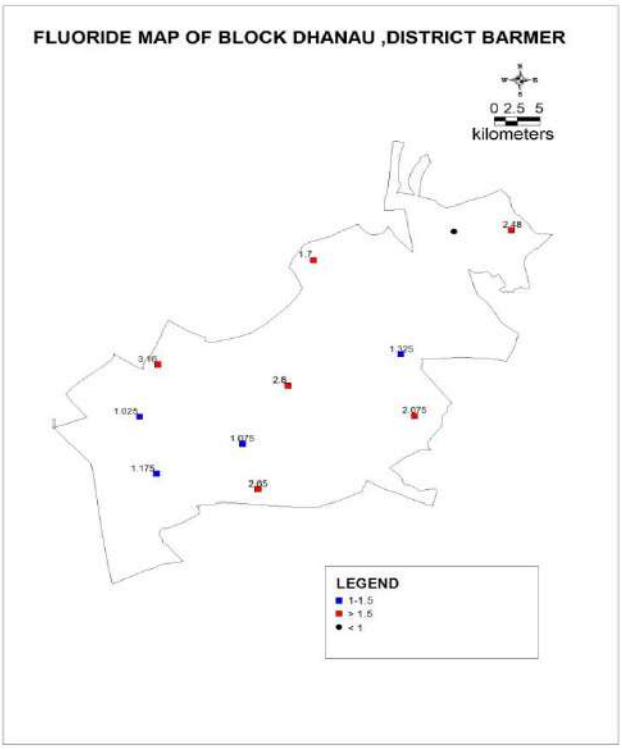


AQUIFER DISPOSITION	
Status of GW Exploration	Exploratory Wells-0 Observation Wells-0 Piezometers - 01 Slim hole -00
Aquifer Characteristics	The Alluvium form the most important aquifer in the block, Specific Yeild value in the range of 0.1 to 0.08.
GW Quality	EC varies from 3000 µS/cm to 8000 µS/cm
Aquifer Potential	Static Water level varies from 52.10 to 76.03 m. The area is still unexplored.

CHEMICAL QUALITY OF GROUND WATER

Suitability for Drinking

TDS(mg/l)	**Range**	**% Samples**
Fresh	0-3000	90.00%
Brackish	>-3000	10.00%
Total Hardness (mg/l)	**Range**	**% Samples**
Soft	0 – 75	0 %
Moderately Hard	75 – 150	20.00%
Hard	150 – 300	60.00 %
Very Hard	>300	20.00 %
CHEMICAL QUALITY MAP	VARIATION IN MAJOR & MINOR ELEMENTS	
	EC < 2000 µS/cm at 25°C	0%

	NO3 in mg/l>45 mg/l	100%
	F in mg/l – 1 to 1.5 mg/l >1.5 mg/l	40% 60%

Suitability for Irrigation

EC

Type of Water	Classification	% Samples
Low Saline< 250 mg/l	Excellent	0.00
Medium Saline 250 – 750 mg/l	Good	0.00
Highly Saline 750 – 2250 mg/l	Permissible	0.00
Very Highly saline> 2250 mg/l	Doubtful	100.00

Na%

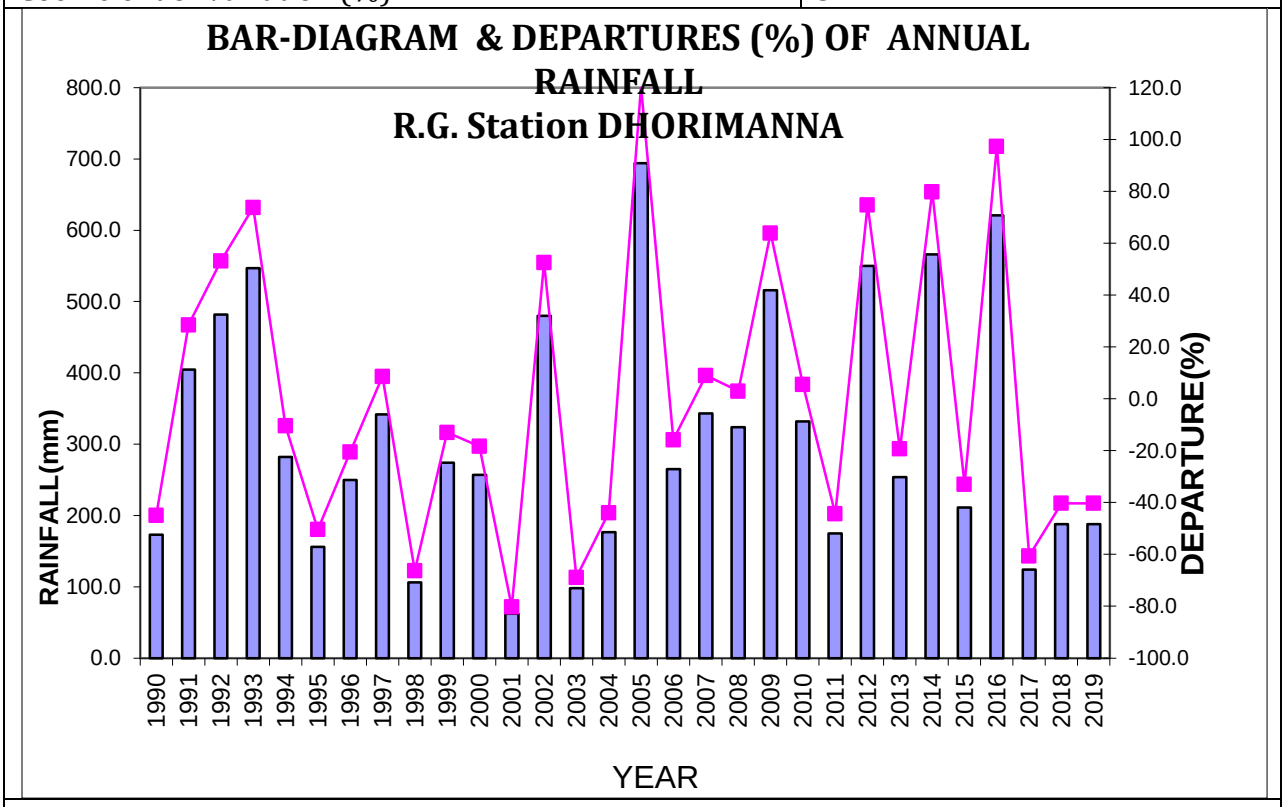
Water Class	Range	% Samples
Excellent	< 20	0.00
Good	20 - 40	0.00
Medium	40 - 60	0.00
Bad	60 - 80	00.0
Very Bad	> 80	100.00

GROUND WATER ISSUES	
1. Salinity	Very High EC and Na%
2. Rainfall and Drought	• Normal Droughts in 20% years • Severe Drought in 13.33% years
3. Decadal Water Level Trend (2009-2019)	Declining
GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)	
Ground Water Recharge Worthy Area (sq. km.)	1244.74
Total Annual Ground Water Recharge (mcm)	32.03
Natural Discharge (mcm)	3.20
Net Annual Ground Water Availability (mcm)	28.82
Existing Gross Ground Water Draft for All uses(mcm)	27.87
Provision for domestic requirement supply to 2025(mcm)	3.30
Stage of Ground Water Development %	96.69
Category	Critical
In-Storage Resource	
Total Area (Sq.Km)	124.474
Specific yield	ALO1 :0.1 ALO3 :0.08
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	951
Water Harvesting Structure	15
Recharging Shaft for Aquifers	03
Farm Pond / Khet Talai	05
Earthen Checkdam	12
Talai (Talab)	01

Tankas	915
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Tanks (Nos) Capacity 50.000 lts	2421
Volume of water to be conserved (mcm)	0.1211
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	3050.60
Surplus Surface water Availability (mcm)	0.00
DEMAND SIDE MANAGEMENT:	
DEMAND SIDE MANAGEMENT	
Irrigitation by permitted TW almost already using by Micro irrigation techniques like irrigation through Sprinkler. No more scope is feasible	
Cropping Pattern change: The sown crops are already less water consuming crops like Bajra, Mung etc. The change in cropping pattern is not feasible.	
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	28.82
Existing Ground Water Draft for All Purposes (mcm)	27.87
Present stage of Ground Water Development (%)	96.69
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	96.30

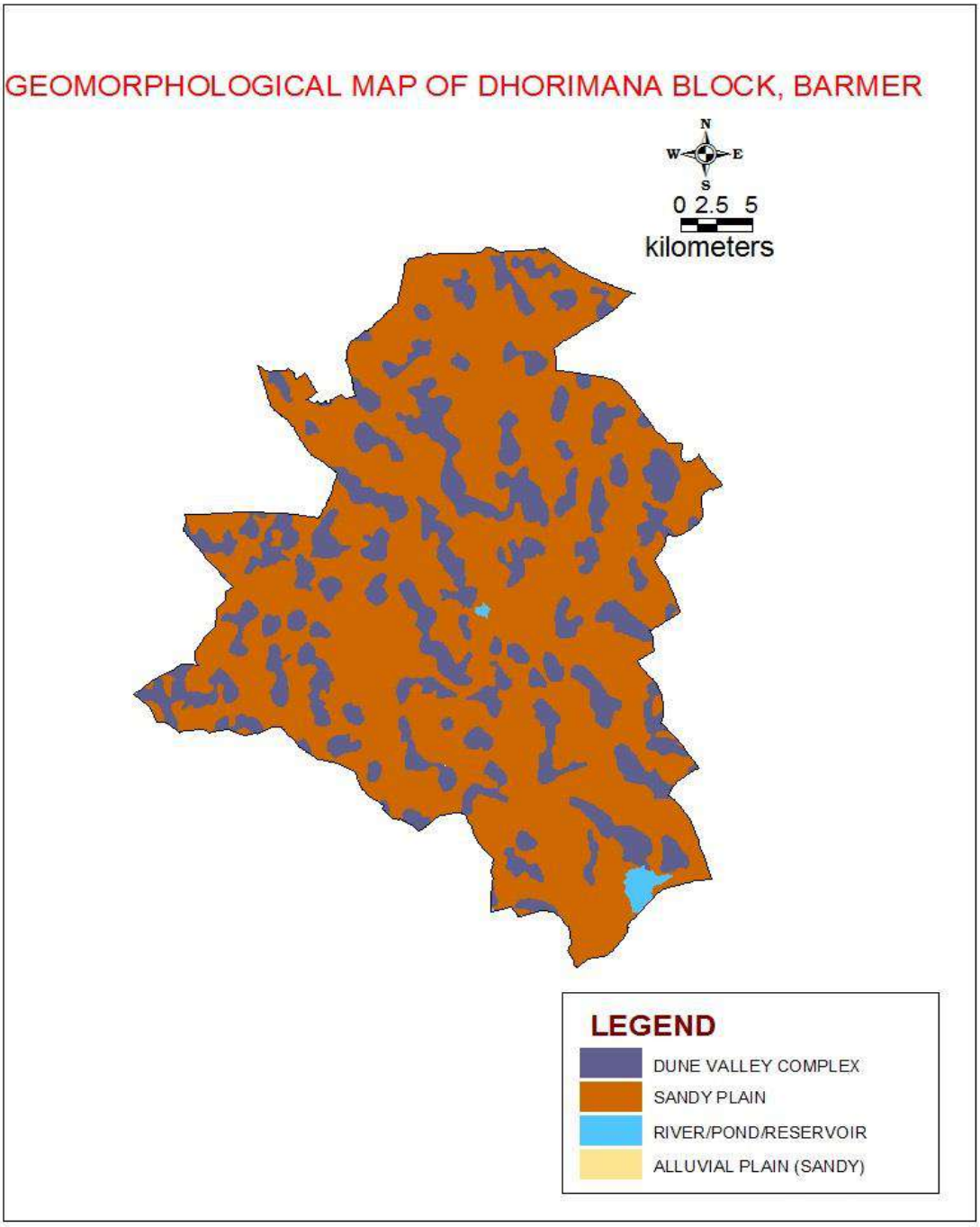
DHORIMANNA BLOCK

SALIENT INFORMATION	
Block Name	**DHORIMANNA**
Longitude	71° 13’ 20” to 71° 37’ 28”
Latitude	24° 58’ 28” to 25° 27’ 29”
Geographical Area Sq.km	1659.86
Hilly Area (Sq.km)	2.57
Population (2011)	142416
Climate	
Average Temperature range (°C)	02 to 48
Rainfall Analysis	
Normal Rainfall (mm)	284.3
Mean Annual rainfall (mm)	314.7
Highest annual rainfall with year (mm)	694 (1983)
Lowest annual rainfall (mm) with year	62 (1989)
Standard deviation (mm)	171.20
Coefficient of Variation (%)	54.4

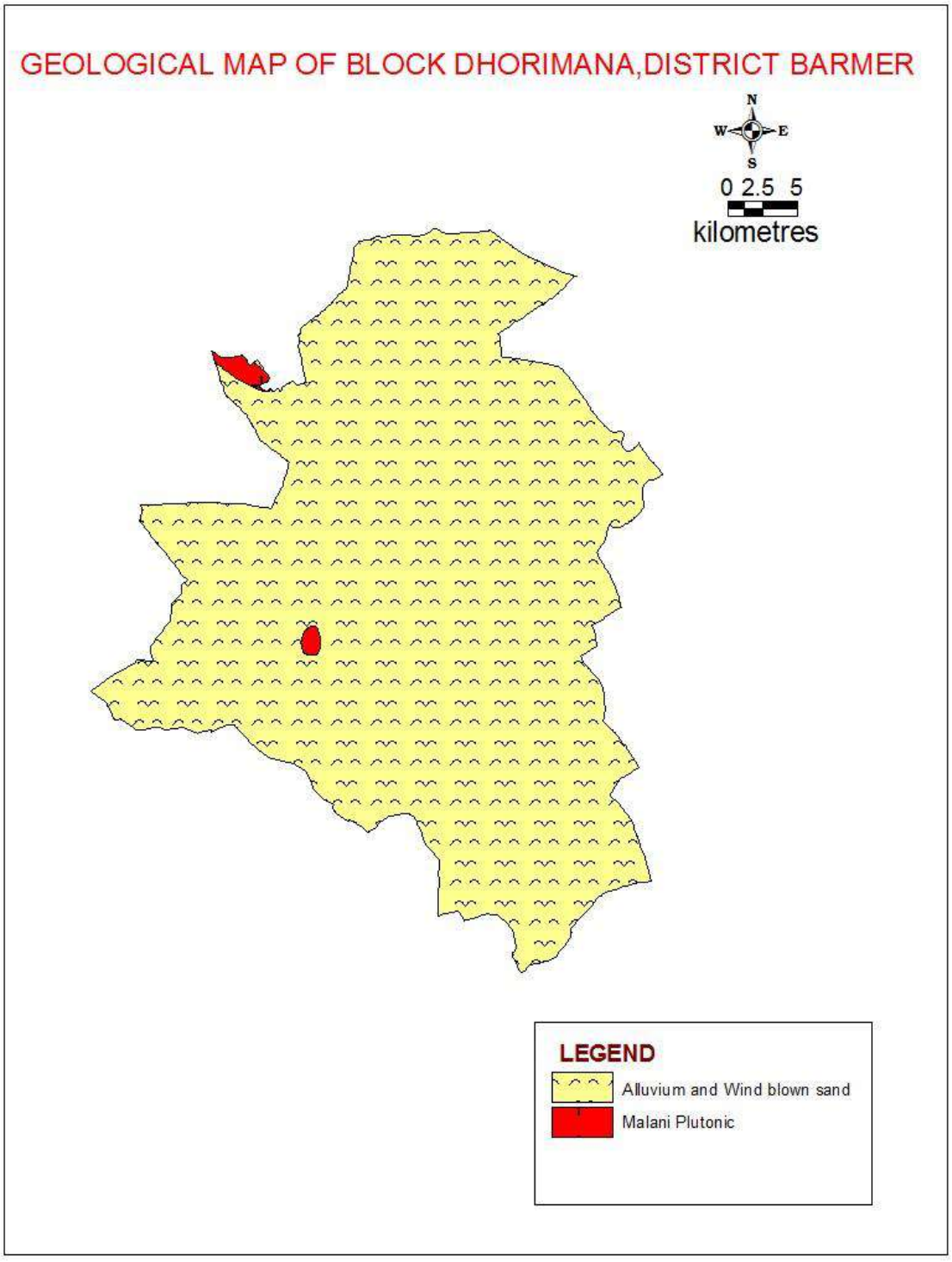


Drought Analysis	
Mild (0 to -25%)	06
Normal (-25% to -50%)	06
Severe (-50% to -75%)	04
Most severe (-75% to -100%)	01

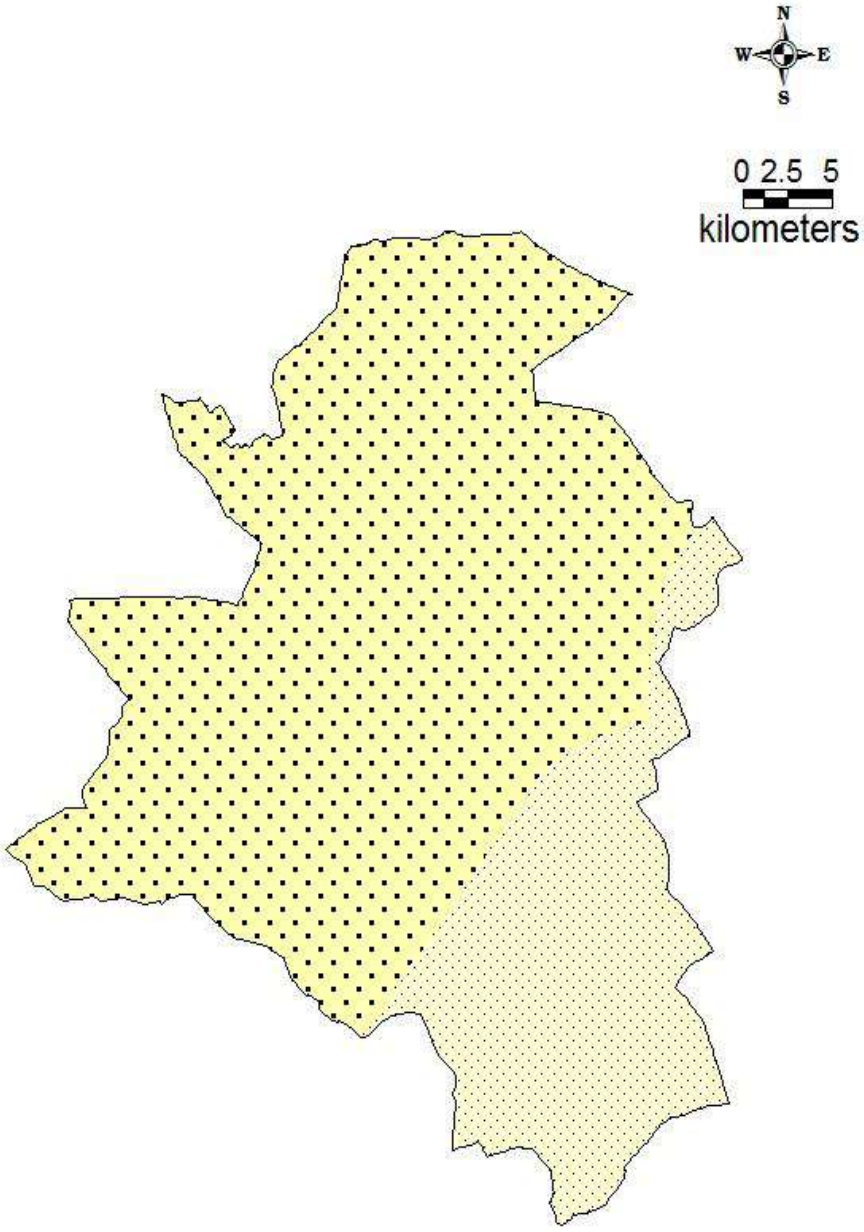
Geomorphology	
Geomorphic Unit	Older alluvium with undulating sandy planes having dune valley complex
Elevation (m amsl)	



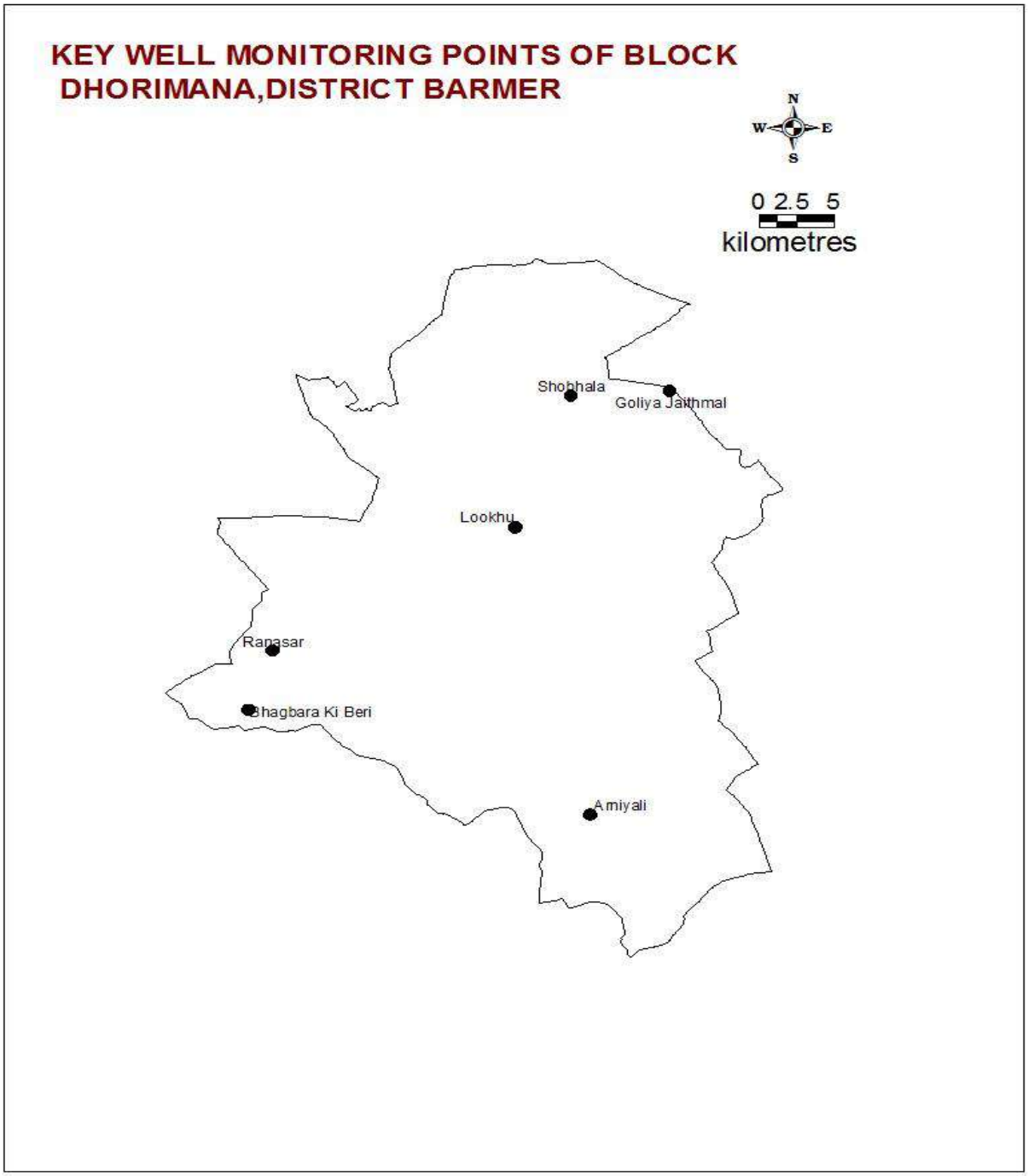
Geology	


GEOLOGICAL MAP OF BLOCK DHORIMANA,DISTRICT BARMER
N
W
E
S
0 2.5 5
kilometres
LEGEND
Alluvium and Wind blown sand
Malani Plutonic

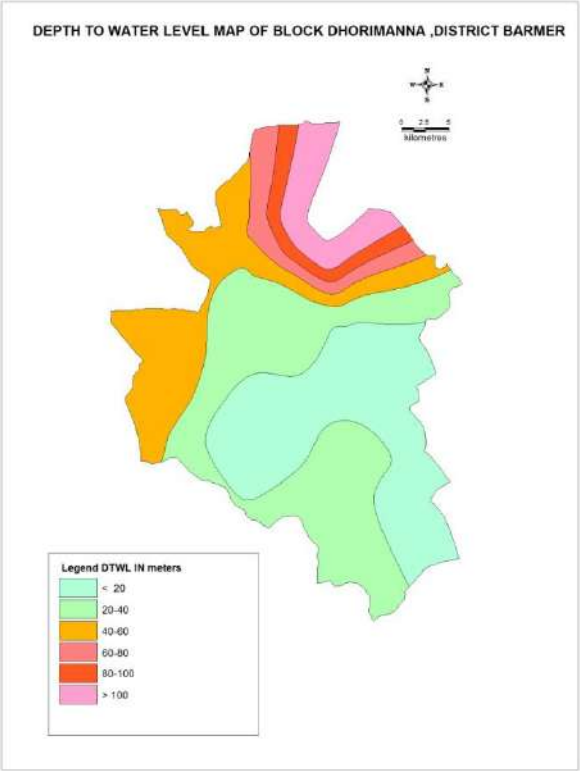
AQUIFER MAP OF BLOCK DHORIMANA,DISTRICT BARMER

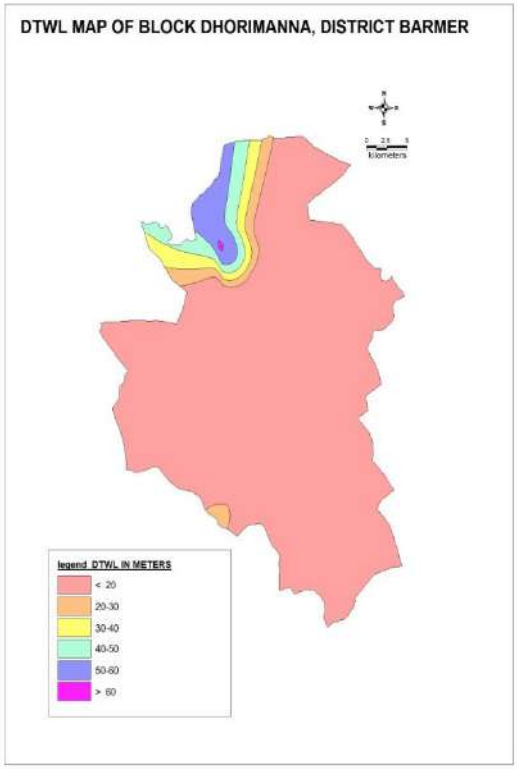


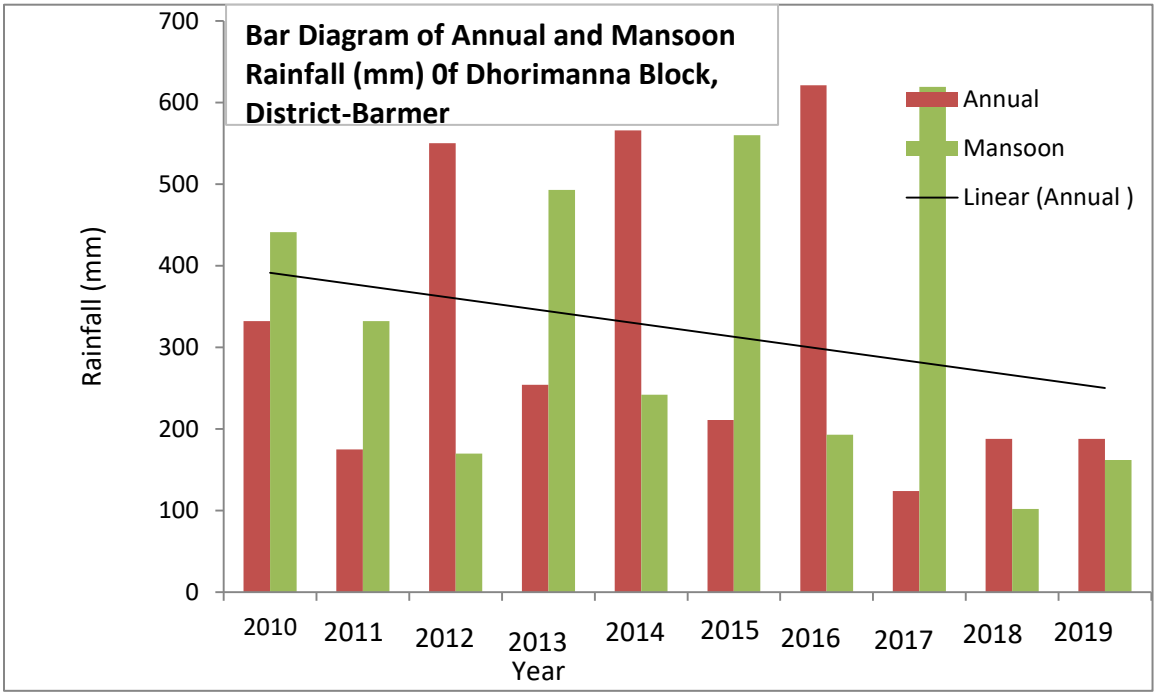
Drainage & Hydrology			
Drainage/Basin/Sub Basin		No Major drainage except few ephemerals streamlets	
Hydrology			
Ponds		0	
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		165986	
Forest Area in ha.		752	
Net Sown Area in ha.		104060	
Area sown more than once in ha.		26321	
Rainfed Crop		Bajra in 48918 hect area	
Area under Irrigation (Net) in ha			
Surface Water		8055	
Ground Water		33583	
Other sources		0	
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
sown	65459	38134	467
Irrigated	3037	38134	467
Principal Crop Area (ha)			
Crop Type			
Cereals		49583	
Oil Seeds		11654	
Pulses		4222	
Hydrogeology			
Monitoring Stations (May 2019)			
CGWB		03	
SGWD		03	
NAQUIM Key Wells		06	



WATER LEVEL BEHAVIOUR	
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019)Water level
2.45 to 72.00 m bgl	1.65 to 71.87 m bgl
Trend (m/yr)	-0.05 (Declining)


DEPTH TO WATER LEVEL MAP OF BLOCK DHORIMANNA ,DISTRICT BARMER
Legend DTWL IN meters
< 20
20-40
40-60
60-80
80-100
> 100


DTWL MAP OF BLOCK DHORIMANNA, DISTRICT BARMER
legend DTWL IN METERS
< 20
20-30
30-40
40-50
50-60
> 60

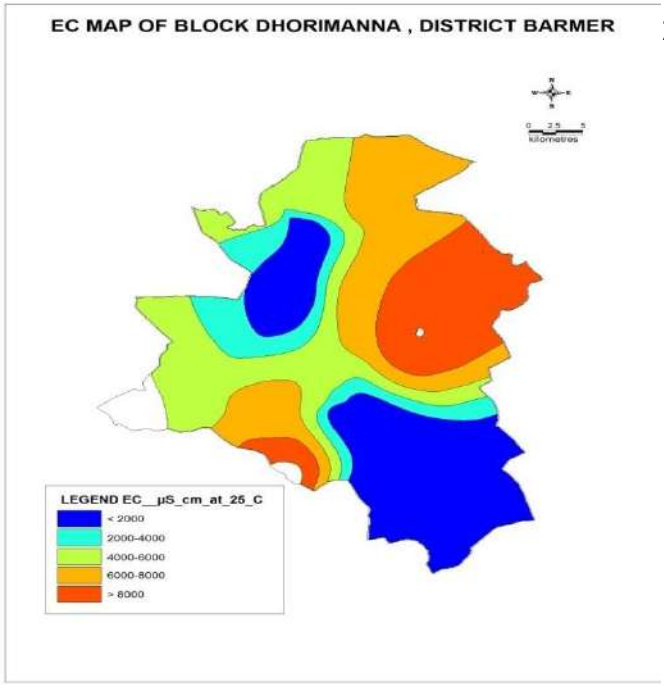

Bar Diagram of Annual and Mansoon Rainfall (mm) 0f Dhorimanna Block, District-Barmer
Rainfall (mm)
700
600
500
400
300
200
100
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year
Annual
Mansoon
Linear (Annual)

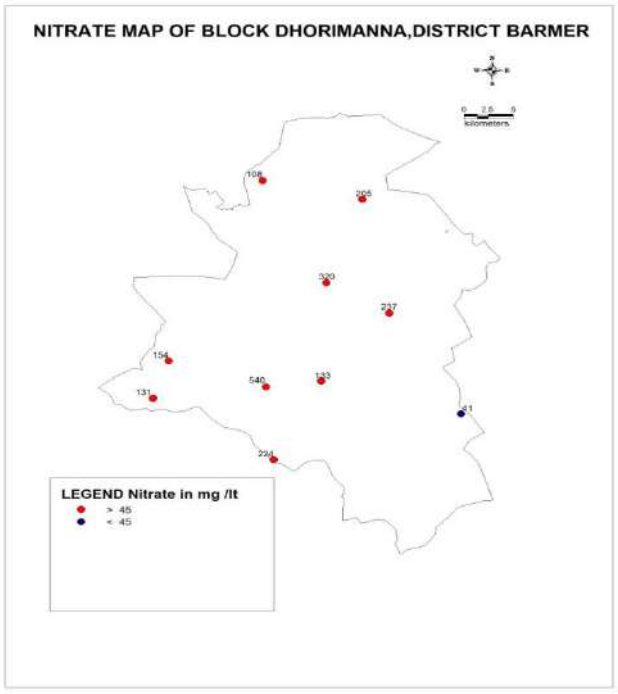
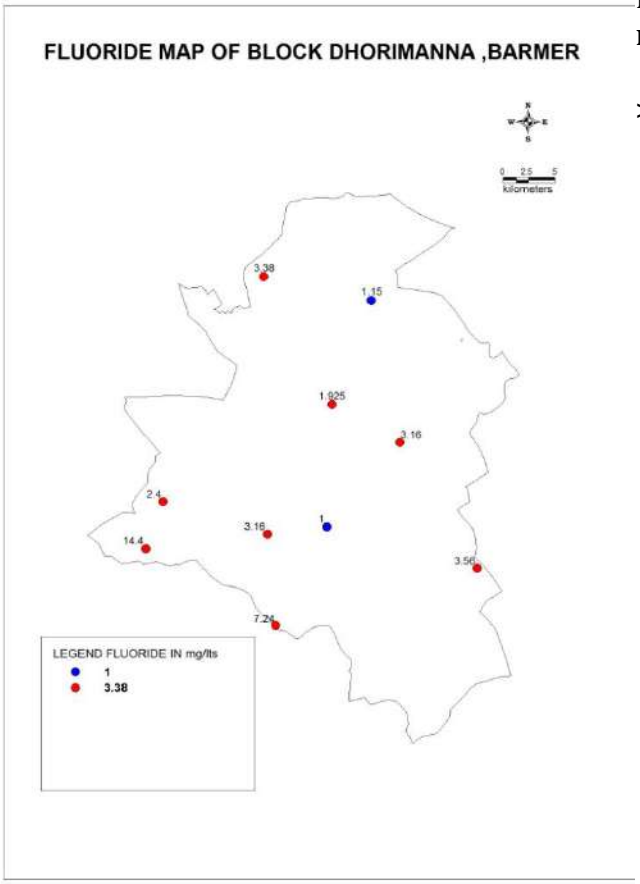
AQUIFER DISPOSITION

Status of GW Exploration	Exploratory Wells-09 Observation Wells-05 Piezometers - 00 Slim hole -00
Aquifer Characteristics	The Alluvium forms the most important aquifer in the block, Specific Yeild value in the range of 0.10 to 0.06.
GW Quality	EC varies from 1370 µS/cm to 10480 µS/cm
Aquifer Potential	Static Water level varies from 2.45 to 72.00 m, Discharge varies from 89 to 471 lpm and Transmissivity varies from 123.60 to 698.6.

CHEMICAL QUALITY OF GROUND WATER

Suitability for Drinking

TDS(mg/l)	**Range**	**% Samples**
Fresh	0-3000	21.43%
Brackish	>-3000	78.57%
Total Hardness (mg/l)	**Range**	**% Samples**
Soft	0 – 75	0 %
Moderately Hard	75 – 150	8.33%
Hard	150 – 300	16.67 %
Very Hard	>300	75.00 %
CHEMICAL QUALITY MAP	VARIATION IN MAJOR & MINOR ELEMENTS	
	EC < 2000 µS/cm at 25°C	7.14%

	NO3 in mg/l>45 mg/l	92.86%
	F in mg/l – 1 to 1.5 mg/l >1.5 mg/l	14.29% 78.57%

Suitability for Irrigation

EC

Type of Water	Classification	% Samples
Low Saline< 250 mg/l	Excellent	0.00
Medium Saline 250 – 750 mg/l	Good	0.00
Highly Saline 750 – 2250 mg/l	Permissible	7.14
Very Highly saline> 2250 mg/l	Doubtful	92.86

Na%

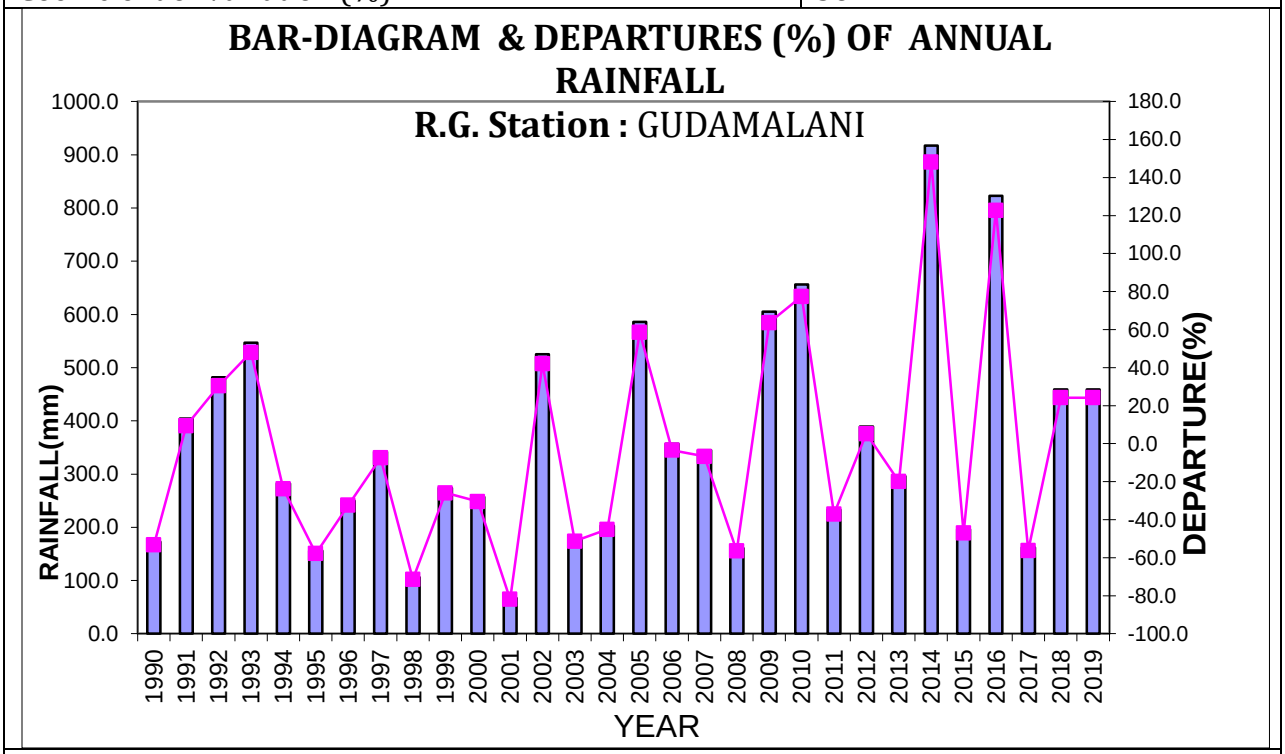
Water Class	Range	% Samples
Excellent	< 20	0.00
Good	20 - 40	0.00
Medium	40 - 60	0.00
Bad	60 - 80	07.14
Very Bad	> 80	92.86

GROUND WATER ISSUES	
1. Salinity	High EC and Na%
2. Rainfall and Drought	• Normal Droughts in 20% years • Severe Drought in 13.33% years
3. Decadal Water Level Trend (2009-2019)	Declining
GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)	
Ground Water Recharge Worthy Area (sq. km.)	1413.75
Total Annual Ground Water Recharge (mcm)	6.80
Natural Discharge (mcm)	0.68
Net Annual Ground Water Availability (mcm)	6.12
Existing Gross Ground Water Draft for All uses(mcm)	12.92
Provision for domestic requirement supply to 2025(mcm)	2.19
Stage of Ground Water Development %	211
Category	Over exploited
In-Storage Resource	
Total Area (Sq.Km)	141.375
Specific yield	ALO1a :0.1 ALO3 :0.06 ALO1b :0.1
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	949
Water Harvesting Structure	12
Farm Pond / Khet Talai	01
Earthen Checkdam	12

Tankas	924
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Tanks (Nos) Capacity 50.000 lts	2545
Volume of water to be conserved (mcm)	0.1273
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	323.98
Surplus Surface water Availability (mcm)	0.07
DEMAND SIDE MANAGEMENT:	
DEMAND SIDE MANAGEMENT	
Irrigitation by permitted TW almost already using by Micro irrigation techniques like irrigation through Sprinkler. No more scope is feasible	
Cropping Pattern change: The sown crops are already less water consuming crops like Bajra, Mung etc. The change in cropping pattern is not feasible.	
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	6.12
Existing Ground Water Draft for All Purposes (mcm)	12.91
Present stage of Ground Water Development (%)	211
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	206.65

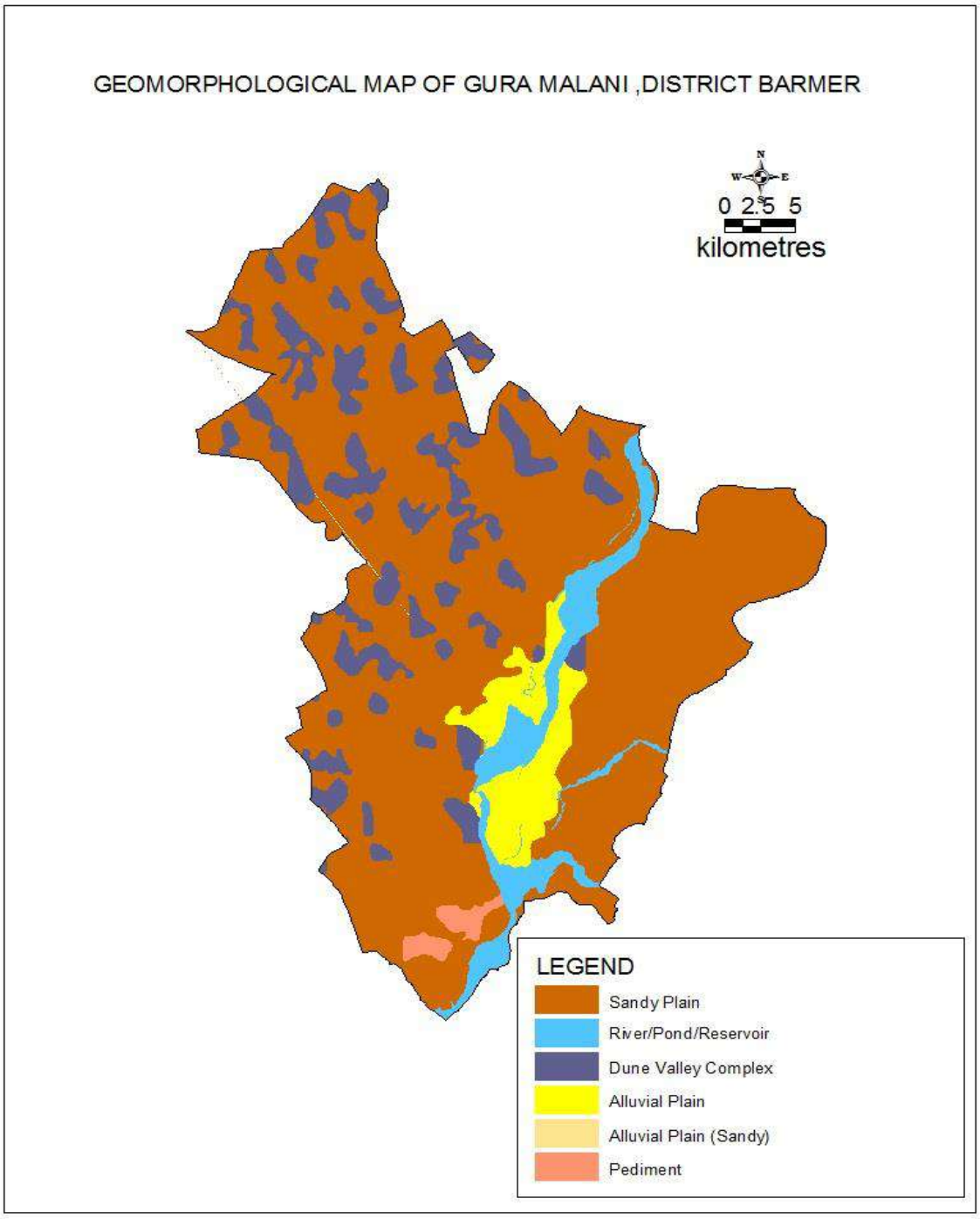
GUDAMALANI BLOCK

SALIENT INFORMATION	
Block Name	**GUDAMALANI**
Longitude	71˚ 30’ 5” to 71˚ 57’ 6”
Latitude	24˚ 59’ 11” to 25˚ 33’ 34”
Geographical Area Sq.km	1282.65
Hilly Area (Sq.km)	0
Population (2011)	153728
Climate	
Average Temperature range (°C)	02 to 48
Rainfall Analysis	
Normal Rainfall (mm)	294.0
Mean Annual rainfall (mm)	369.6
Highest annual rainfall with year (mm)	917 (2019)
Lowest annual rainfall (mm) with year	67 (1989)
Standard deviation (mm)	209.7
Coefficient of Variation (%)	56.7

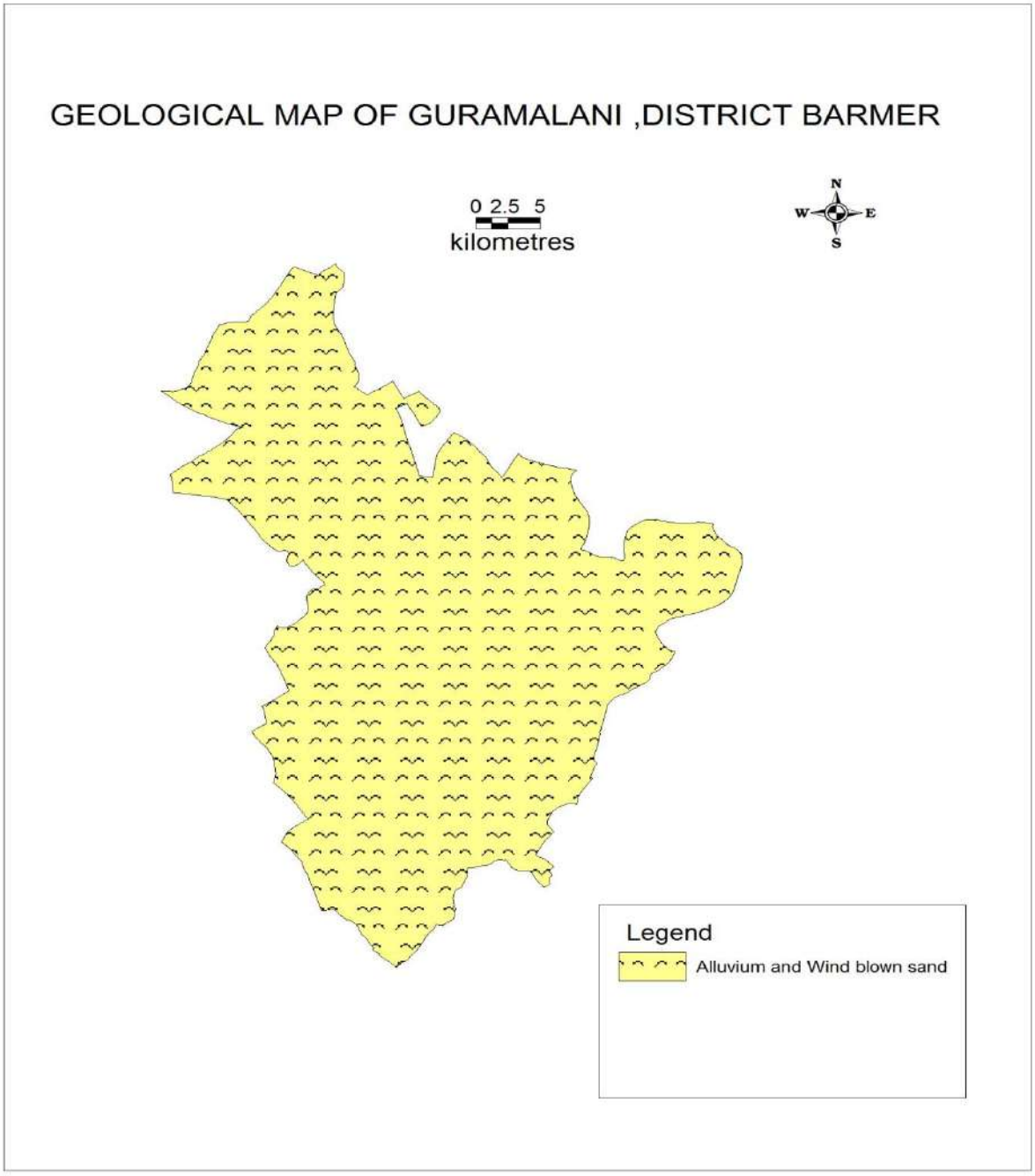


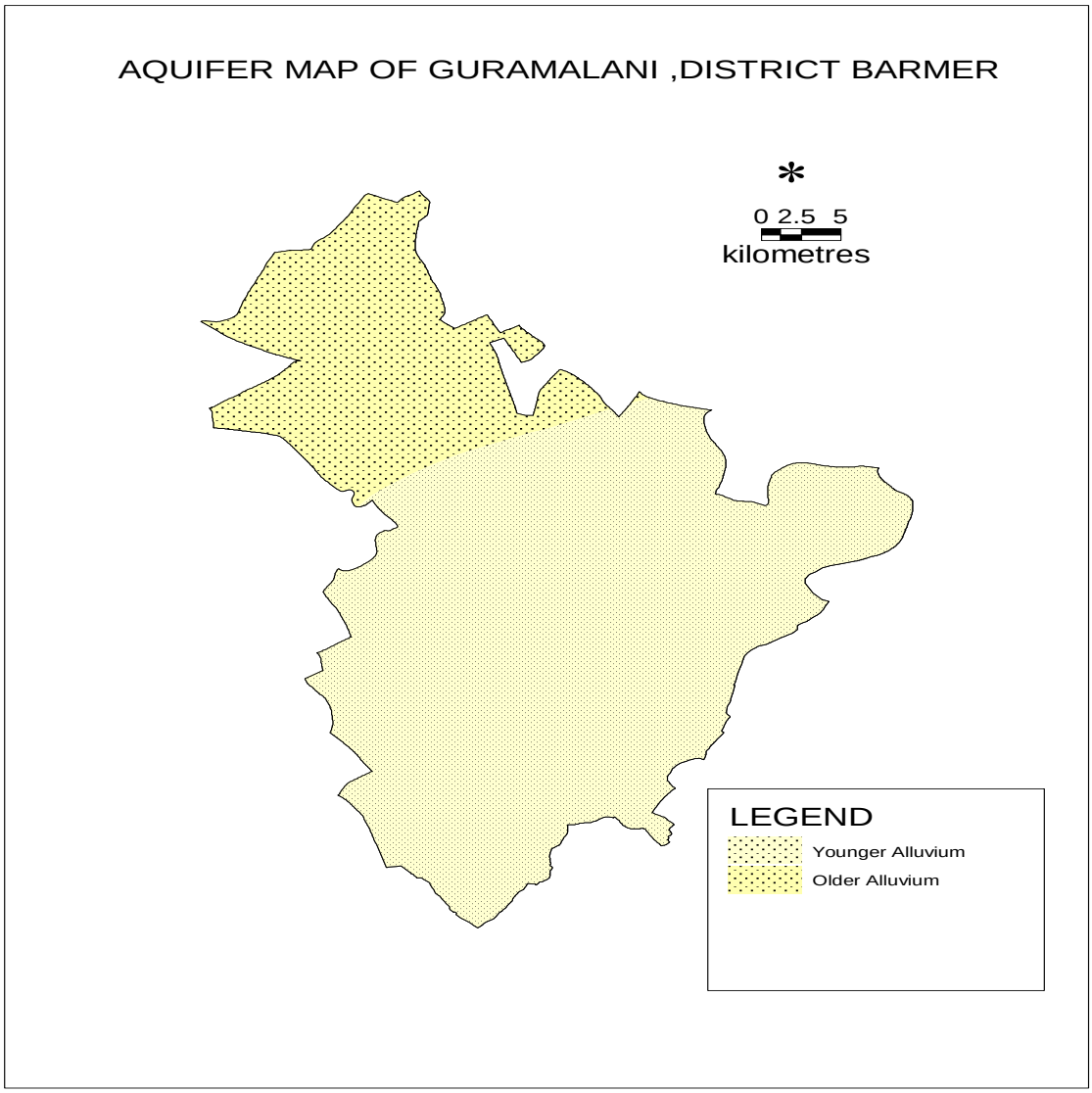
Drought Analysis	
Mild (0 to -25%)	05
Normal (-25% to -50%)	06
Severe (-50% to -75%)	06
Most severe (-75% to -100%)	01
Geomorphology	

Geomorphic Unit	Older alluvial plain and anlluvial plain (Sandy), Sandy plain having major Luni Ind rive.
Elevation (m amsl)	



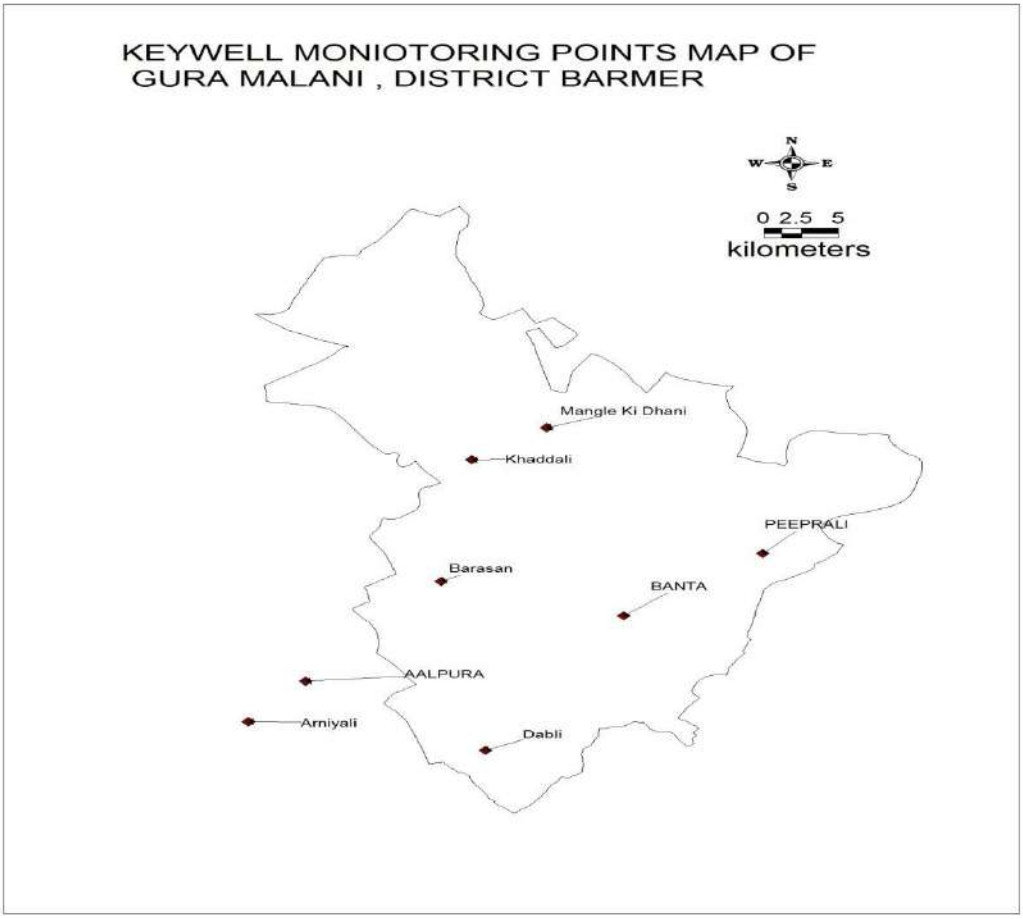
Geology	


GEOLOGICAL MAP OF GURAMALANI ,DISTRICT BARMER
0 2.5 5
kilometres
N
W
E
S
Legend
Alluvium and Wind blown sand

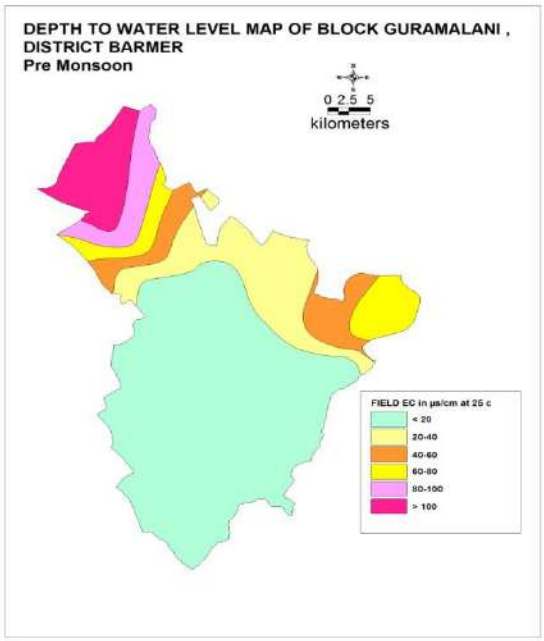


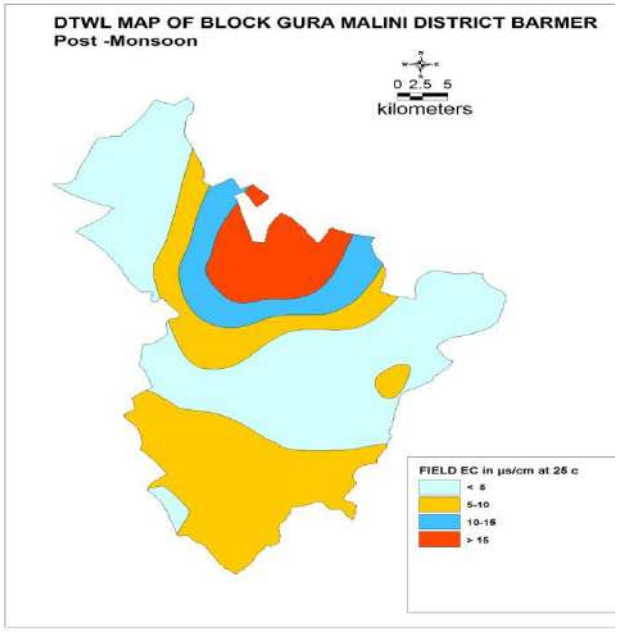
Drainage & Hydrology	
Drainage/Basin/Sub Basin	Major drainage of Luni Ind Basin
Hydrology	
Ponds	0
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN	
Geographical Area in ha.	128265
Forest Area in ha.	1733
Net Sown Area in ha.	138963
Area sown more than once in ha.	44637
Rainfed Crop	Bajra in 65089 hect area
Area under Irrigation (Net) in ha	
Surface Water	13534
Ground Water	47724
Other sources	0

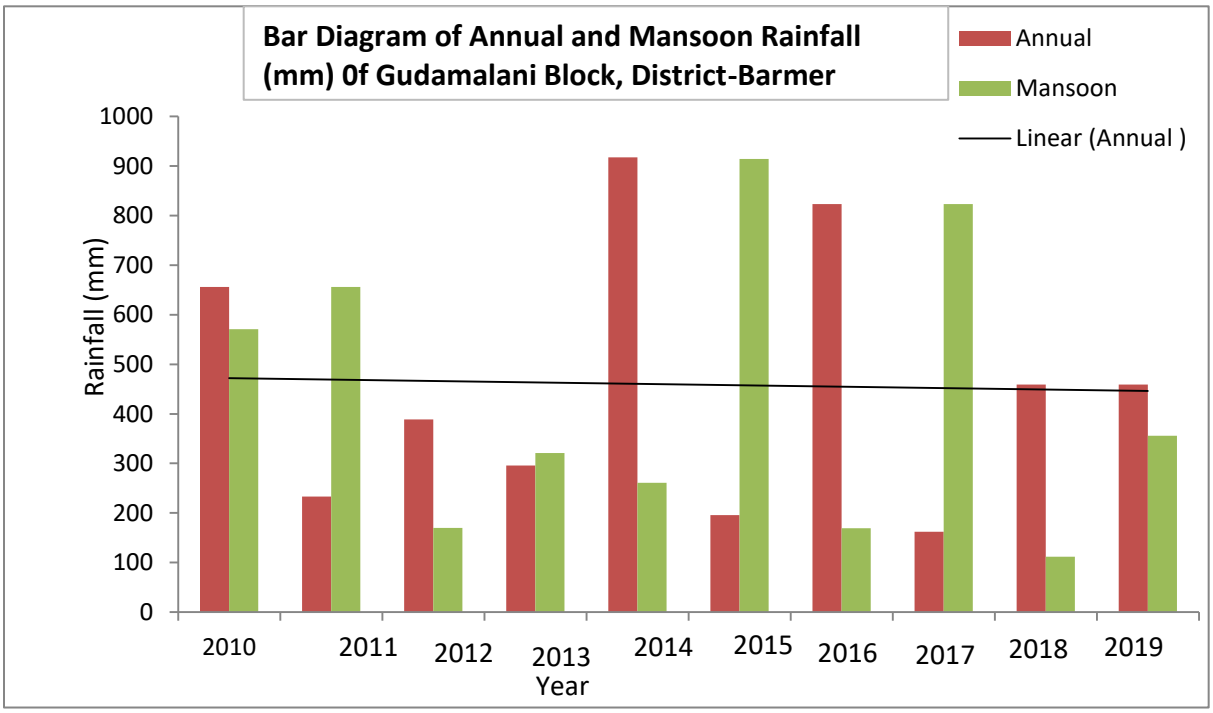
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
sown	81026	57710	227
Irrigated	3485	57546	227
Principal Crop Area (ha)			
Crop Type			
Cereals		49583	
Oil Seeds		6913	
Pulses		8623	
Hydrogeology			
Monitoring Stations (May 2019)			
CGWB		00	
SGWD		03	
NAQUIM Key Wells		09	



WATER LEVEL BEHAVIOUR	
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019)Water level
3.65 to18.65m bgl	3.30 to 18.70 m bgl
Trend (m/yr)	-0.07 (Declining)







AQUIFER DISPOSITION

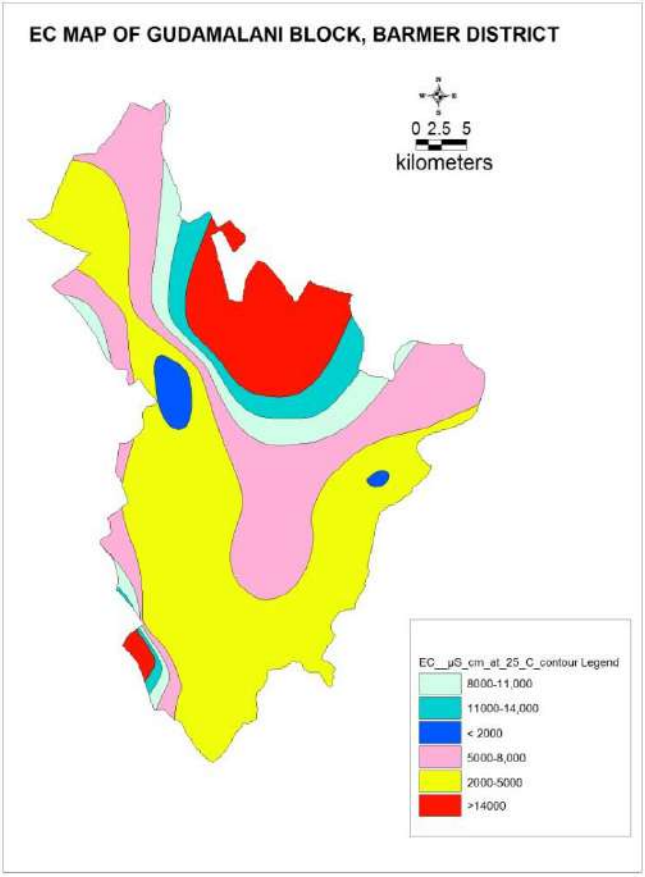
Status of GW Exploration	Exploratory Wells-01 Observation Wells-00 Piezometers - 00 Slim hole -00
Aquifer Characteristics	The Alluvium forms the most important aquifer in the block, Specific Yeild value in the range of 0.10 to 0.06.
GW Quality	EC varies from 880 µS/cm to 19590 µS/cm

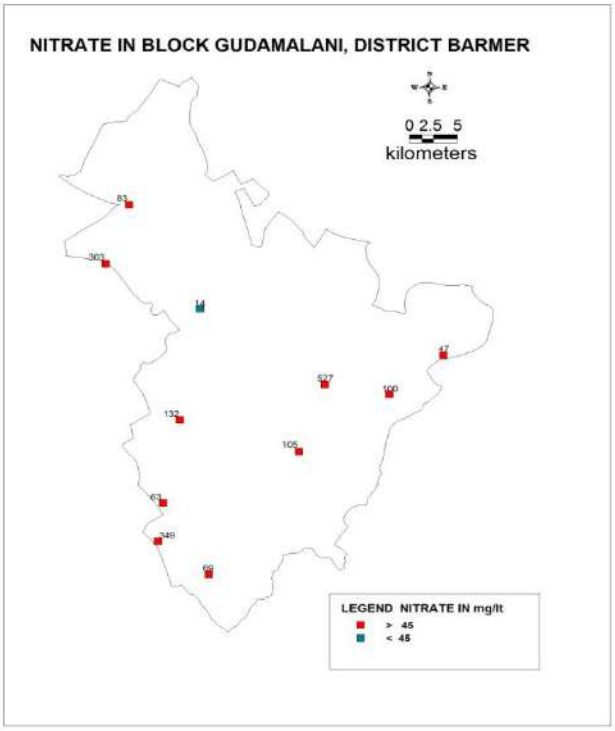
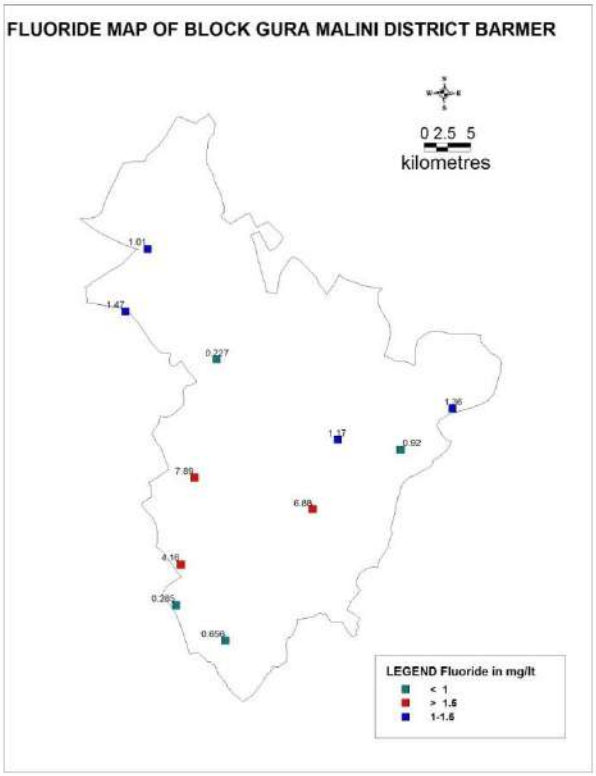
Aquifer Potential	Static Water level varies from 3.65 to 18.65 m. Area is yet unexplored and only one Exploratory Well was constructed in 1991 which was abandoned due to lack of granular zone.

CHEMICAL QUALITY OF GROUND WATER

Suitability for Drinking

TDS(mg/l)	**Range**	**% Samples**
Fresh	0-3000	50.00%
Brackish	>-3000	50.00%
Total Hardness (mg/l)	**Range**	**% Samples**
Soft	0 – 75	0 %
Moderately Hard	75 – 150	9.10%
Hard	150 – 300	27.27 %
Very Hard	>300	63.63 %

CHEMICAL QUALITY MAP	VARIATION IN MAJOR & MINOR ELEMENTS	
	EC < 2000 µS/cm at 25°C	16.66%

	NO3 in mg/l>45 mg/l	90.91%
	F in mg/l – 1 to 1.5 mg/l >1.5 mg/l	33.33% 33.33%

Suitability for Irrigation

EC

Type of Water	Classification	% Samples
Low Saline< 250 mg/l	Excellent	0.00
Medium Saline 250 – 750 mg/l	Good	0.00
Highly Saline 750 – 2250 mg/l	Permissible	25.00
Very Highly saline> 2250 mg/l	Doubtful	75.00

Na%

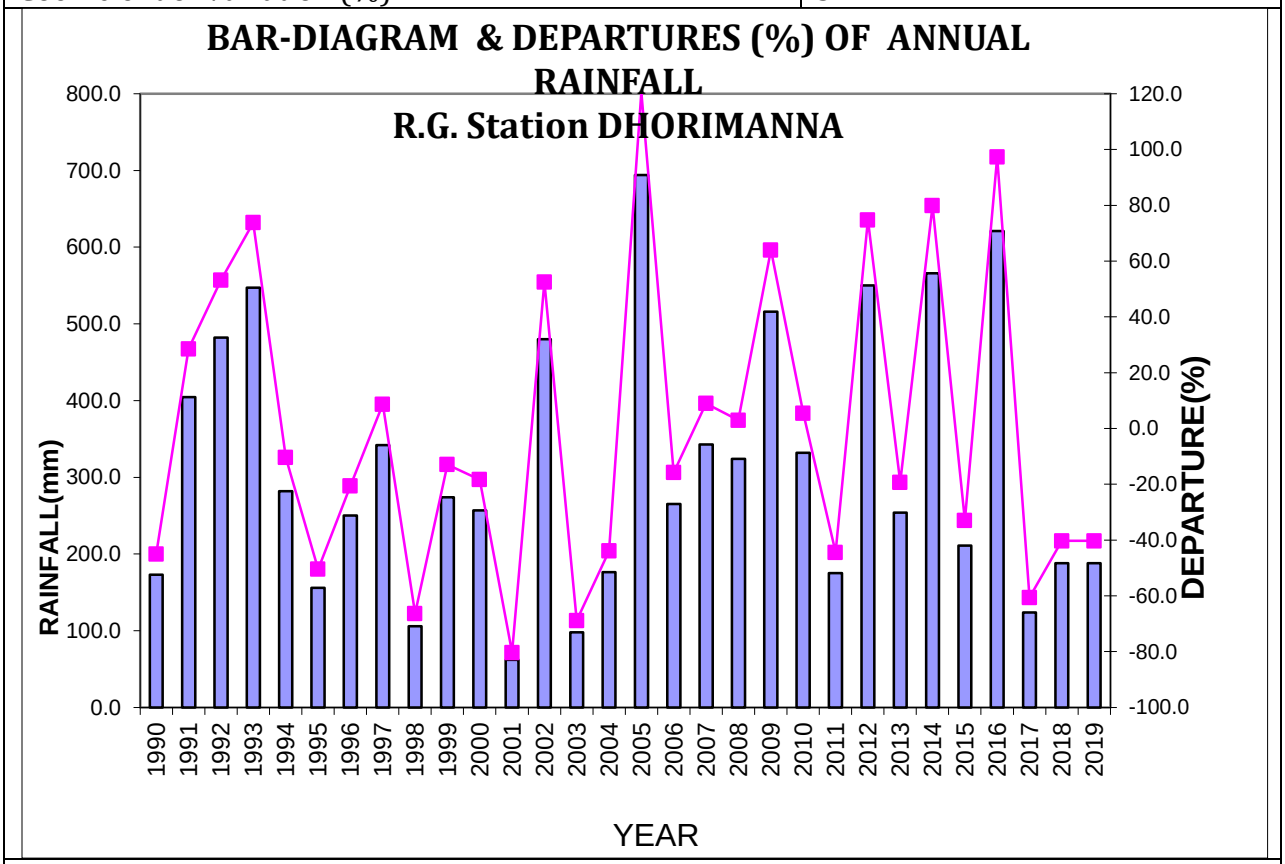
Water Class	Range	% Samples
Excellent	< 20	0.00
Good	20 - 40	0.00
Medium	40 - 60	0.00
Bad	60 - 80	0.00
Very Bad	> 80	100.00

GROUND WATER ISSUES	
1. Salinity	High EC and Na%
2. Rainfall and Drought	• Normal Droughts in 20% years • Severe Drought in 20% years
3. Decadal Water Level Trend (2009-2019)	Declining
GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)	
Ground Water Recharge Worthy Area (sq. km.)	1182.35
Total Annual Ground Water Recharge (mcm)	35.78
Natural Discharge (mcm)	3.58
Net Annual Ground Water Availability (mcm)	32.21
Existing Gross Ground Water Draft for All uses(mcm)	43.10
Provision for domestic requirement supply to 2025(mcm)	5.70
Stage of Ground Water Development %	133.84
Category	Over exploited
In-Storage Resource	
Total Area (Sq.Km)	118.235
Specific yield	ALO1a :0.1 ALO1b :0.1 ALO3 :0.06 ALO1c :0.1
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	805
Farm Pond / Khet Talai	06
Earthen Checkdam	04
Tankas	795

SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Tanks (Nos) Capacity 50.000 lts	2458
Volume of water to be conserved (mcm)	0.1229
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	302.09
Surplus Surface water Availability (mcm)	0.73
DEMAND SIDE MANAGEMENT:	
DEMAND SIDE MANAGEMENT	
Irrigitation by permitted TW almost already using by Micro irrigation techniques like irrigation through Sprinkler. No more scope is feasible	
Cropping Pattern change: The sown crops are already less water consuming crops like Bajra, Mung etc. The change in cropping pattern is not feasible.	
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	32.21
Existing Ground Water Draft for All Purposes (mcm)	43.10
Present stage of Ground Water Development (%)	133.84
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	133.30

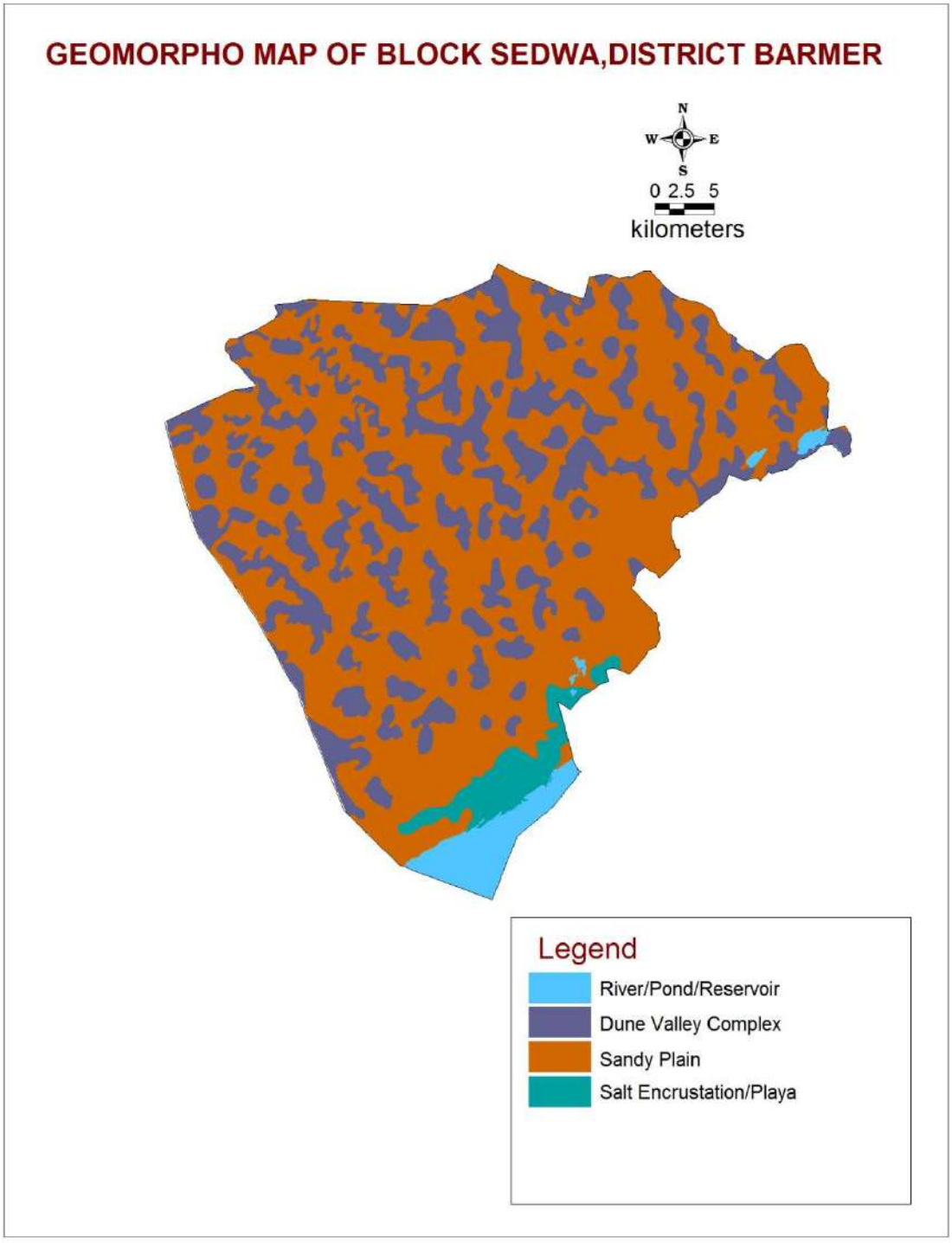
SEDWA BLOCK

SALIENT INFORMATION	
Block Name	**SEDWA**
Longitude	70˚ 55’ 23” to 71˚ 29’ 18”
Latitude	24˚ 38’ 41” to 25˚ 8’ 25”
Geographical Area Sq.km	1703.57
Hilly Area (Sq.km)	0
Population (2011)	281547
Climate	
Average Temperature range (°C)	02 to 48
Rainfall Analysis	
Normal Rainfall (mm)	275.2
Mean Annual rainfall (mm)	314.7
Highest annual rainfall with year (mm)	694 (1983)
Lowest annual rainfall (mm) with year	62 (1989)
Standard deviation (mm)	171.20
Coefficient of Variation (%)	54.4



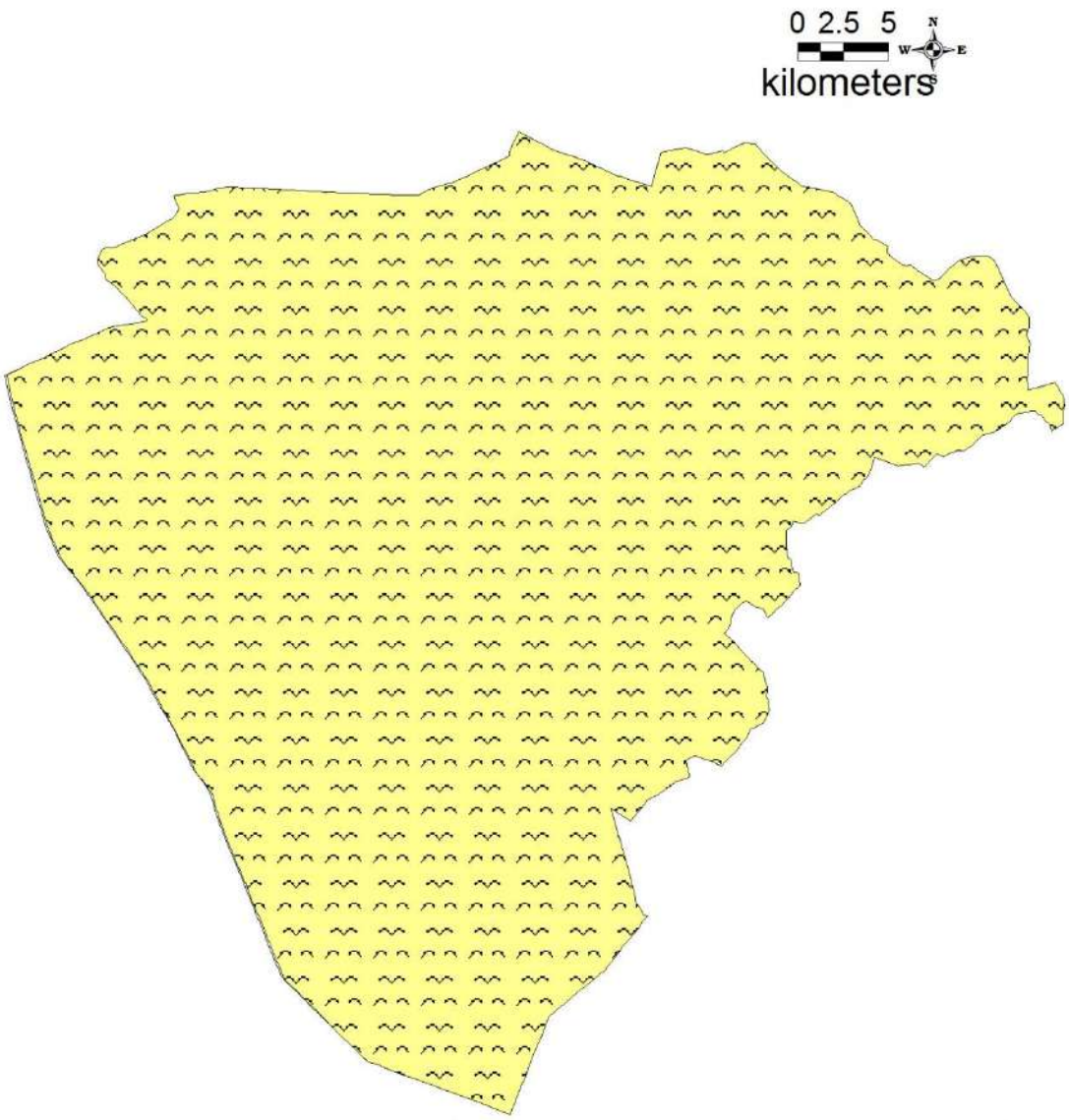
Drought Analysis	
Mild (0 to -25%)	06
Normal (-25% to -50%)	06

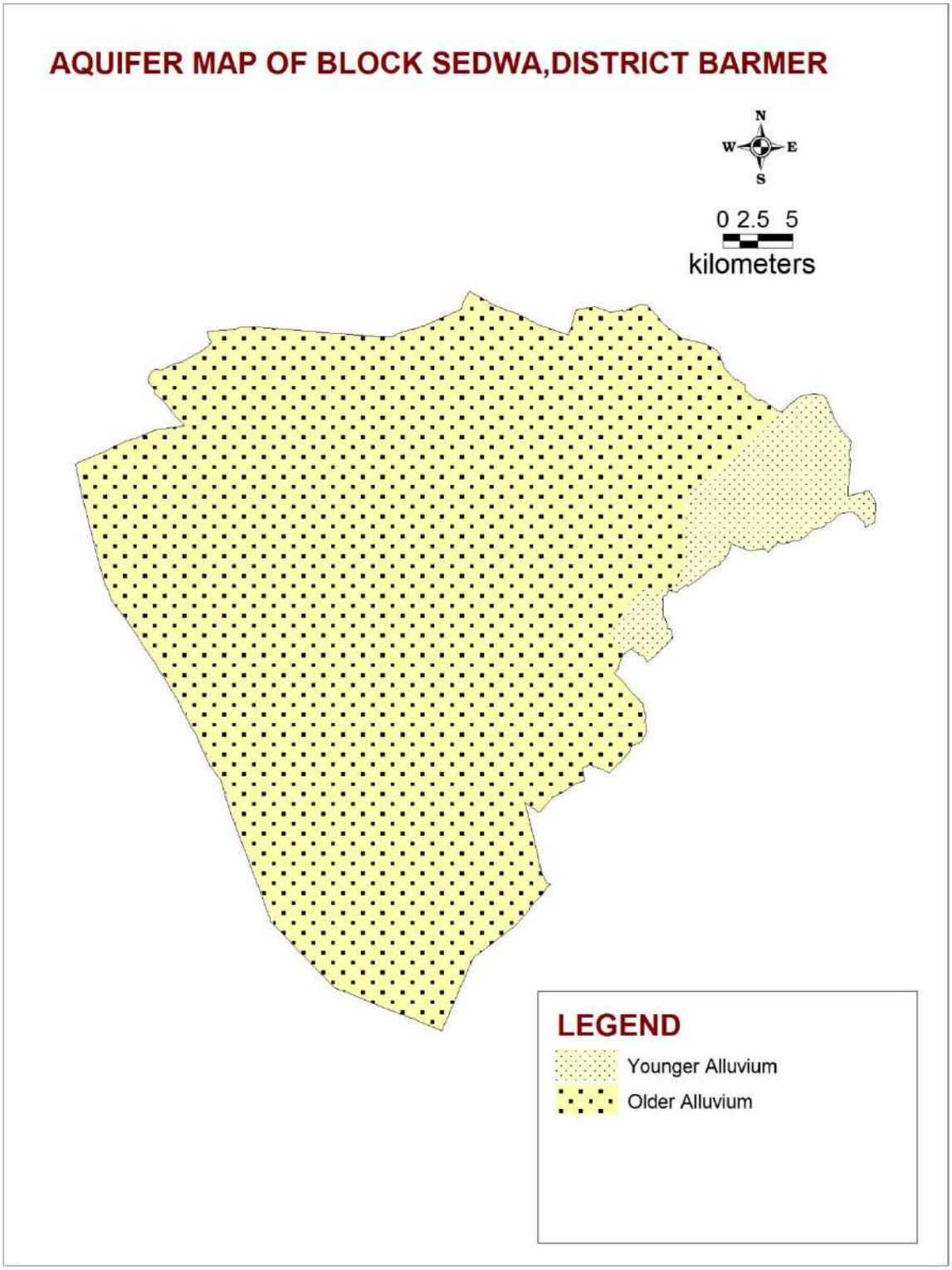
Severe (-50% to -75%)	04
Most severe (-75% to -100%)	01
Geomorphology	
Geomorphic Unit	Older alluvium with undulating sandy planes having dune valley complex including some salt encrustation/playa.
Elevation (m amsl)	


GEOMORPHO MAP OF BLOCK SEDWA,DISTRICT BARMER
N
W
E
S
0 2.5 5
kilometers
Legend
River/Pond/Reservoir
Dune Valley Complex
Sandy Plain
Salt Encrustation/Playa

Geology	

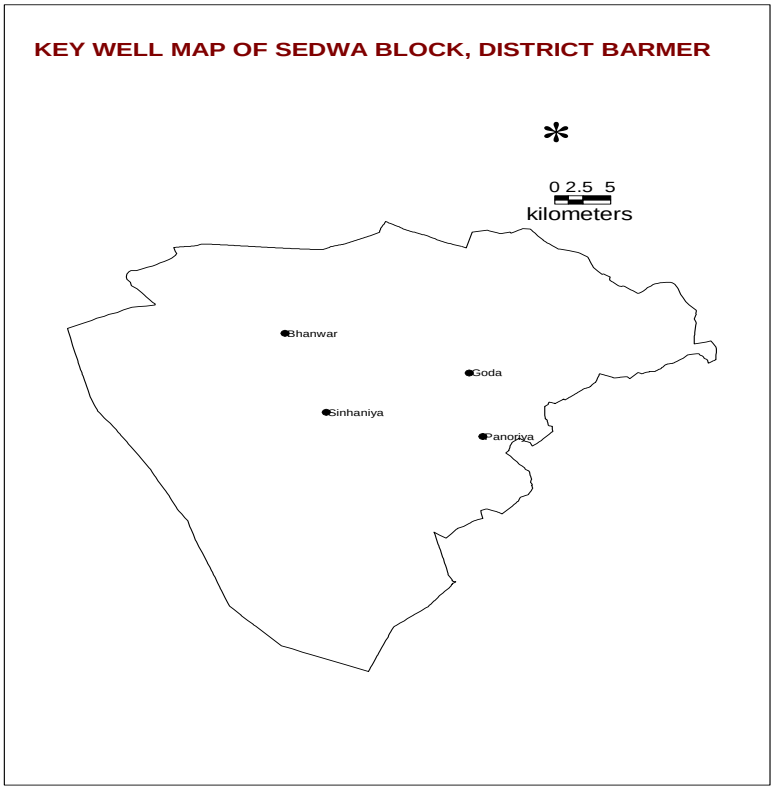
GEOLOGICAL MAP OF SEDWA BLOCK,DISTRICT BARMER



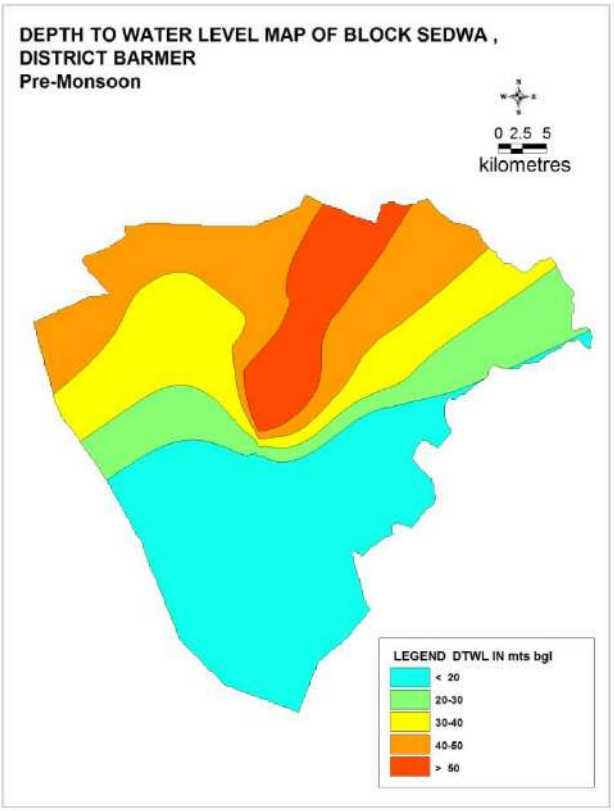


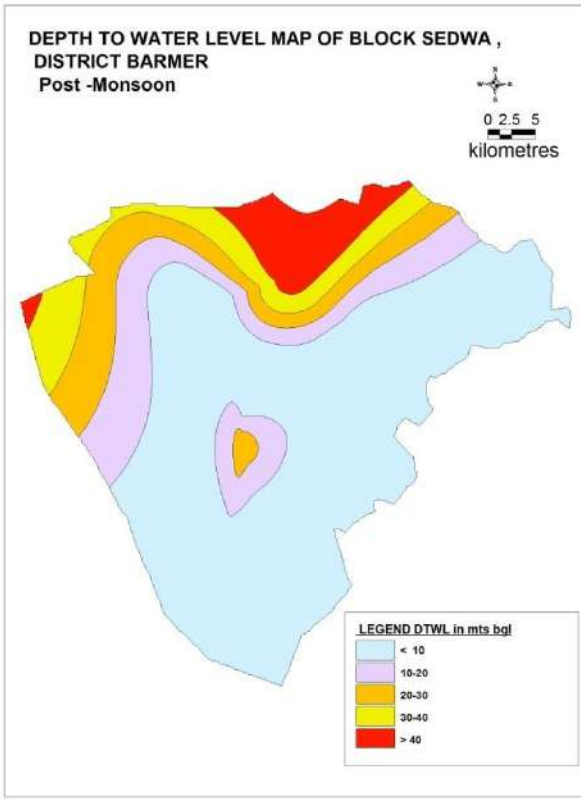
Drainage & Hydrology	
Drainage/Basin/Sub Basin	No Major drainage except few ephemerals streamlets.

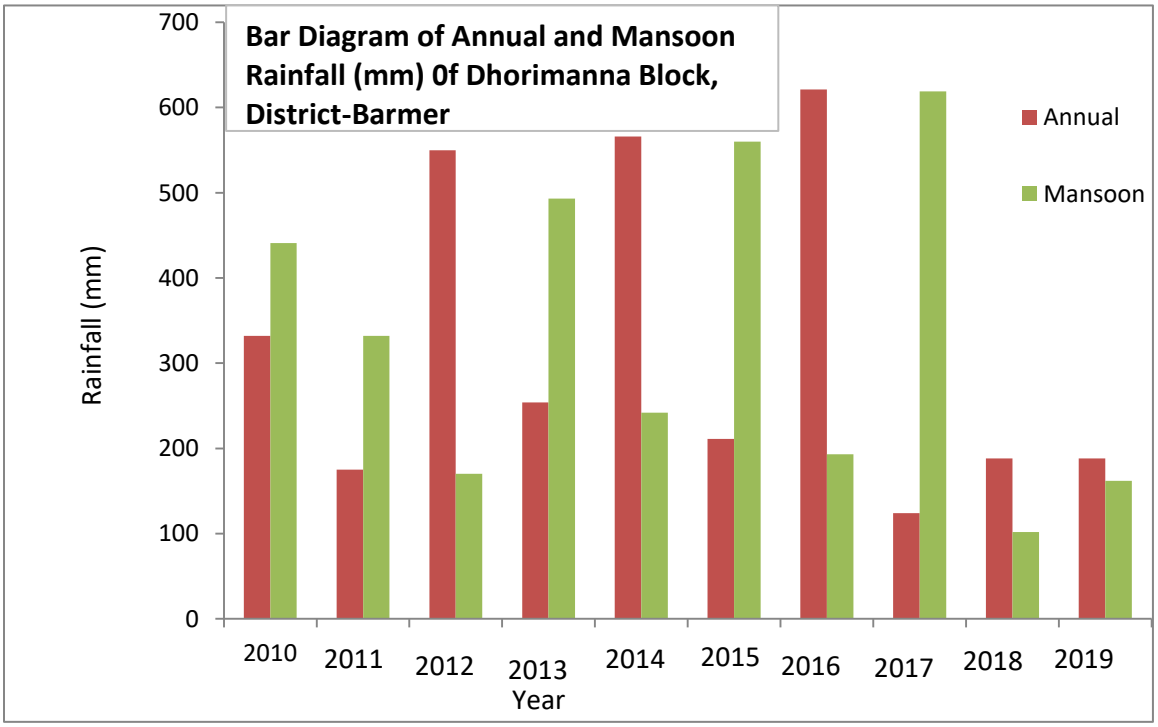
Hydrology			
Ponds		0	
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		170357	
Forest Area in ha.		1100	
Net Sown Area in ha.		271139	
Area sown more than once in ha.		87908	
Rainfed Crop		Bajra in 67380 hect area	
Area under Irrigation (Net) in ha			
Surface Water		9395	
Ground Water		148341	
Other sources		0	
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
sown	142778	121569	6792
Irrigated	29375	121569	6792
Principal Crop Area (ha)			
Crop Type			
Cereals		86593	
Oil Seeds		54161	
Pulses		1930	
Hydrogeology			
Monitoring Stations (May 2019)			
CGWB		06	
SGWD		06	
NAQUIM Key Wells		04	



WATER LEVEL BEHAVIOUR	
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019)Water level
3.10 to 59.00 m bgl	1.80 to 58.95 m bgl
Trend (m/yr)	0.27 (Rising)





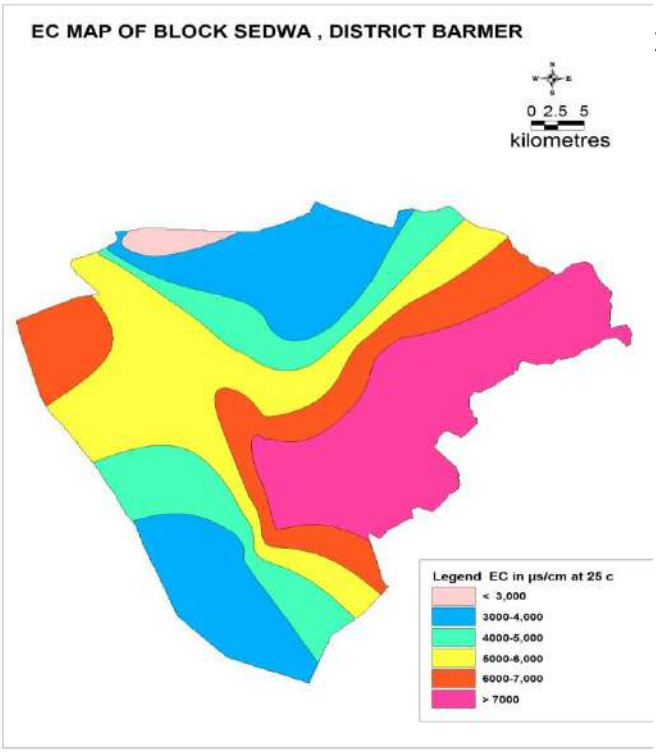


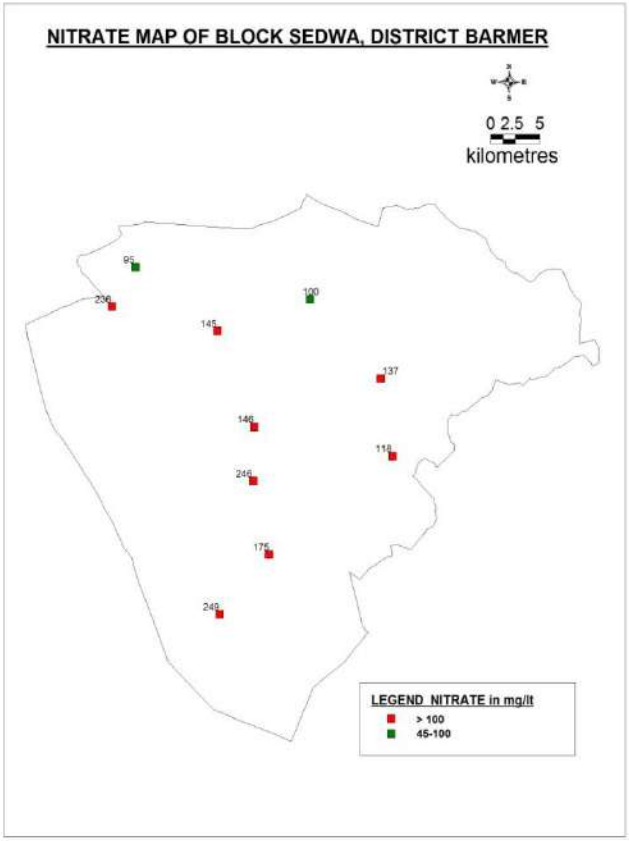
AQUIFER DISPOSITION

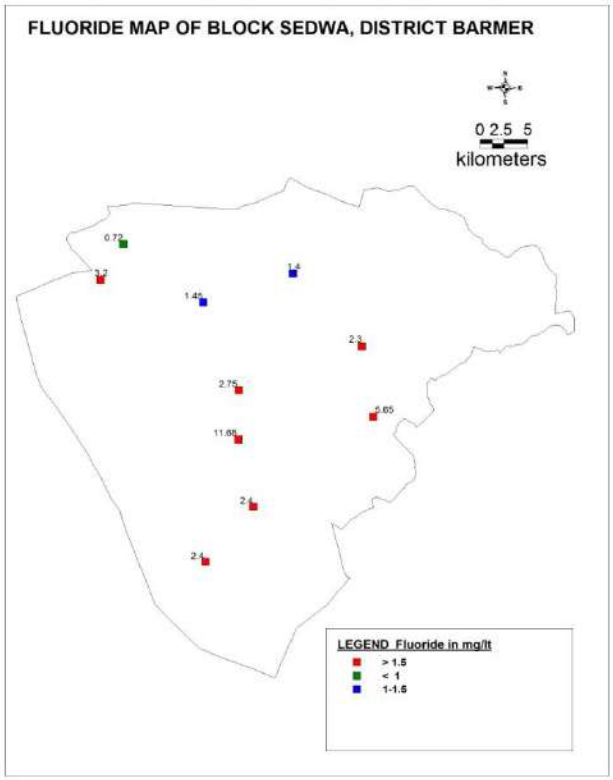
Status of GW Exploration	Exploratory Wells-00 Observation Wells-00 Piezometers - 00 Slim hole -00
Aquifer Characteristics	The Alluvium forms the most important aquifer in the block, Specific Yeild value in the range of 0.10 to 0.06.
GW Quality	EC varies from 2930 µS/cm to 7700 µS/cm
Aquifer Potential	Static Water level varies from 3.10 to 59.00 m, Area is yet unexplored and only NHS and GWD wells were present

CHEMICAL QUALITY OF GROUND WATER

Suitability for Drinking

TDS(mg/l)	**Range**	**% Samples**
Fresh	0-3000	30.00%
Brackish	>-3000	70.00%
Total Hardness (mg/l)	**Range**	**% Samples**
Soft	0 – 75	0 %
Moderately Hard	75 – 150	10.00%
Hard	150 – 300	20.00 %
Very Hard	>300	70.00 %
CHEMICAL QUALITY MAP	VARIATION IN MAJOR & MINOR ELEMENTS	
	EC < 2000 µS/cm at 25°C	0%

	NO3 in mg/l>45 mg/l	100%



F in mg/l – 1 to 1.5 mg/l	20.00%
>1.5 mg/l	70.00%

Suitability for Irrigation

EC

Type of Water	Classification	% Samples
Low Saline< 250 mg/l	Excellent	0.00
Medium Saline 250 – 750 mg/l	Good	0.00
Highly Saline 750 – 2250 mg/l	Permissible	0.00
Very Highly saline> 2250 mg/l	Doubtful	100

Na%

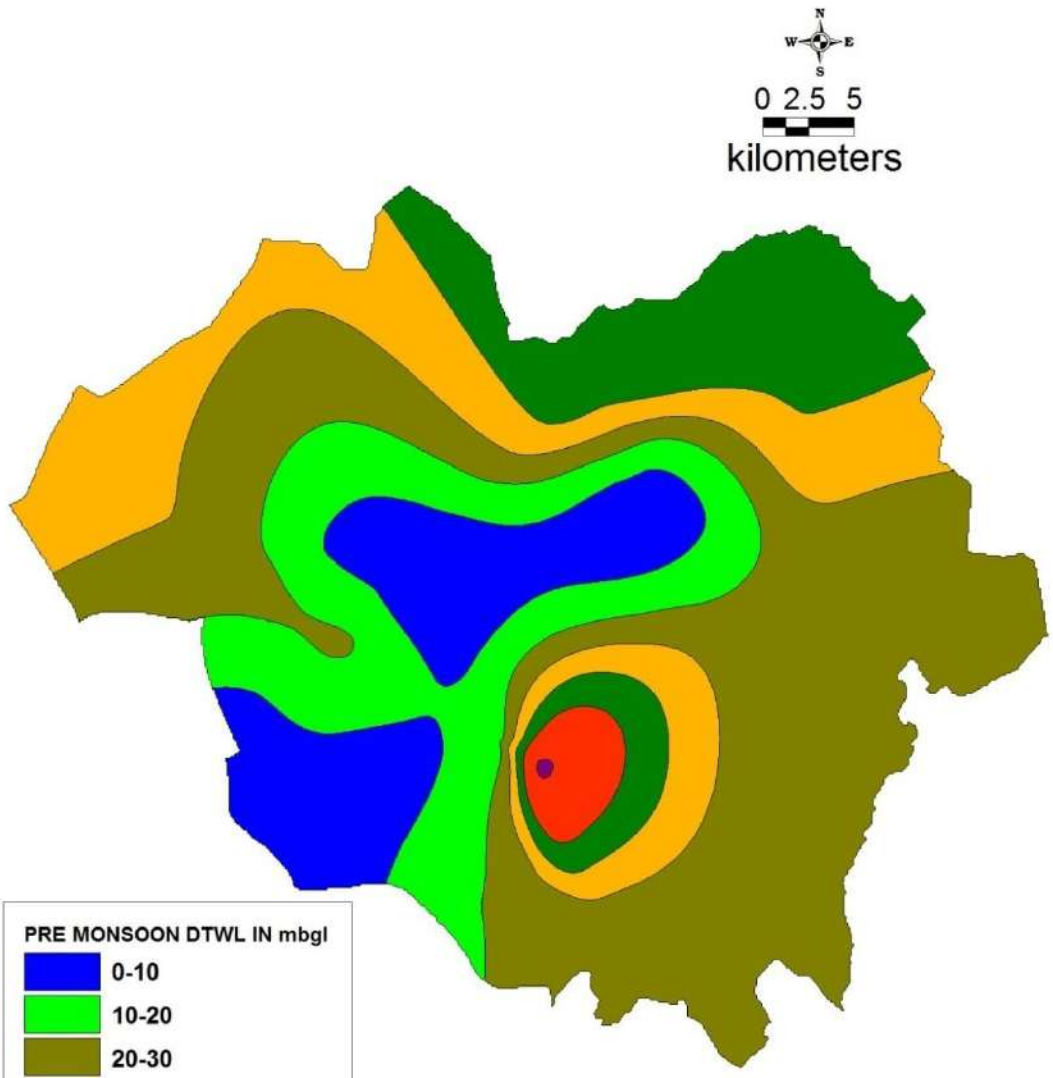
Water Class	Range	% Samples
Excellent	< 20	0.00
Good	20 - 40	0.00
Medium	40 - 60	0.00
Bad	60 - 80	0.00
Very Bad	> 80	100

GROUND WATER ISSUES

1. Salinity	High EC and Na%
2. Rainfall and Drought	• Normal Droughts in 20% years • Severe Drought in 13.33% years

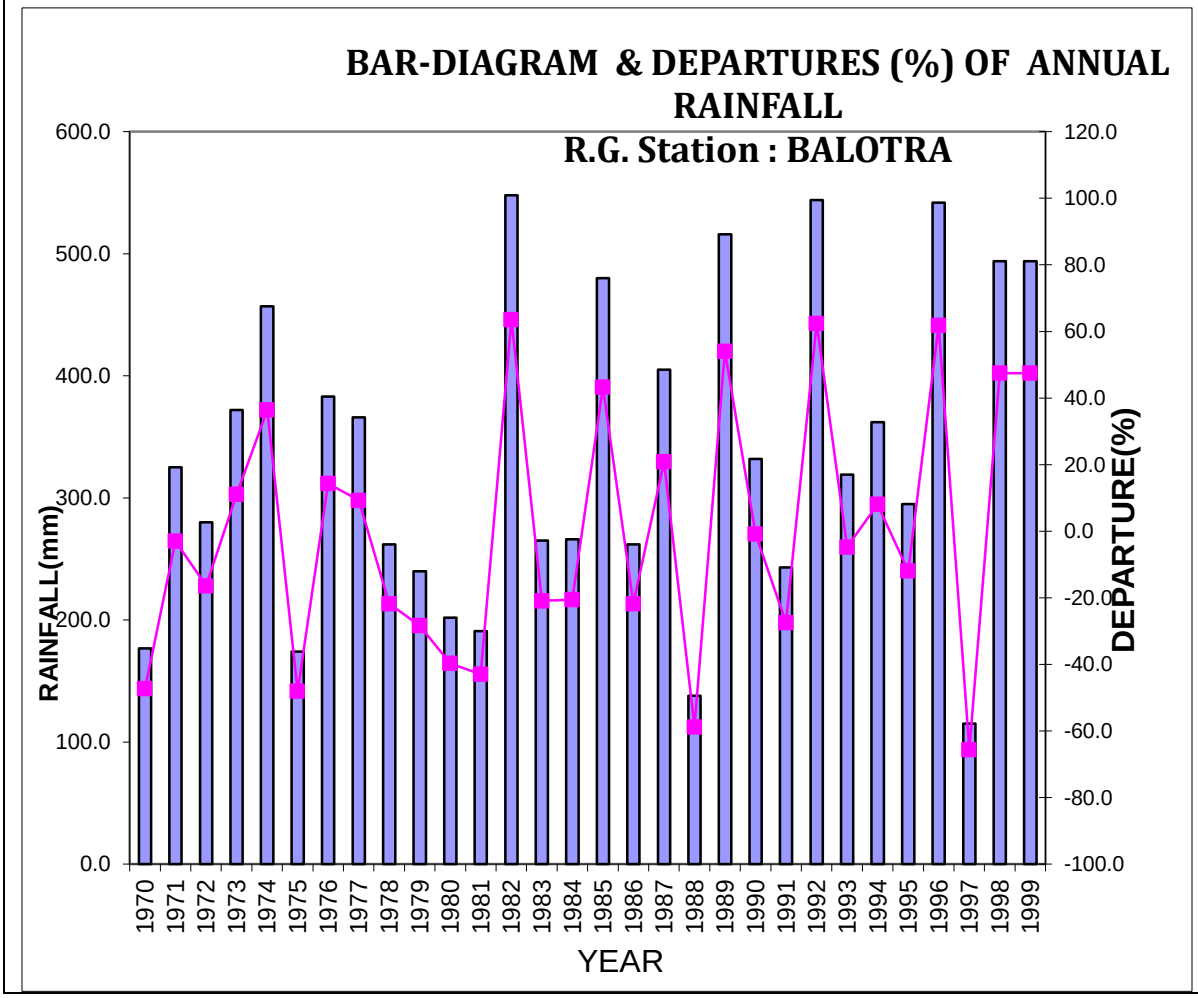
3. Decadal Water Level Trend (2009-2019)	Rising
GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)	
Ground Water Recharge Worthy Area (sq. km.)	1137.50
Total Annual Ground Water Recharge (mcm)	25.76
Natural Discharge (mcm)	2.58
Net Annual Ground Water Availability (mcm)	23.18
Existing Gross Ground Water Draft for All uses(mcm)	22.28
Provision for domestic requirement supply to 2025(mcm)	2.34
Stage of Ground Water Development %	96.11
Category	Critical
In-Storage Resource	
Total Area (Sq.Km)	113.750
Specific yield	ALO1 :0.10 ALO3 :0.06
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	492
Water Harvesting Structure	20
Talai(Talab)	02
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Tanks (Nos) Capacity 50.000 lts	3382
Volume of water to be conserved (mcm)	0.1691
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	571.8962
Surplus Surface water Availability (mcm)	0.16
DEMAND SIDE MANAGEMENT:	
DEMAND SIDE MANAGEMENT	
Irrigitation by permitted TW almost already using by Micro irrigation techniques like irrigation through Sprinkler. No more scope is feasible	
Cropping Pattern change: The sown crops are already less water consuming crops like Bajra, Mung etc. The change in cropping pattern is not feasible.	
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	23.18
Existing Ground Water Draft for All Purposes (mcm)	22.28
Present stage of Ground Water Development (%)	96.11
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	95.42

DEPTH TO WATER LEVEL MAP OF BLOCK GIDA , DISTRICT BARMER

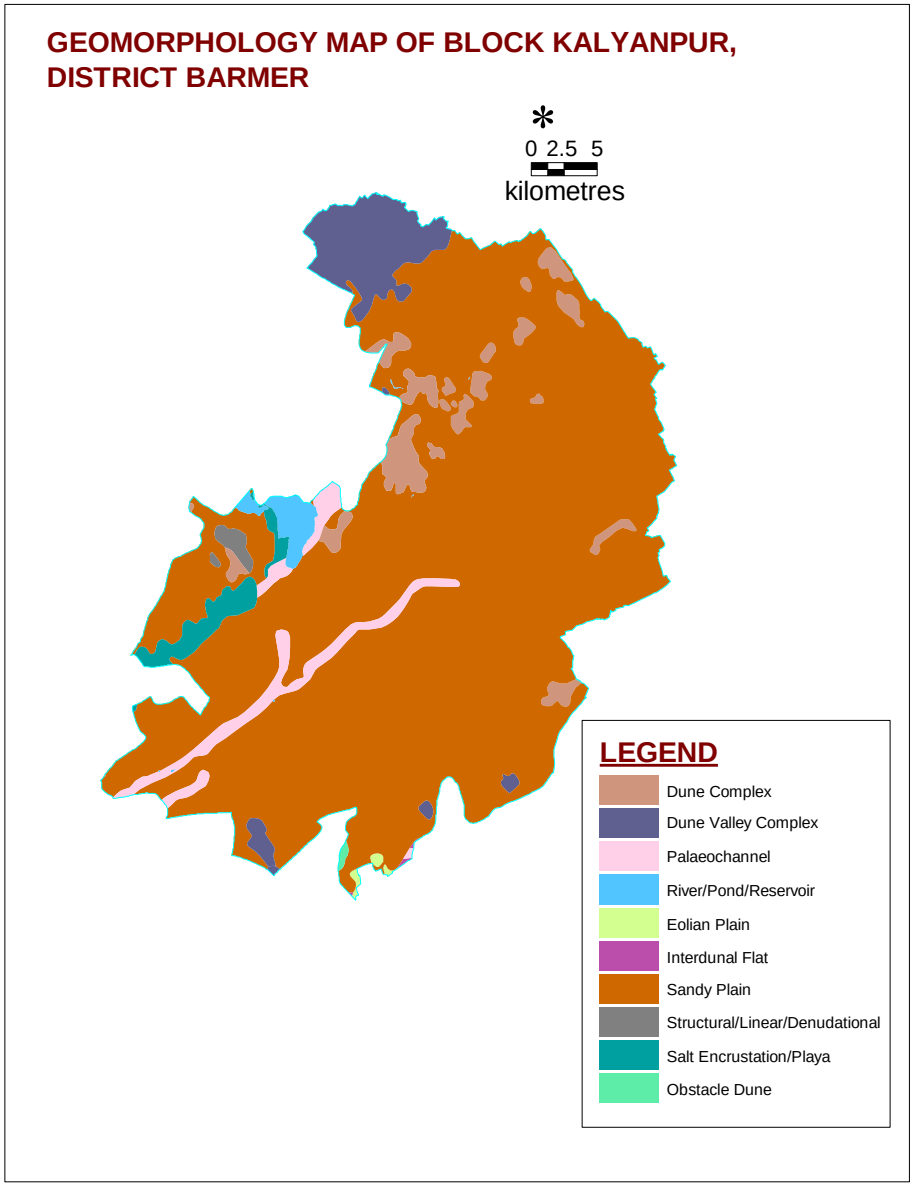


KALYANPUR BLOCK

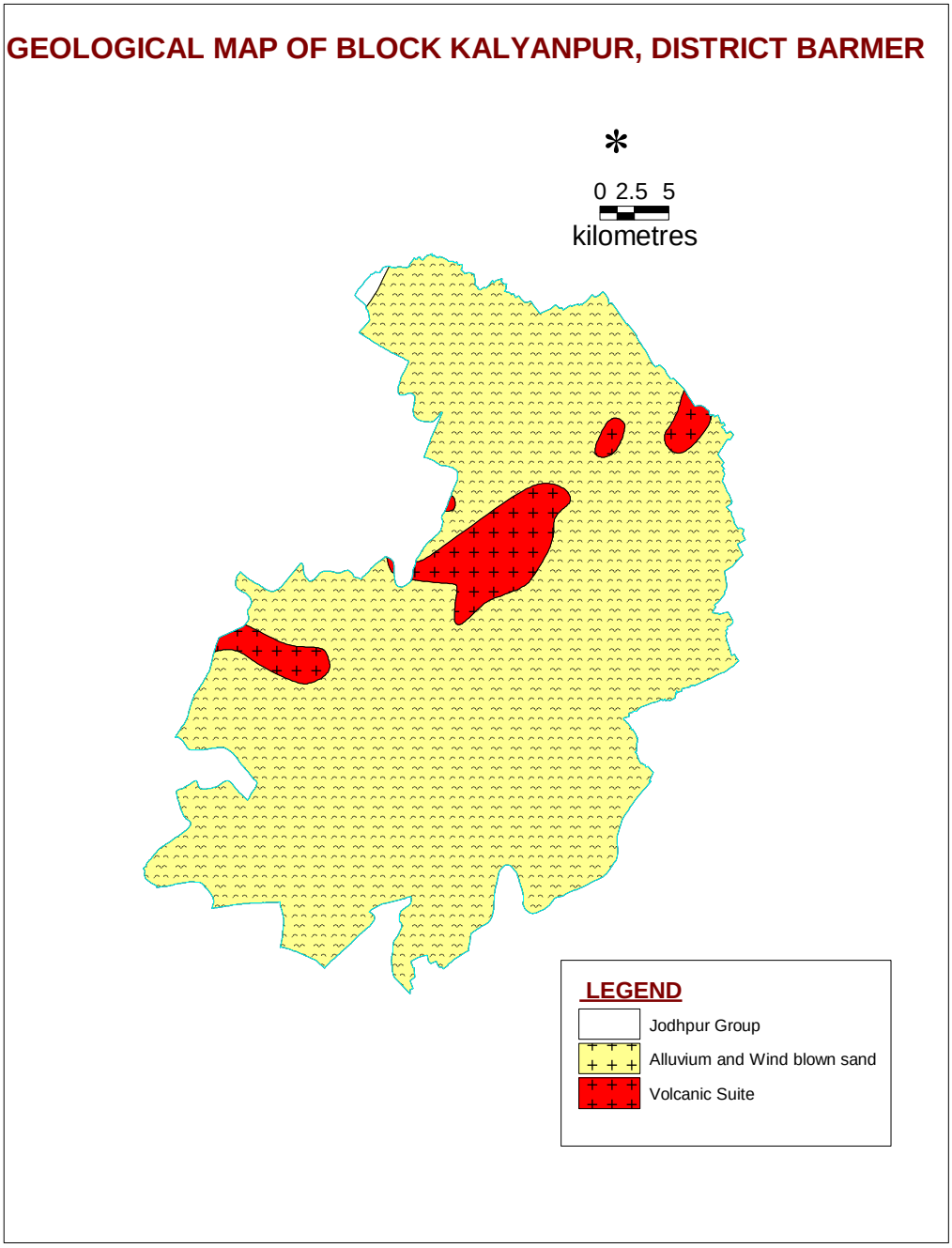
SALIENT INFORMATION	
Block Name	**KALYANPUR**
Longitude	72°17.5'26" to 72°42'3.5"
Latitude	25°49'15" to 26°18'14"
Geographical Area Sq.km	1263.04
Hilly Area (Sq.km)	0
Population (2011)	No Census available
Climate	
Average Temperature range (°C)	03 to 48
Rainfall Analysis	
Normal Rainfall (mm)	262.13
Mean Annual rainfall (mm)	334.95
Highest annual rainfall with year (mm)	548 (2002)
Lowest annual rainfall (mm) with year	115 (2017)
Standard deviation (mm)	128.76
Coefficient of Variation (%)	38.44



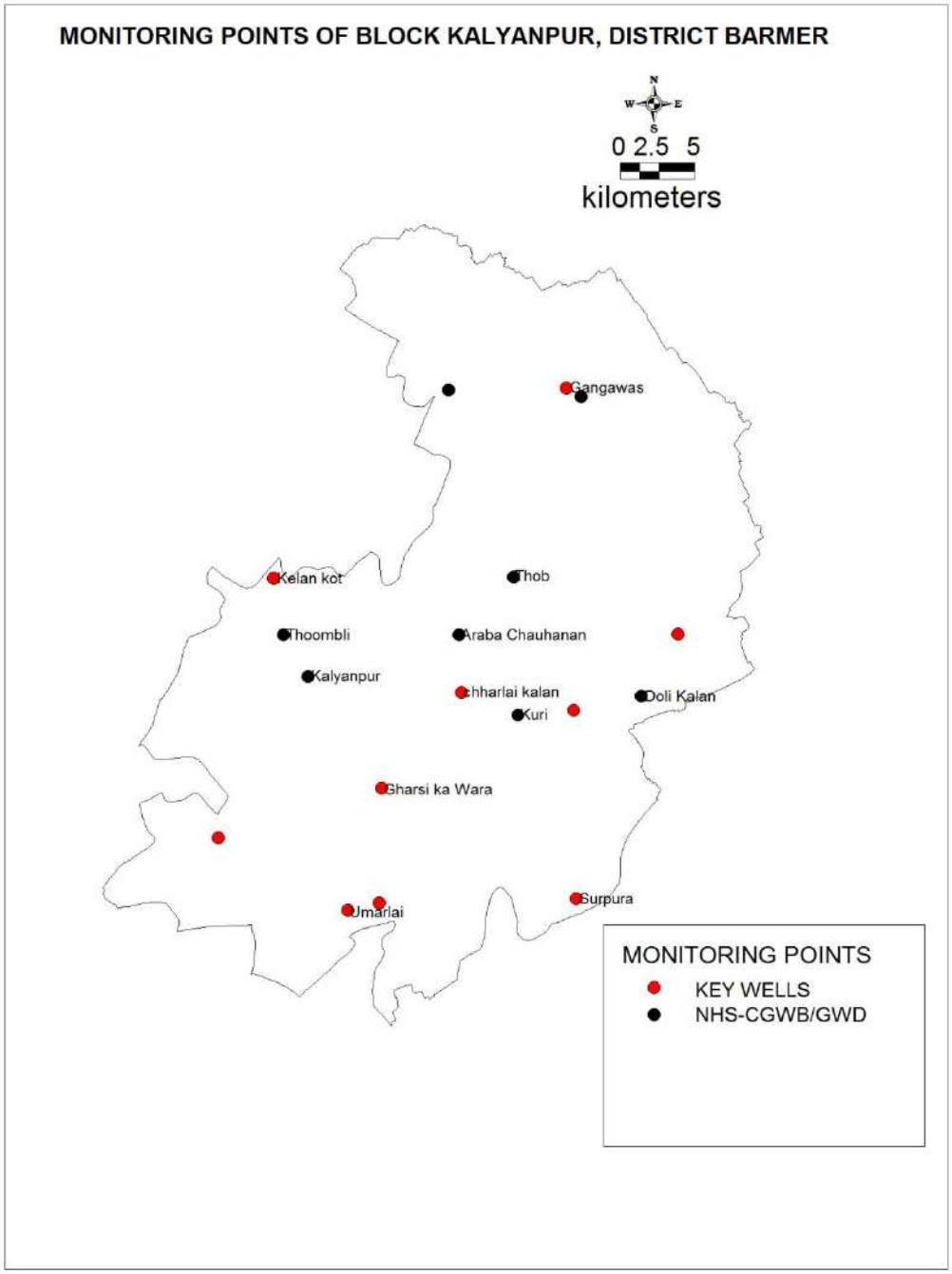
Drought Analysis	
Mild (0 to -25%)	09
Normal (-25% to -50%)	06
Severe (-50% to -75%)	02
Most severe (-75% to -100%)	00
Geomorphology	
Geomorphic Unit	undulating planes, sand dunes and abruptly rising hills of rhyolite and granites
Elevation (m amsl)	



Geology	Older alluvium and granites

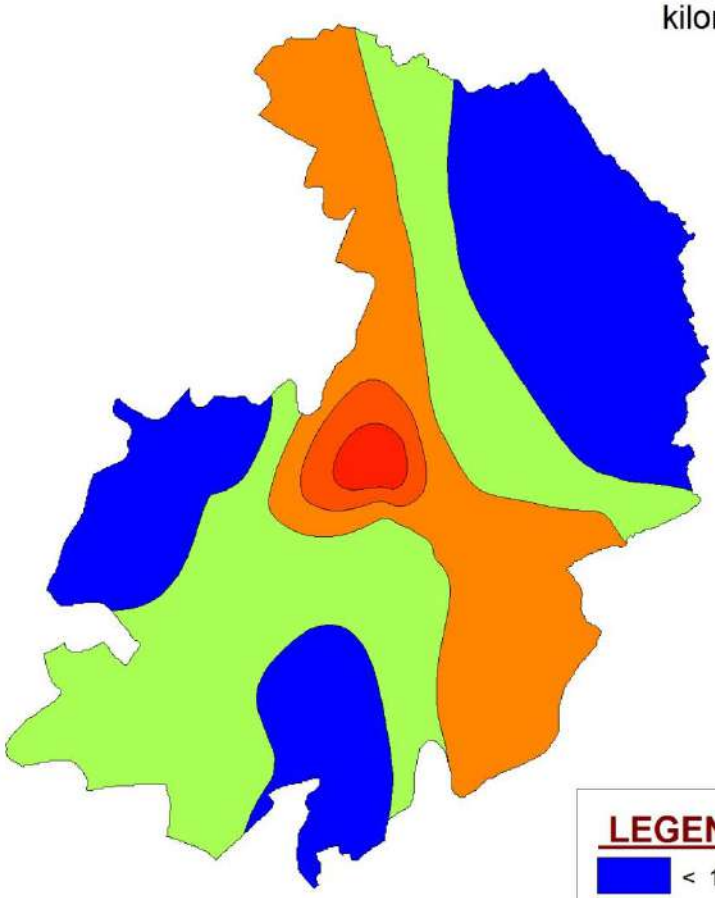


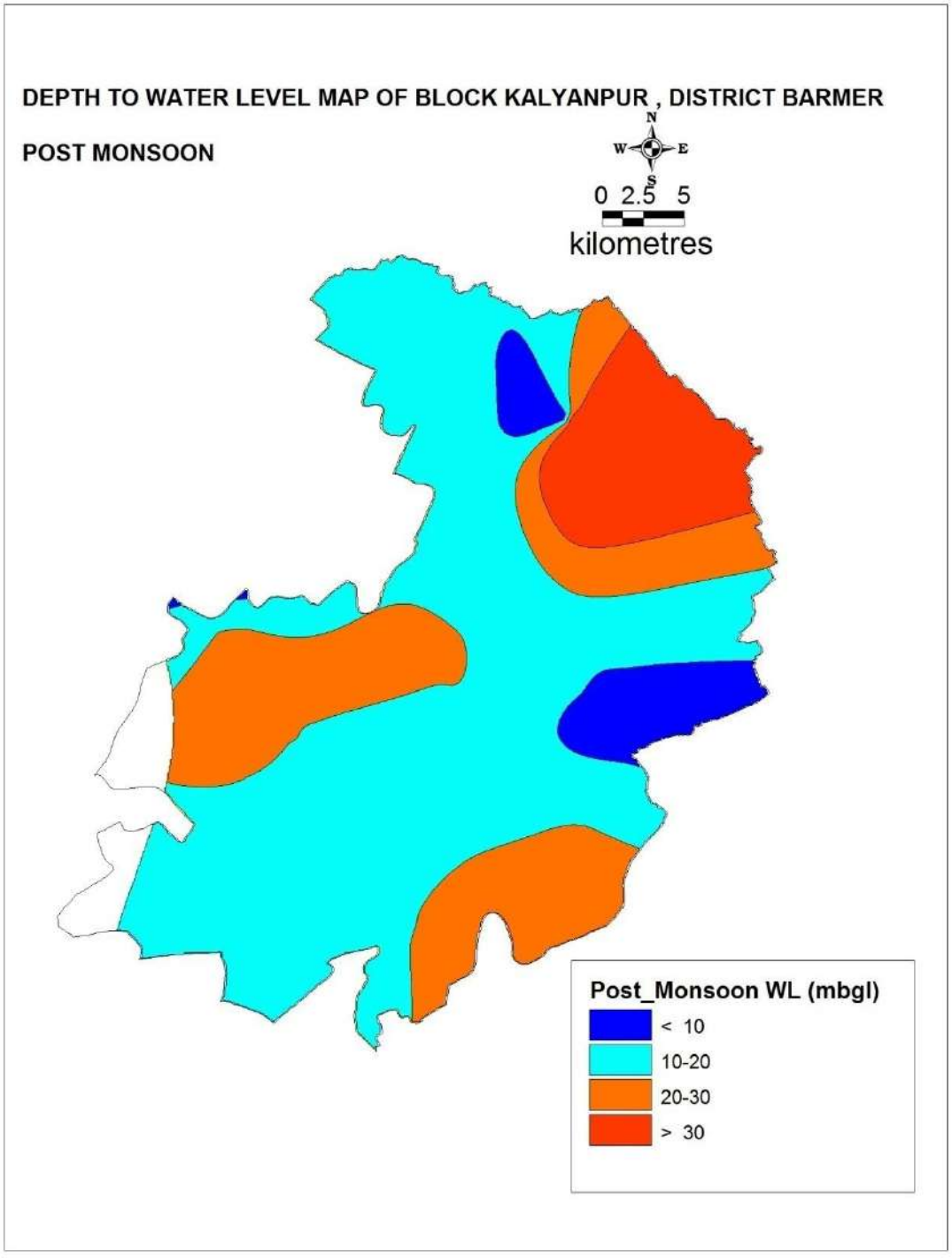
Drainage & Hydrology			
Drainage/Basin/Sub Basin		No Major drainage except few ephemerals streamlets	
Hydrology			
Ponds		0	
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		126304	
Forest Area in ha.			
Net Sown Area in ha.			
Area sown more than once in ha.			
Rainfed Crop			
Area under Irrigation (Net) in ha			
Surface Water			
Ground Water			
Other sources			
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
sown			
Irrigated			
Principal Crop Area (ha)			
Crop Type			
Cereals			
Oil Seeds			
Pulses			
Hydrogeology			
Monitoring Stations (May 2019)			
CGWB		5 (3 EW monitored once)	
SGWD		3	
NAQUIM Key Wells		08	



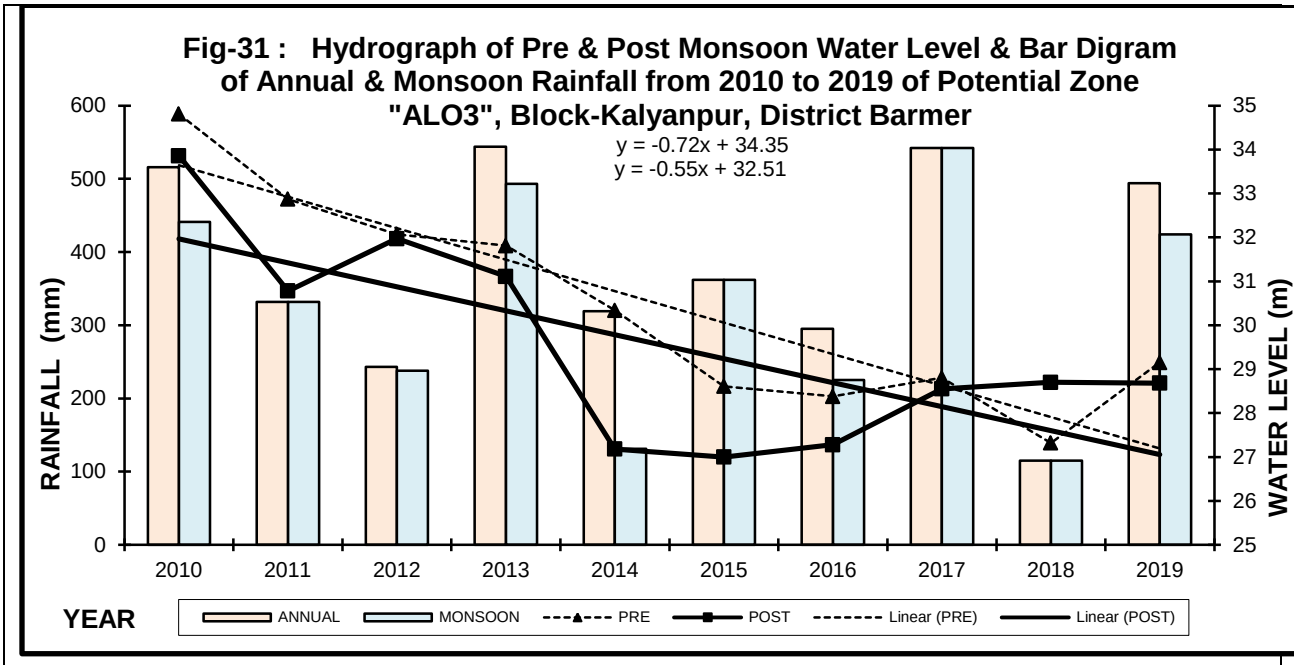
WATER LEVEL BEHAVIOUR (of NHS monitoring points, EWand key wells)	
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019)Water level
5.15 (DW) - 60.13 (Pz)m bgl	4.9 (DW) - 59.4 (Pz)

DEPTH TO WATER LEVEL MAP OF BLOCK GIDA, DISTRICT BARMER
Pre MONSOON

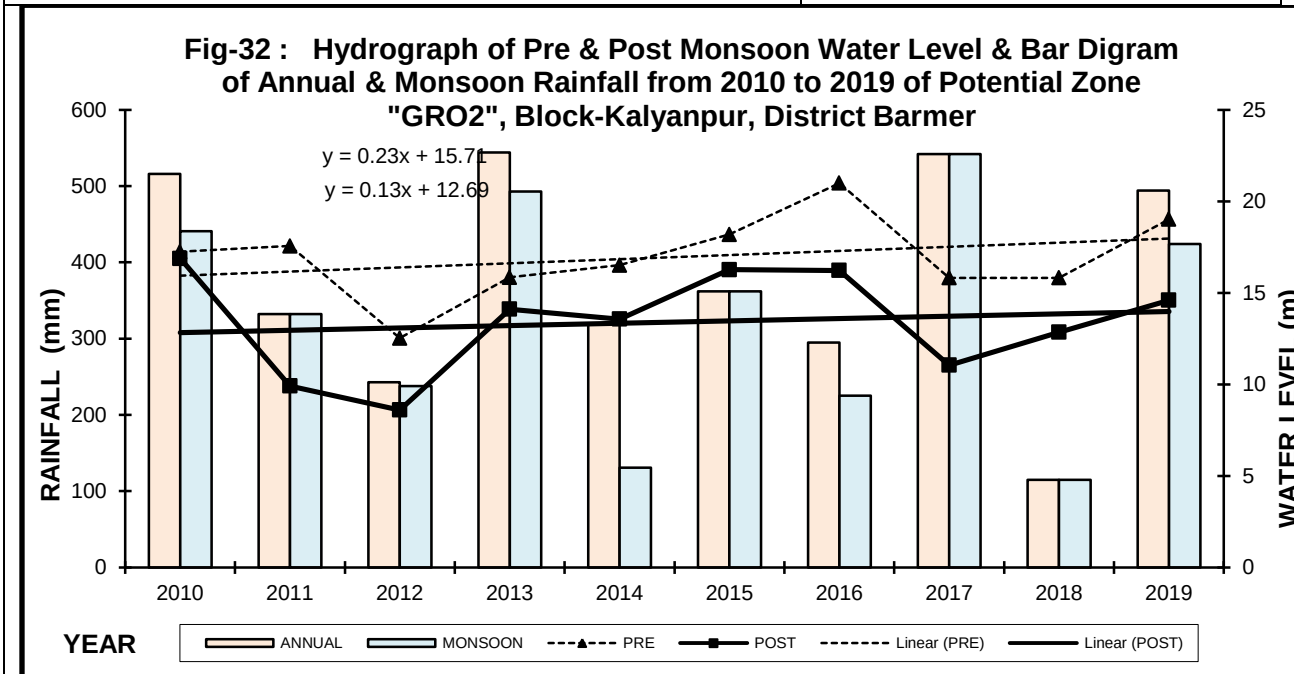




WATER LEVEL BEHAVIOUR (Zone wise)	
Pre-Monsoon (May-2019) Water level (AlO3 Zone)	Post-Monsoon (November-2019)Water level (AlO3 Zone)
27.32 – 34.81 m bgl	27 – 33.86 m bgl

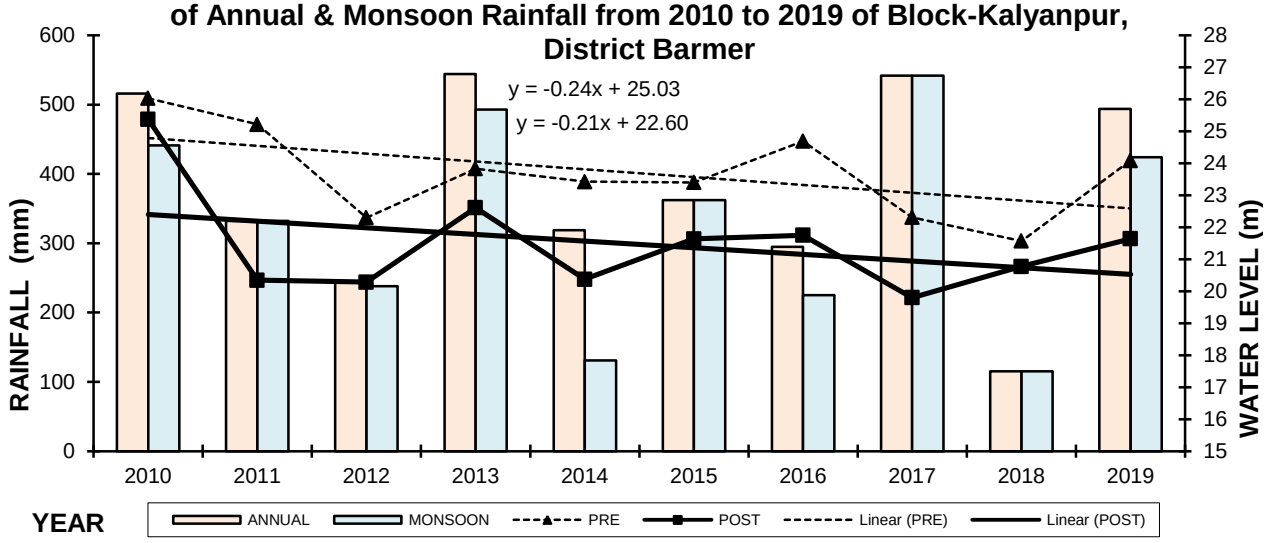


Pre-Monsoon (May-2019) Water level (GRO2 Zone)	Post-Monsoon (November-2019)Water level (GRO2 Zone)
15.82 – 21.0 m bgl	8.6 – 16.88 m bgl



WATER LEVEL BEHAVIOUR (of block as whole)	
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019) Water level
21.57 – 26.03 m bgl	19.8 – 25.37 m bgl

Fig-33 : Hydrograph of Pre & Post Monsoon Water Level & Bar Digram of Annual & Monsoon Rainfall from 2010 to 2019 of Block-Kalyanpur, District Barmer



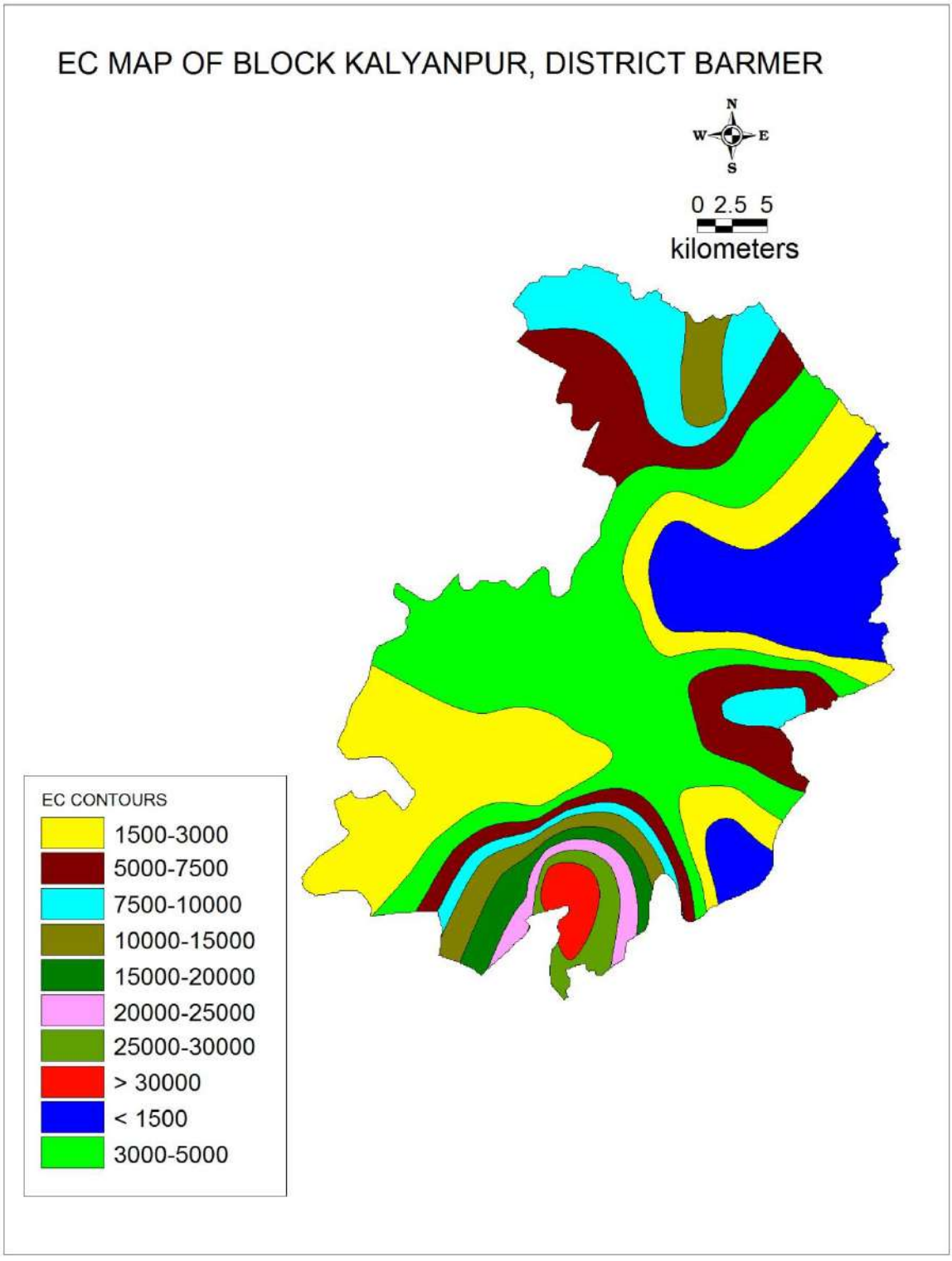
AQUIFER DISPOSITION

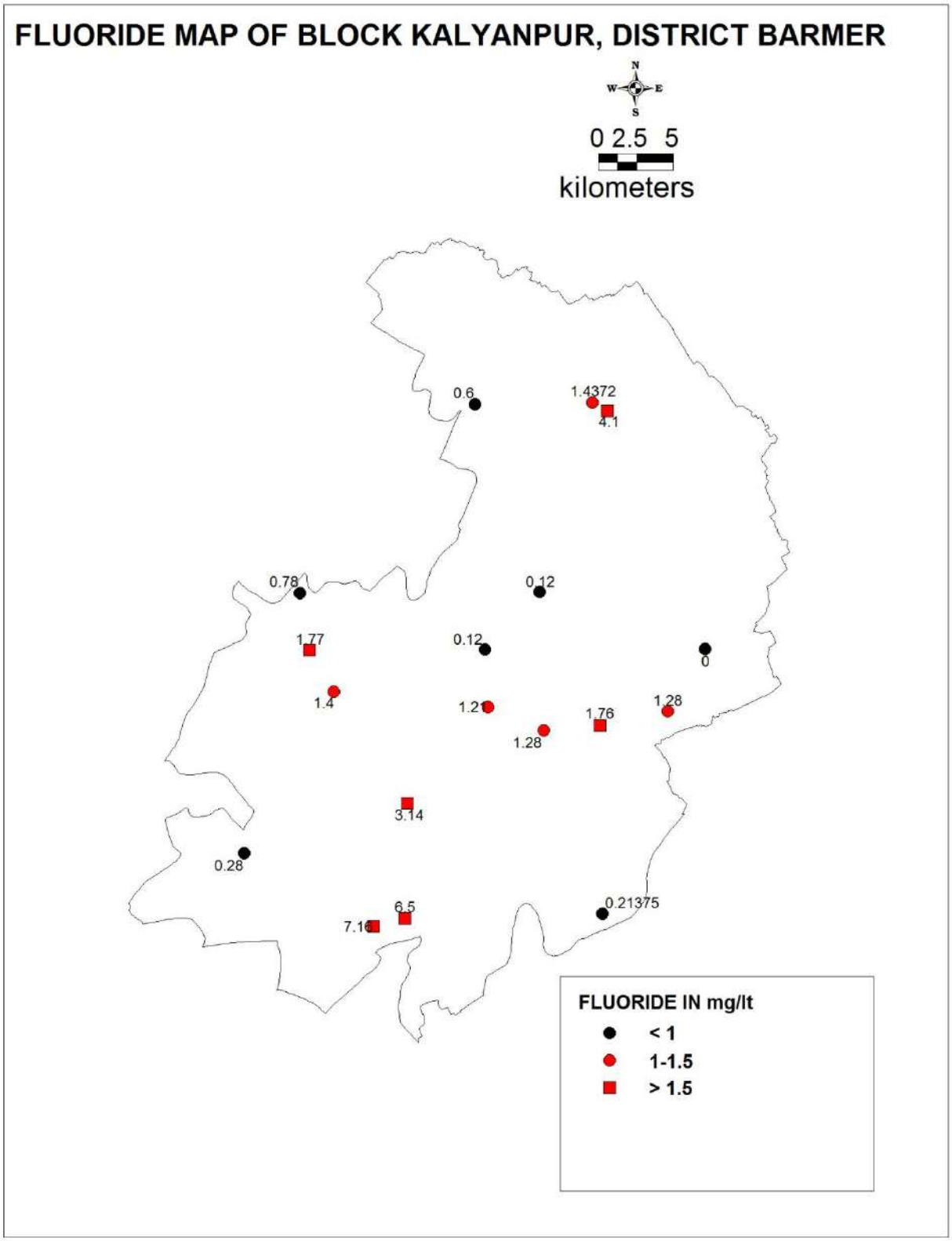
Status of GW Exploration	Exploratory Wells-3 Observation Wells-0 Piezometers - 00 Slim hole -00
Aquifer Characteristics	The older Alluvium, and Granite forms the most important aquifer in the block, Specific Yeild value is 0.015 for older alluvium and 0.06 for granite.
GW Quality	EC varies from 450 µS/cm to 19770 µS/cm

CHEMICAL QUALITY OF GROUND WATER

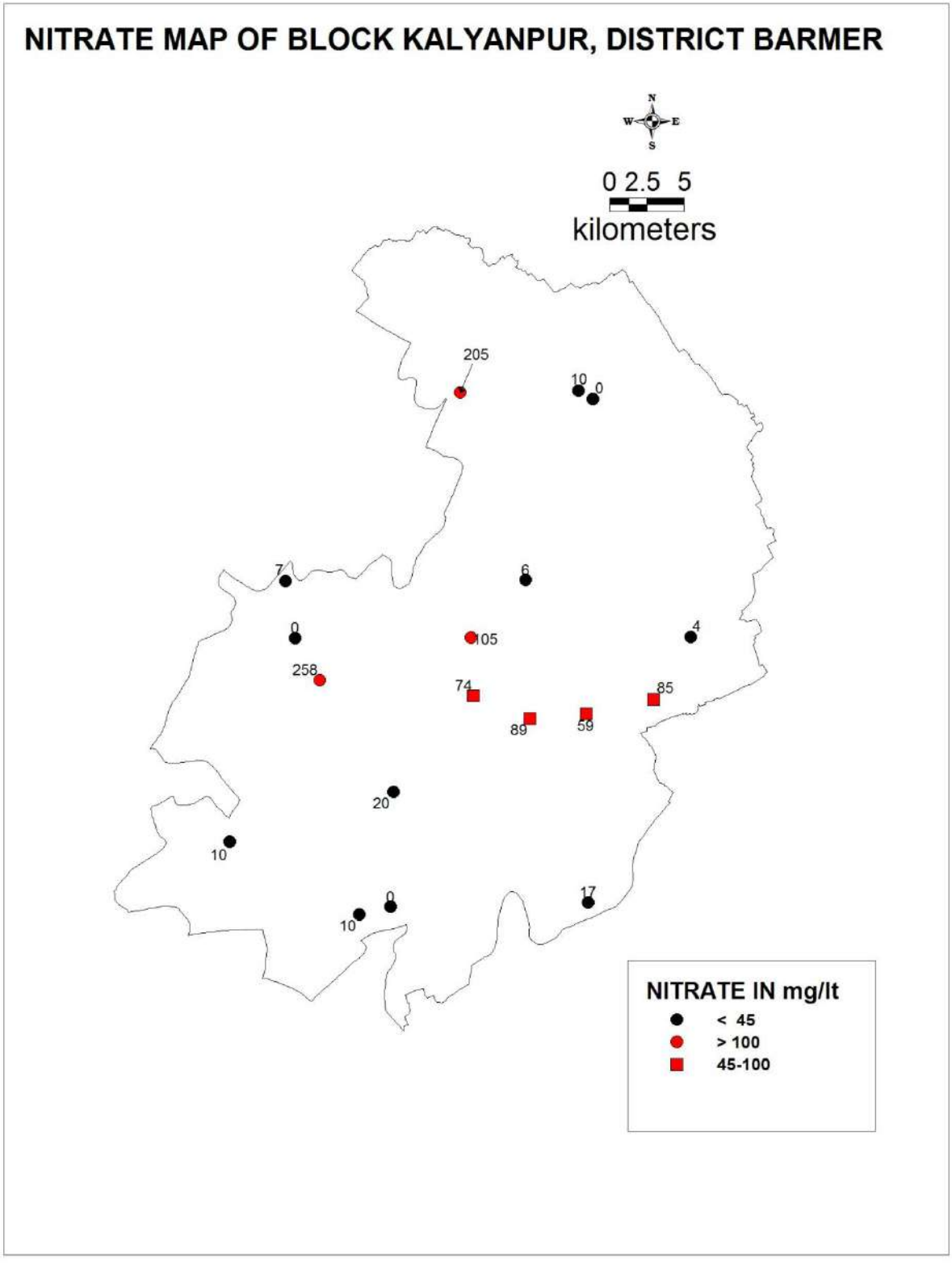
Suitability for Drinking

TDS	mg/l	No. of Samples	% of Samples
Fresh	0-3000	10	66.67
Brackish	3000-10000	4	26.67
Saline	> 10000	1	6.67
Brine	>35000	0	0.00
Hardness (mg/l)	Water Class	No. of Samples	% Sample
0 – 75	Soft	0	0.00
75 – 150	Moderately Hard	2	13.33
150 – 300	Hard	4	26.67
>300	Ver Hard	9	60.00
Nitrate	(mg/l)		
	< 45	8	53%
	> 45	7	47%
Fluoride	mg/l		
	1-1.5	12	66.6666667
	>1.5	6	33.3333333


EC MAP OF BLOCK KALYANPUR, DISTRICT BARMER
N
W
E
S
0 2.5 5
kilometers
EC CONTOURS
1500-3000
5000-7500
7500-10000
10000-15000
15000-20000
20000-25000
25000-30000
> 30000
< 1500
3000-5000


FLUORIDE MAP OF BLOCK KALYANPUR, DISTRICT BARMER
N
W
E
S
0 2.5 5
kilometers
0.6
1.4372
4.1
0.78
0.12
1.77
0.12
0
1.4
1.2
1.76
1.28
1.28
3.14
0.28
6.5
7.16
0.21375
FLUORIDE IN mg/lt
< 1
1-1.5
> 1.5

NITRATE MAP OF BLOCK KALYANPUR, DISTRICT BARMER



Suitability for Irrigation

EC

Type of Water	Classification	% Samples
Low Saline< 250 mg/l	Excellent	0
Medium Saline 250 – 750 mg/l	Good	22.22222
Highly Saline 750 – 2250 mg/l	Permissible	11.11111
Very Highly saline> 2250 mg/l	Doubtful	66.66667

Na%

Water Class	Range	% Samples
Excellent	< 20	0.00
Good	20 - 40	8.00
Medium	40 - 60	0.00
Bad	60 - 80	00.0
Very Bad	> 80	92.00

GROUND WATER ISSUES

1. Salinity		High EC and declining water level trend
1. Inland Salinity	area in sq.km	944.54
2. Ground Water Resource=Net availability - Draft		42.76
2. Rainfall and Drought		Mild Droughts in 30% years Normal Droughts in 20% years Severe Drought in 7.00% years
3. Decadal Water Level Trend (2009-2019)		Declining (-0.42)

GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)

Total Annual Ground Water Recharge (MCM)	6.5378
Natural Discharge (MCM)	0.6538
Net Annual Ground Water Availability (MCM)	5.8839
Existing Gross Ground Water Draft for All uses(MCM)	5.4563

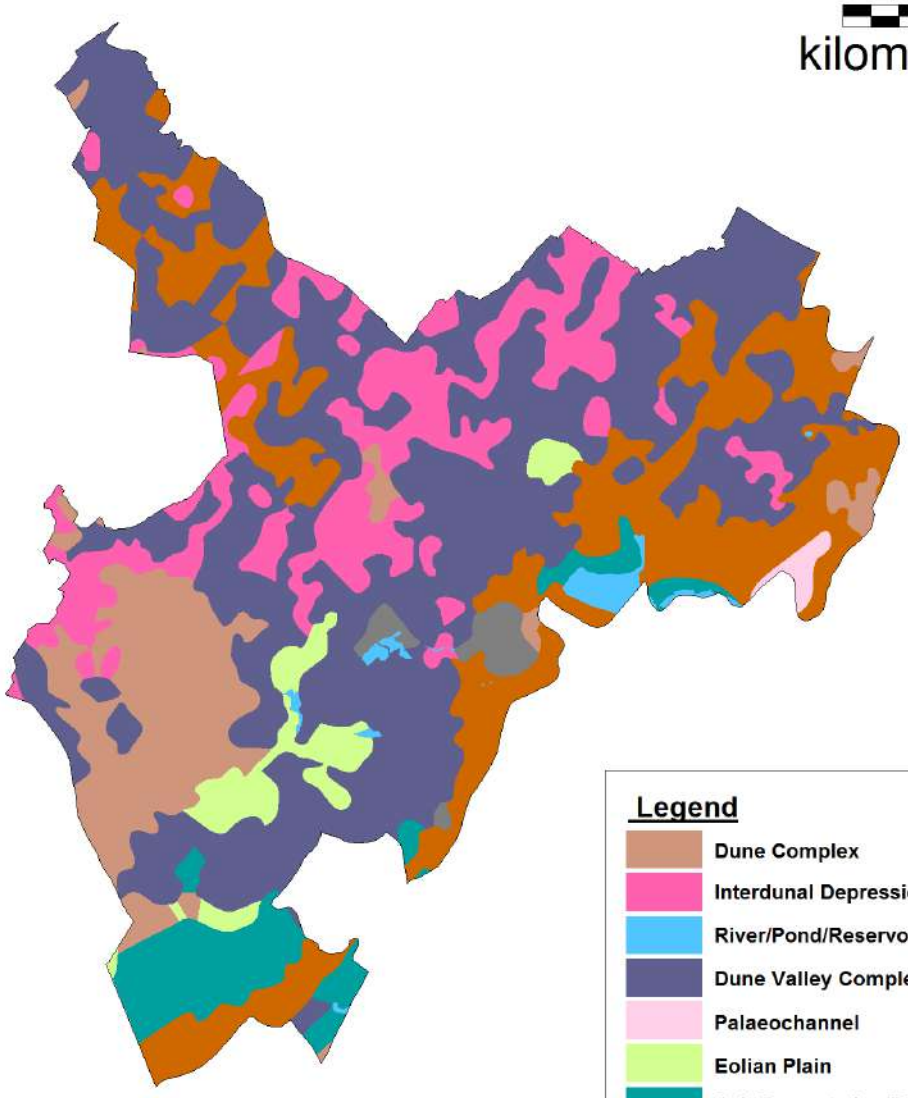
Provision for domestic and industrial requirement supply to 2025(MCM)	1.0372
Stage of Ground Water Development %	92.73
Category	Critical
In-Storage Resource	
Total Area (Sq.	28256
Aquifer	Older Alluvium
Sy	0.06
Aquifer	Granite
Sy	0.015
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Possibilities	
Existing Structures constructed by State Govt.	250
Farm Pond / Khet Talai	03
Stagered Trench	01
Tankas	246
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Agricultural Supply -GW	4,688
Domestic Supply - GW	0.7683
Total Supply	4,689
Area suitable for Artificial recharge & Water Conservation Structures(sq.km)	
Type of Aquifer	Specific yield
Soft Rock	0.06
Hard Rock	0.015
Tanks (Nos) Capacity 50.000 lts	2222
Volume of water to be conserved (mcm)	0.1111
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	40.81
Surplus Surface water Availability (mcm)	0.29
DEMAND SIDE MANAGEMENT:	
DEMAND SIDE MANAGEMENT	
Irrigitation by permitted TW almost already using Micro irrigation techniques like irrigation through Sprinkler. No more scope is feasible	
Cropping Pattern change: The sown crops are already less water consuming crops like Bajra, Mung etc. The change in cropping pattern is not feasible.	
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	5.8839
Additional GW resources available after Supply side interventions (MCM)	0.11

Net Ground Water Availability after Supply side intervention	6.00
Existing Ground Water Draft for All Purposes (mcm)	5.4563
Existing Ground Water Draft for All Purposes (mcm) after intervention	5.4563
Present stage of Ground Water Development (%)	92.73
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	90.95

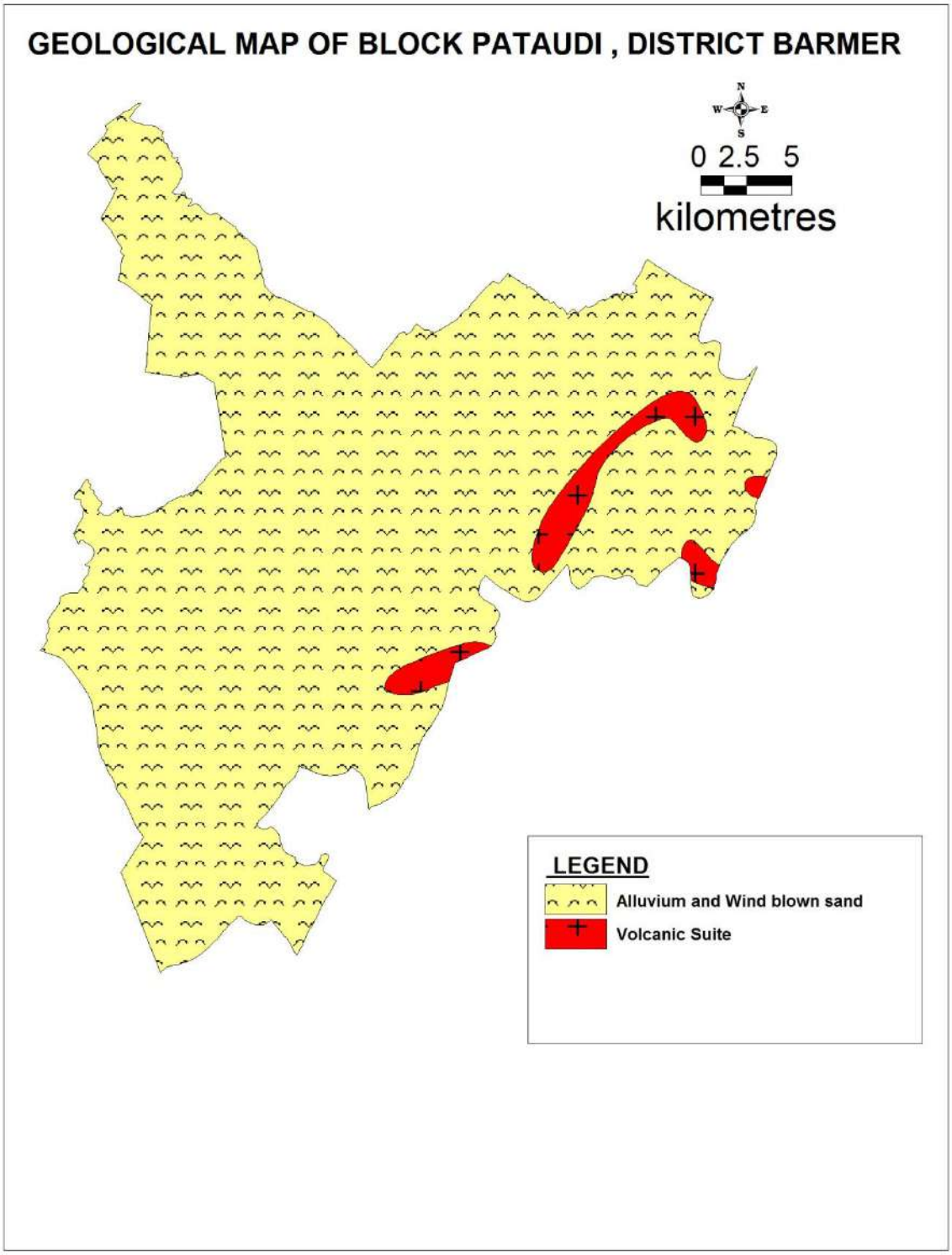
PATAUDI BLOCK

SALIENT INFORMATION	
Block Name	**PATAUDI**
Longitude	72°05'10" to 72°29'24"
Latitude	25°53'52" to 26°19'26"
Geographical Area Sq.km	831.62
Hilly Area (Sq.km)	0
Population (2011)	No Census available
Climate	
Average Temperature range (°C)	03 to 48
Rainfall Analysis	
Normal Rainfall (mm)	267.39
Mean Annual rainfall (mm) (from Rain Gauge of Balotra)	334.95
Highest annual rainfall with year (mm)	548 (2002)
Lowest annual rainfall (mm) with year	115 (2017)
Standard deviation (mm)	128.76
Coefficient of Variation (%)	38.44
Drought Analysis	
Mild (0 to -25%)	09
Normal (-25% to -50%)	06
Severe (-50% to -75%)	02
Most severe (-75% to -100%)	00
Geomorphology	
Geomorphic Unit	undulating planes, sand dunes and abruptly rising hills of rhyolite and granites
Geology	Older Alluvium, younger alluvium, rhyolite
Elevation (m amsl)	

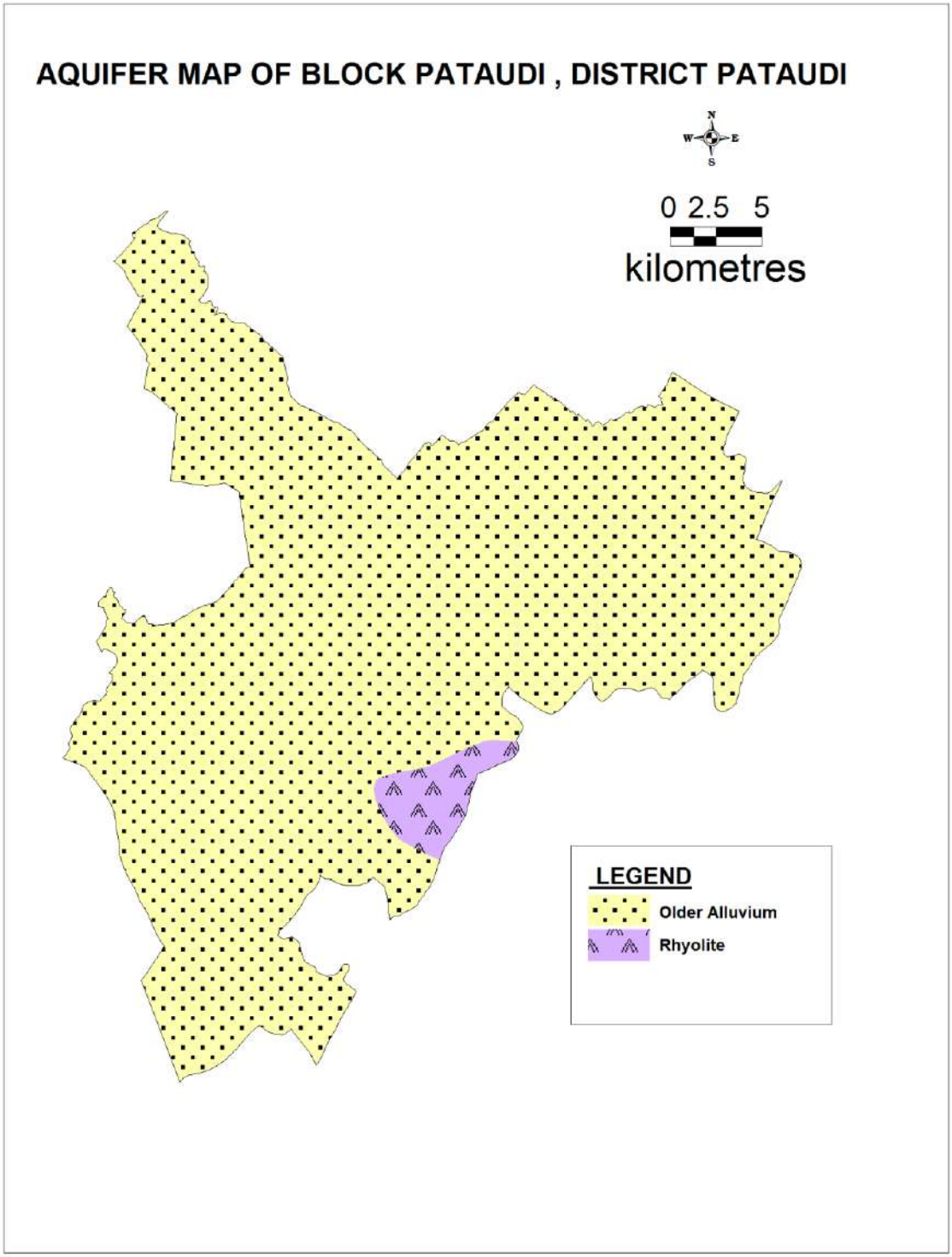
GEOMORPHOLOGY MAP OF BLOCK PATAUDI , DISTRICT BARMER



Geology	Older alluvium, younger alluvium and granites



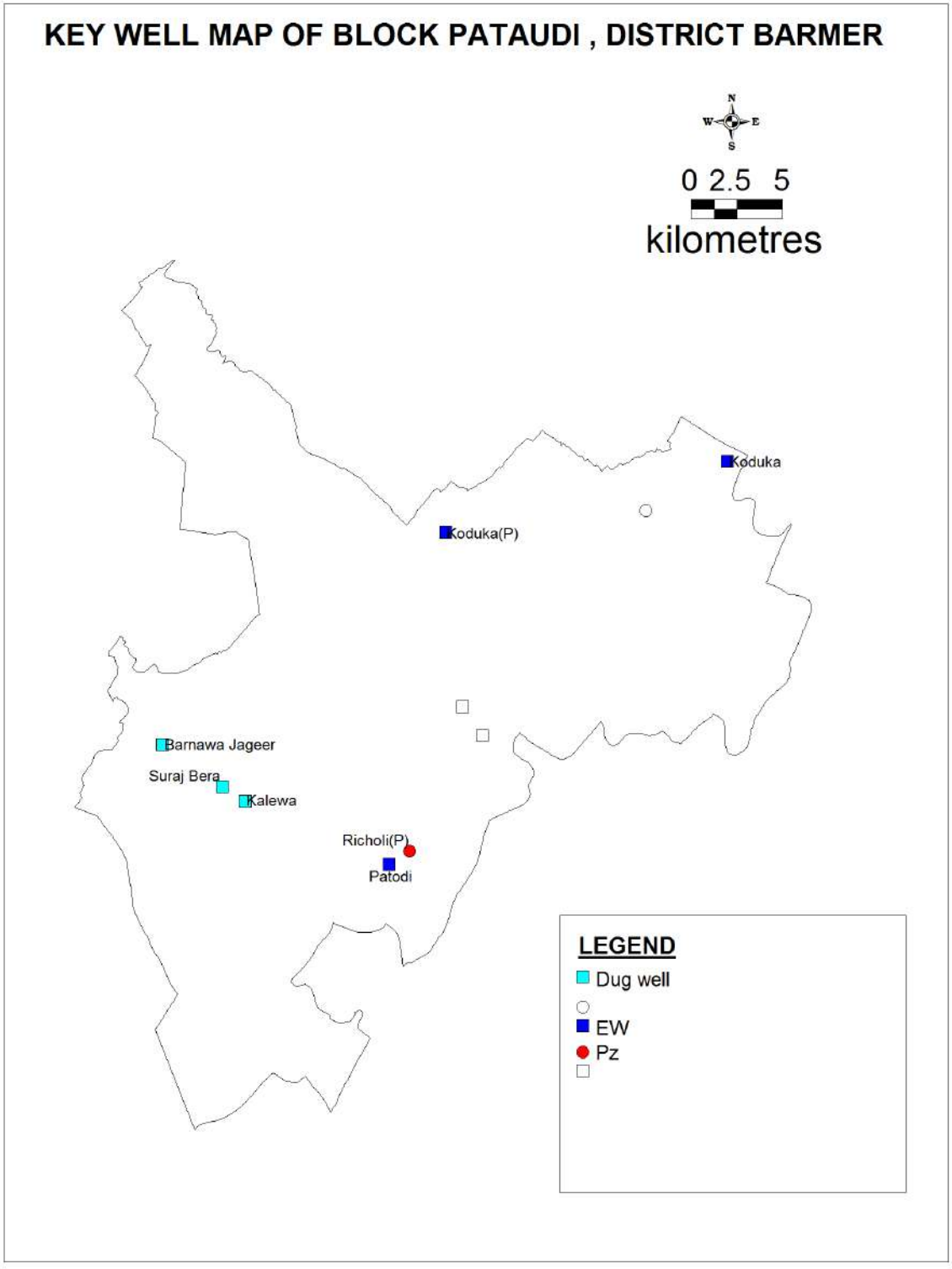
Drainage & Hydrology	
Drainage/Basin/Sub Basin	No Major drainage except few ephemerals streamlets
Hydrology	



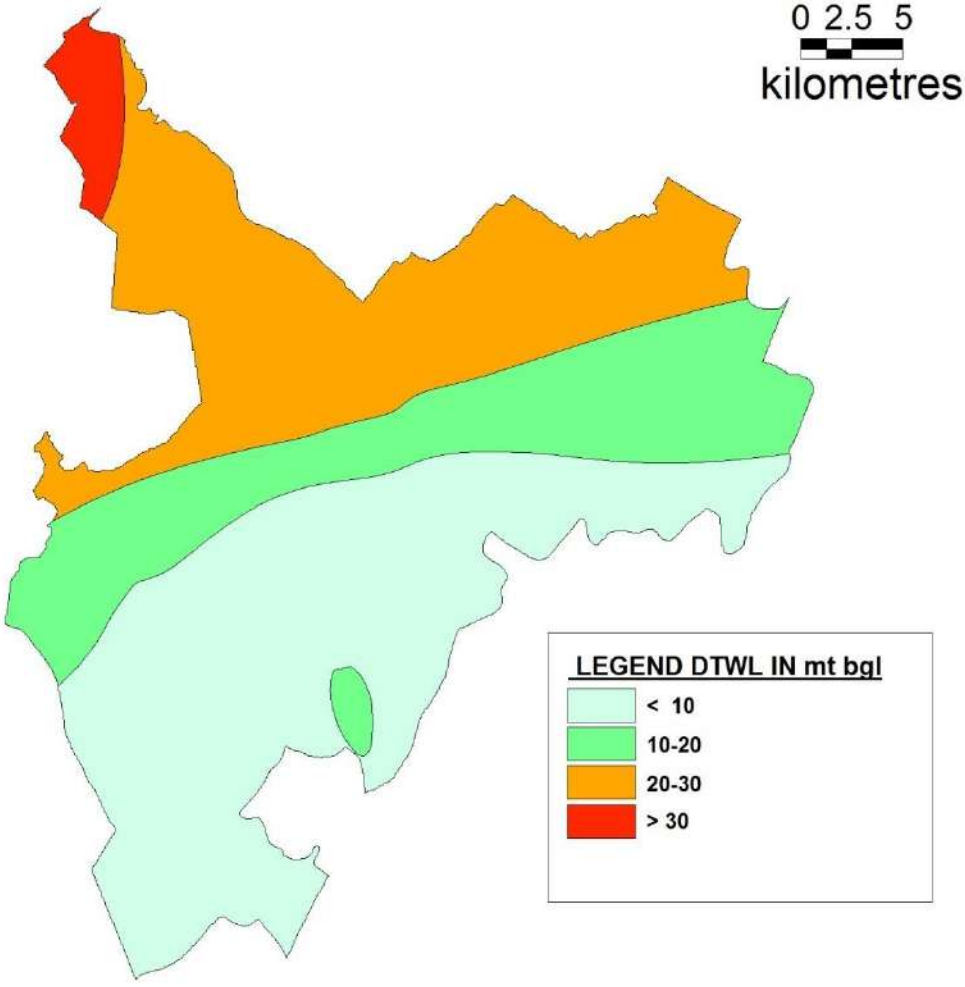
Ponds	

LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		831.62	
Forest Area in ha.			
Net Sown Area in ha.		No data available	
Area sown more than once in ha.			
Rainfed Crop			
Area under Irrigation (Net) in ha			
Surface Water			
Ground Water			
Other sources			
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
sown			
Irrigated			
Principal Crop Area (ha)			
Crop Type			
Cereals			
Oil Seeds			
Pulses			
Hydrogeology			
Monitoring Stations			
CGWB		0 (2 EW were monitored once)	
SGWD		6	
NAQUIM Key Wells		4	
WATER LEVEL BEHAVIOUR (of NHS monitoring points, EW and key wells)			
Pre-Monsoon (May-2020) Water level		Post-Monsoon (November-2020)Water level	
3.8 (DW) – 26.5 (DW)m bgl		4.02 (DW) – 22.5 (DW)	

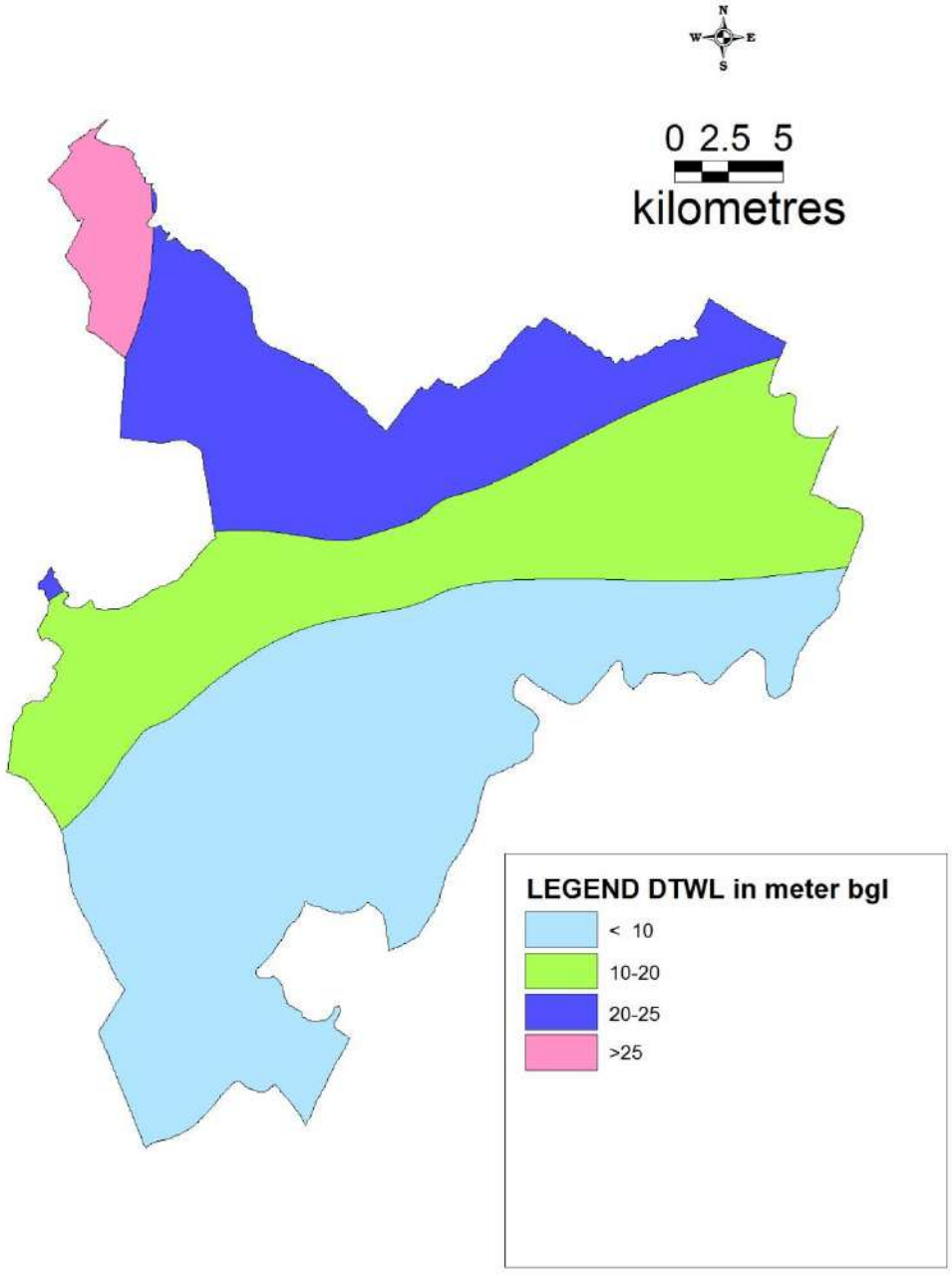
KEY WELL MAP OF BLOCK PATAUDI , DISTRICT BARMER



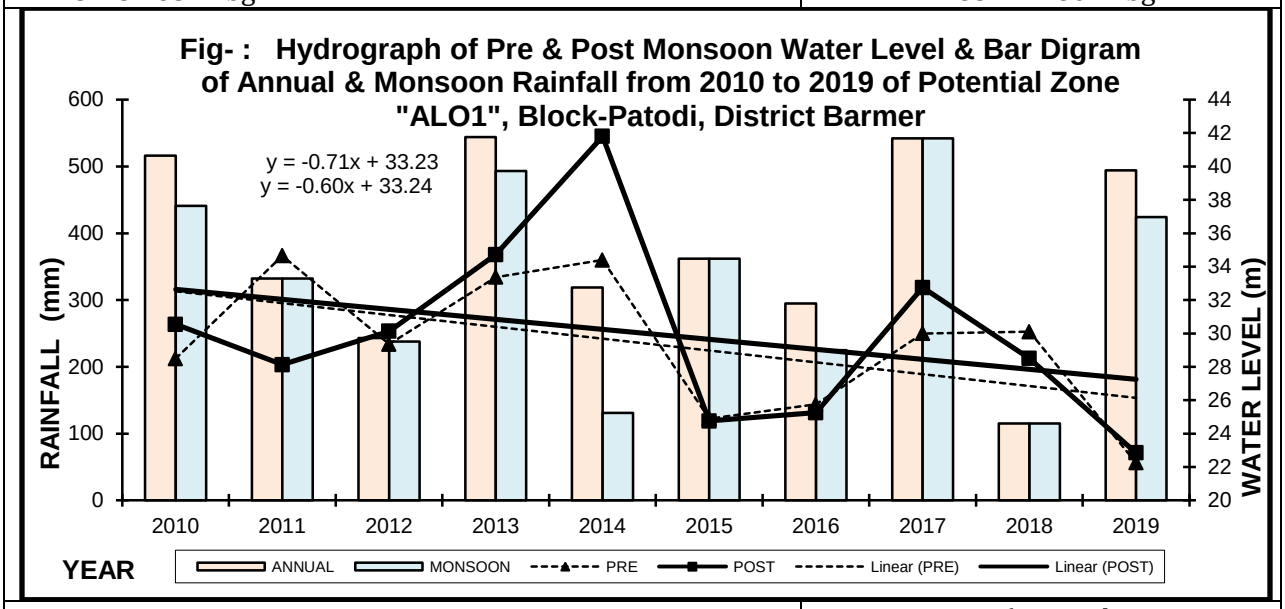
DEPTH YO WATER LEVEL MAP OF BLOCK PATAUDI
DISTRICT BARMER
(Pre MONSOON)



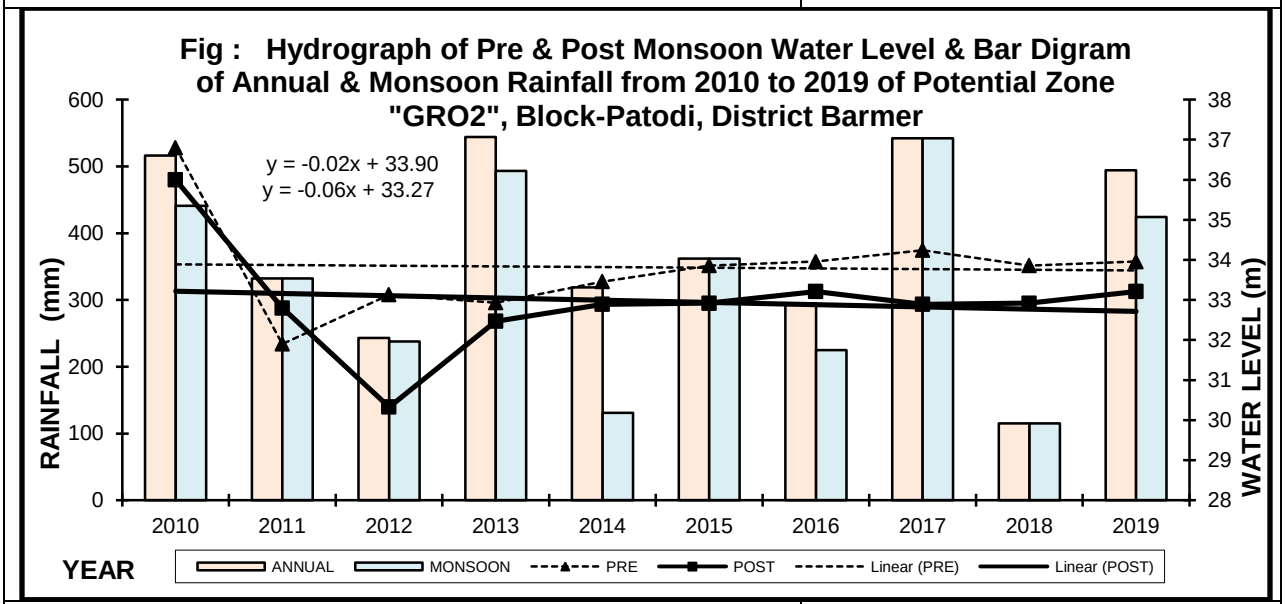
DTWL MAP OF BLOCK PATAUDI, DISTRICT BARMER
(Post-Monsoon}



WATER LEVEL BEHAVIOUR (Zone wise)	
Pre-Monsoon (May-2019) Water level (AlO1 Zone)	Post-Monsoon (November-2019)Water level(AlO1 Zone)
22.25 – 34.65 m bgl	22.85 – 41.80 m bgl

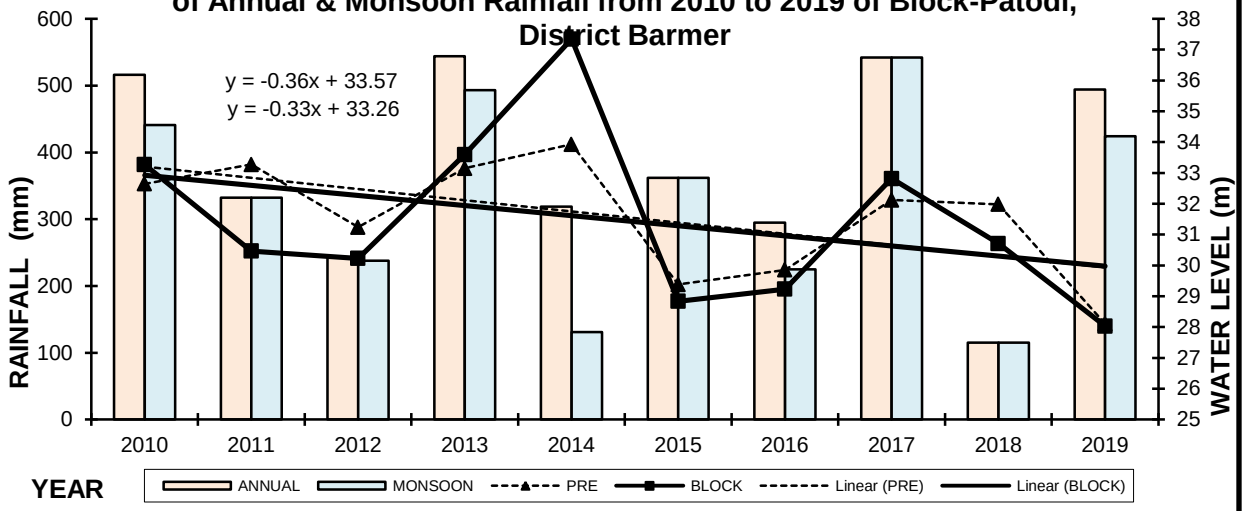


Pre-Monsoon (May-2019) Water level (GRO2 Zone)	Post-Monsoon (November-2019)Water level(GRO2 Zone)
31.90 – 36.80 m bgl	30.33 – 36.0 m bgl



WATER LEVEL BEHAVIOUR (of block as whole)	
Pre-Monsoon (May-2019) Water level	Post-Monsoon (November-2019)Water level
28.11–33.93 m bgl	28.03 – 37.35 m bgl

Fig : Hydrograph of Pre & Post Monsoon Water Level & Bar Digram of Annual & Monsoon Rainfall from 2010 to 2019 of Block-Patodi, District Barmer



AQUIFER DISPOSITION

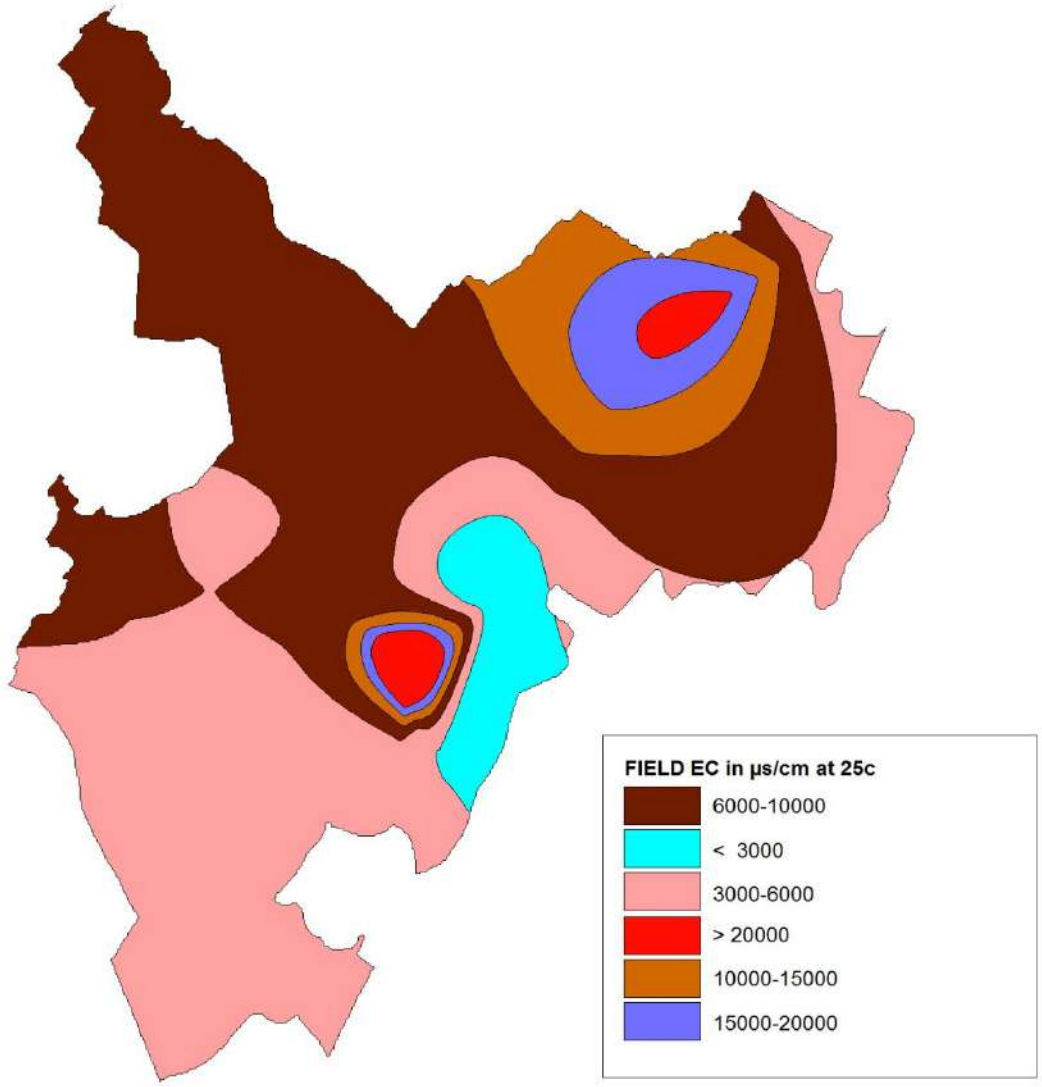
Status of GW Exploration	Exploratory Wells-2 Observation Wells-0 Piezometers - 00 Slim hole -00
Aquifer Characteristics	The older Alluvium, and Granite forms the most important aquifer in the block, Specific Yeildvalue is 0.015 for older alluvium and 0.06 for granite.
GW Quality	EC varies from 625 µS/cm to 32330 µS/cm

CHEMICAL QUALITY OF GROUND WATER

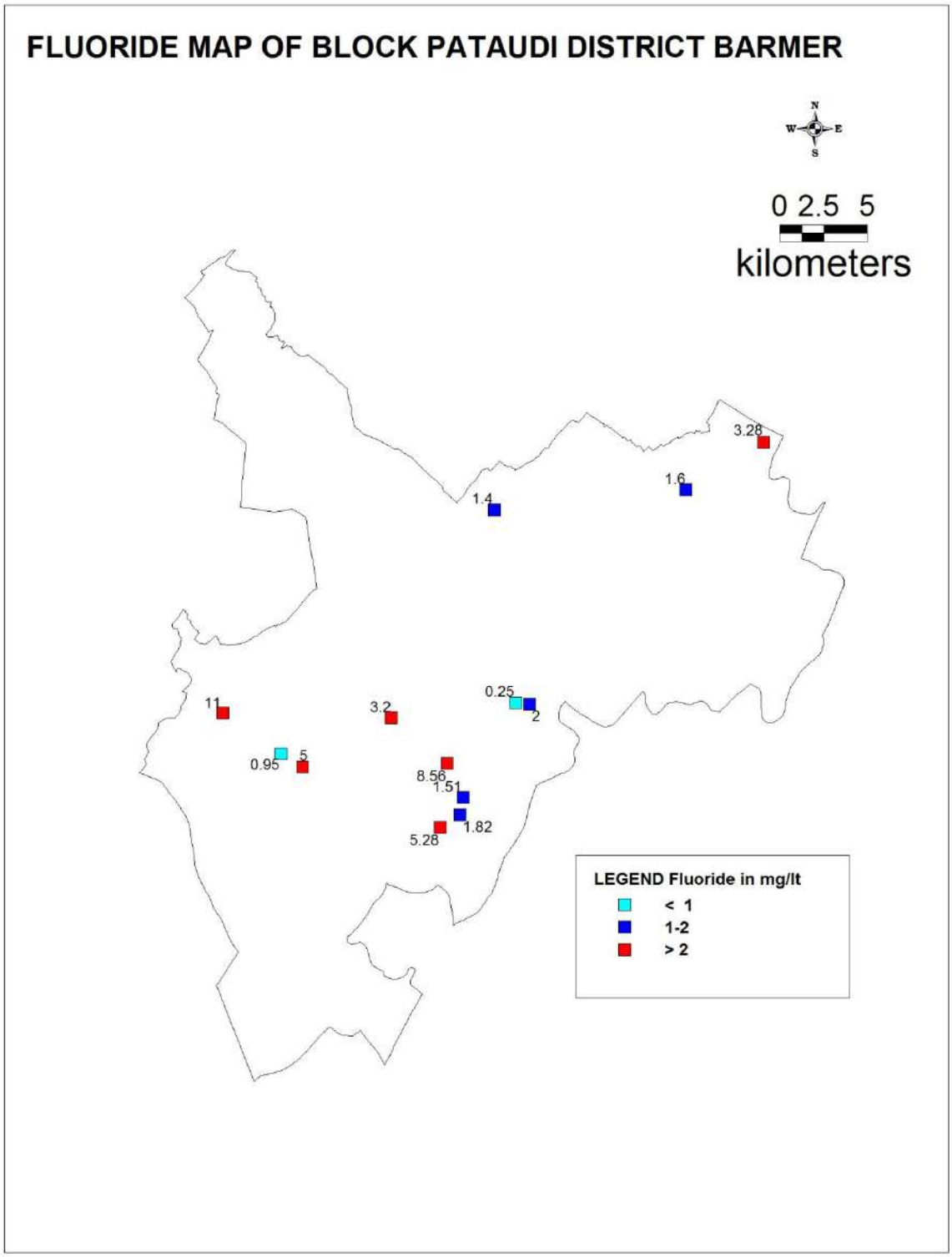
Suitability for Drinking

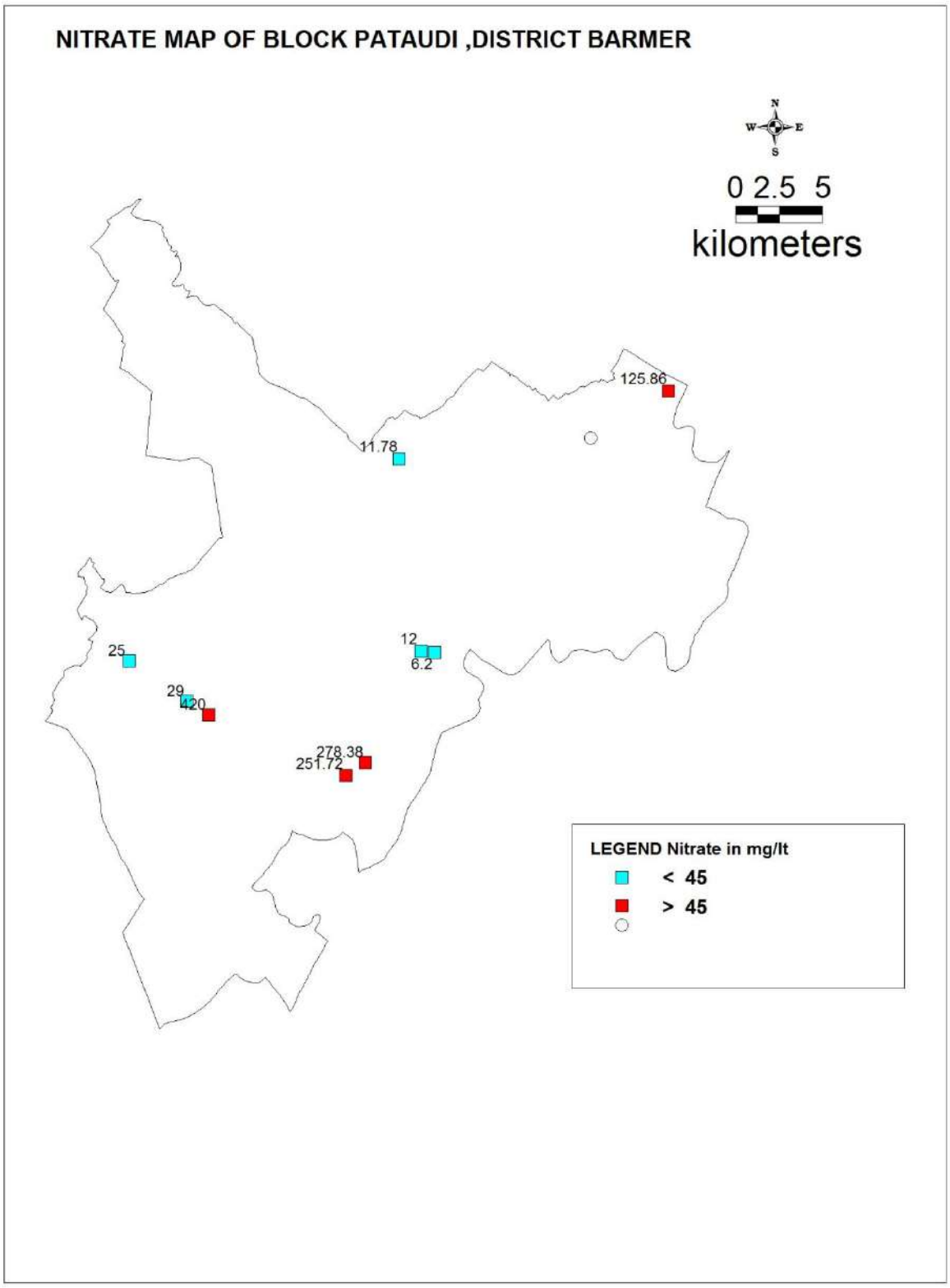
TDS	mg/l	No. of Samples	% of Samples
Fresh	0-3000	5	45.45
Brackish	3000-10000	5	45.45
Saline	> 10000	1	9.09
Brine	>35000	0	0.00
Hardness (mg/l)	Water Class	No. of Samples	% Sample
0 – 75	Soft	0	0.00
75 – 150	Moderately Hard	0	0.00
150 – 300	Hard	1	10.00
>300	Ver Hard	9	90.00
Nitrate	(mg/l)		
	< 45	6	60%
	> 45	4	40%
Fluoride	mg/l		
	1-1.5	3	23.077
	>1.5	10	76.92

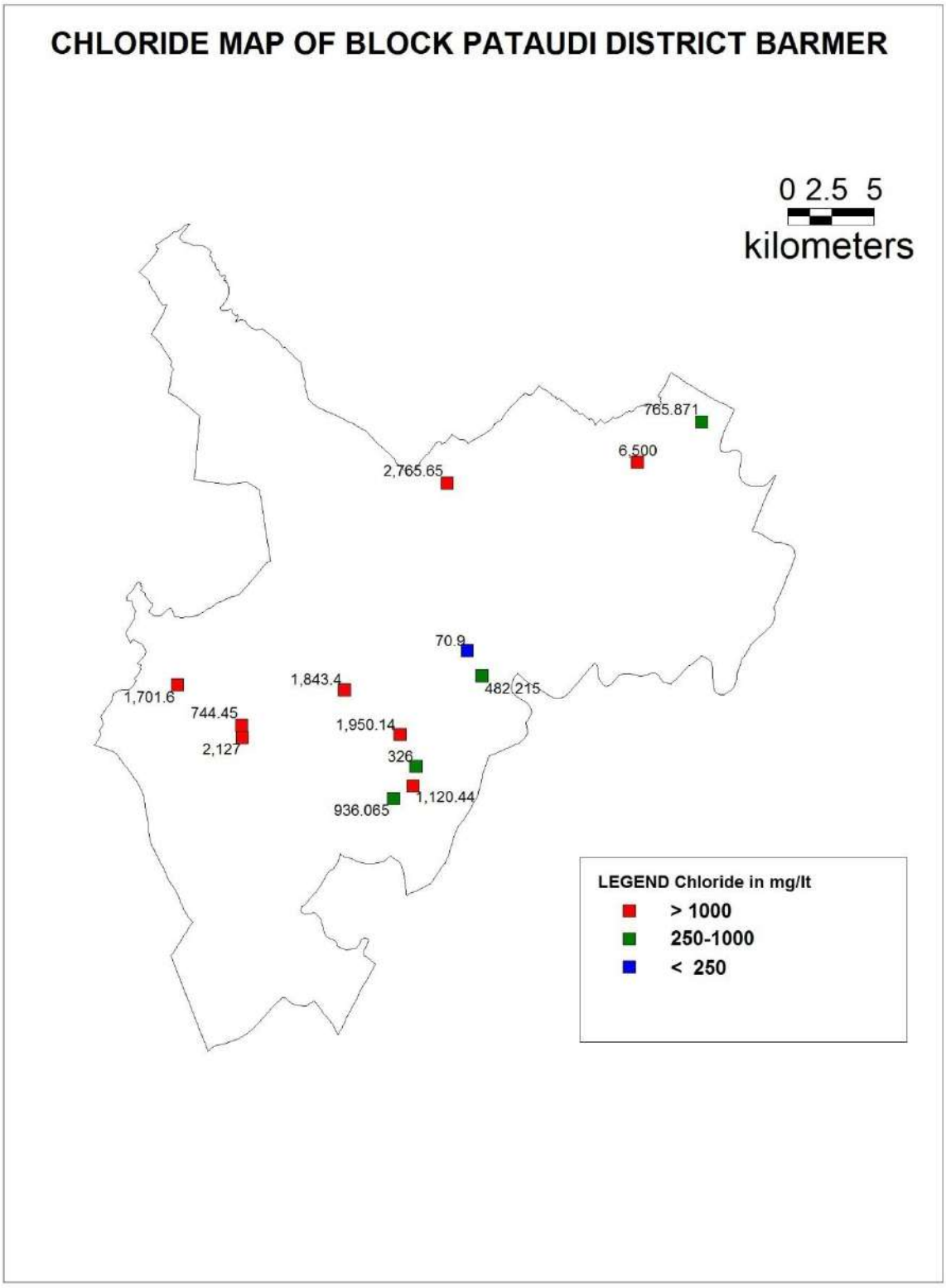
EC MAP MAP OF BLOCK PATODI ,DISTRICT BARMER



FLUORIDE MAP OF BLOCK PATAUDI DISTRICT BARMER




NITRATE MAP OF BLOCK PATAUDI ,DISTRICT BARMER
N
W
E
S
0 2.5 5
kilometers
125.86
11.78
12
6.2
25
29
420
278.38
251.72
LEGEND Nitrate in mg/lt
< 45
> 45


CHLORIDE MAP OF BLOCK PATAUDI DISTRICT BARMER
0 2.5 5
kilometers
765.871
6.500
2,765.65
70.9
1,843.4
482.215
1,701.6
744.45
1,950.14
2,127
326
1,120.44
936.065
LEGEND Chloride in mg/lt
> 1000
250-1000
< 250

Suitability for Irrigation

EC

Type of Water	Classification	% Samples
Low Saline< 250 mg/l	Excellent	0
Medium Saline 250 – 750 mg/l	Good	7.692308
Highly Saline 750 – 2250 mg/l	Permissible	7.692308
Very Highly saline> 2250 mg/l	Doubtful	84.61538

Na%

Water Class	Range	% Samples
Excellent	< 20	
Good	20 - 40	
Medium	40 - 60	
Bad	60 - 80	
Very Bad	> 80	

GROUND WATER ISSUES

1. Salinity		High EC and declining water level trend
1. Inland Salinity	area in sq.km	481.62
2. Ground Water Resource=Net availability - Draft		-2.787
2. Rainfall and Drought		Mild Droughts in 30% years Normal Droughts in 20% years Severe Drought in 7.00% years
3. Decadal Water Level Trend (2009-2019)		Declining (-1.86)

GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)

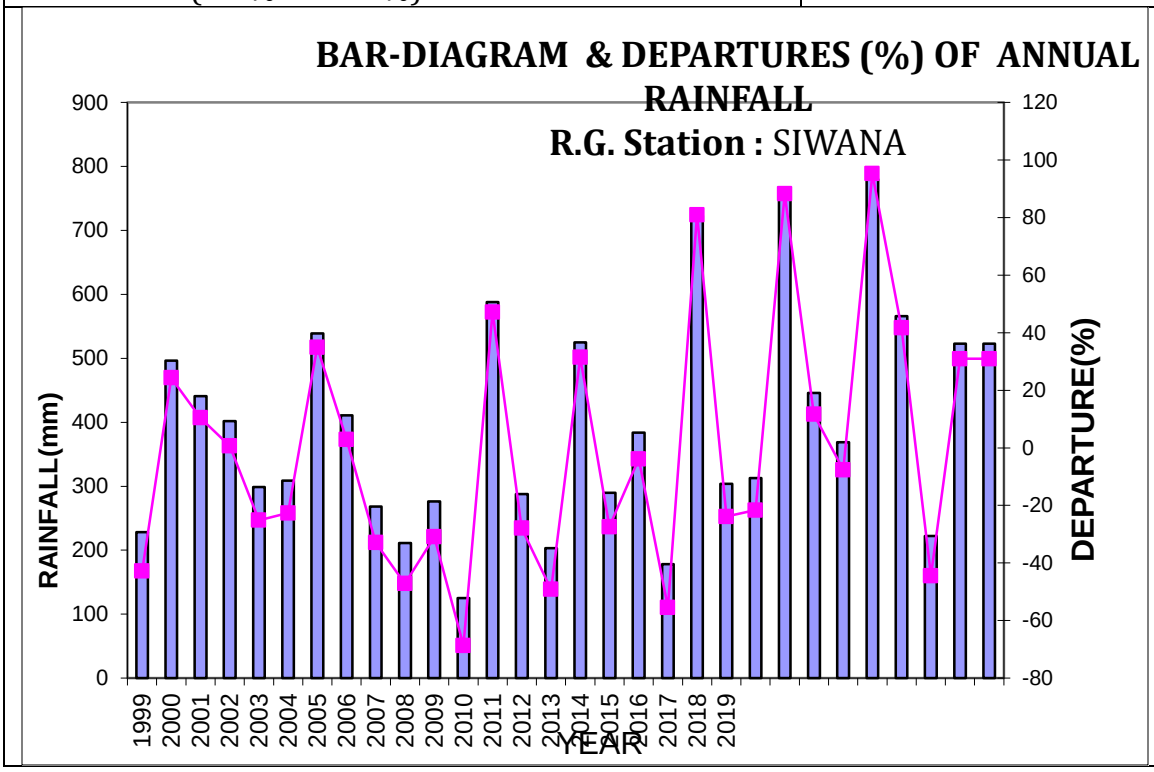
Total Annual Ground Water Recharge (MCM)	8.0282
Natural Discharge (MCM)	0.8028
Net Annual Ground Water Availability (MCM)	7.2254
Existing Gross Ground Water Draft for All uses(MCM)	10.0124
Provision for domestic and industrial requirement supply to 2025(MCM)	0.4095
Stage of Ground Water Development %	138.57

Category	Over Exploited
In-Storage Resource	
Total Area	35000 ha m
Aquifer	Older Alluvium
Sy	0.06
Aquifer	Granite
Sy	0.015
Aquifer	Younger ALuuvium
Sy	0.1
GROUND WATER RESOURCE ENHANCEMENT	
Artificial Recharge & Water Conservation Structures constructed by State Govt	
Existing Structures constructed by State Govt.	611
Farm Pond / Khet Talai	00
Water Harvesting Structure	01
Tankas	610
SUPPLY SIDE MANAGEMENT	
Water Supply(mcm)	
Agricultural Supply -GW	9.7044
Domestic Supply - GW	0.303
Total Supply	10.0124
Area suitable for Artificial recharge & Water Conservation Structures(sq.km)	
Type of Aquifer	Specific yield
"ALO1"	0.1
"ALO3"	0.06
"GRO2"	0.015
Tanks (Nos) Capacity 50.000 lts	1487
Volume of water to be conserved (mcm)	0.07435
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	99.77
Surplus Surface water Availability (mcm)	0.06
DEMAND SIDE MANAGEMENT:	
DEMAND SIDE MANAGEMENT	
Irrigitation by permitted TW almost already using Micro irrigation techniques like irrigation through Sprinkler. No more scope is feasible	
Cropping Pattern change: The sown crops are already less water consuming crops like Bajra, Mung etc. The change in cropping pattern is not feasible.	
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	7.2254
Additional GW resources available after Supply side interventions (MCM)	0.07435
Net Ground Water Availability after Supply side intervention	7.29975

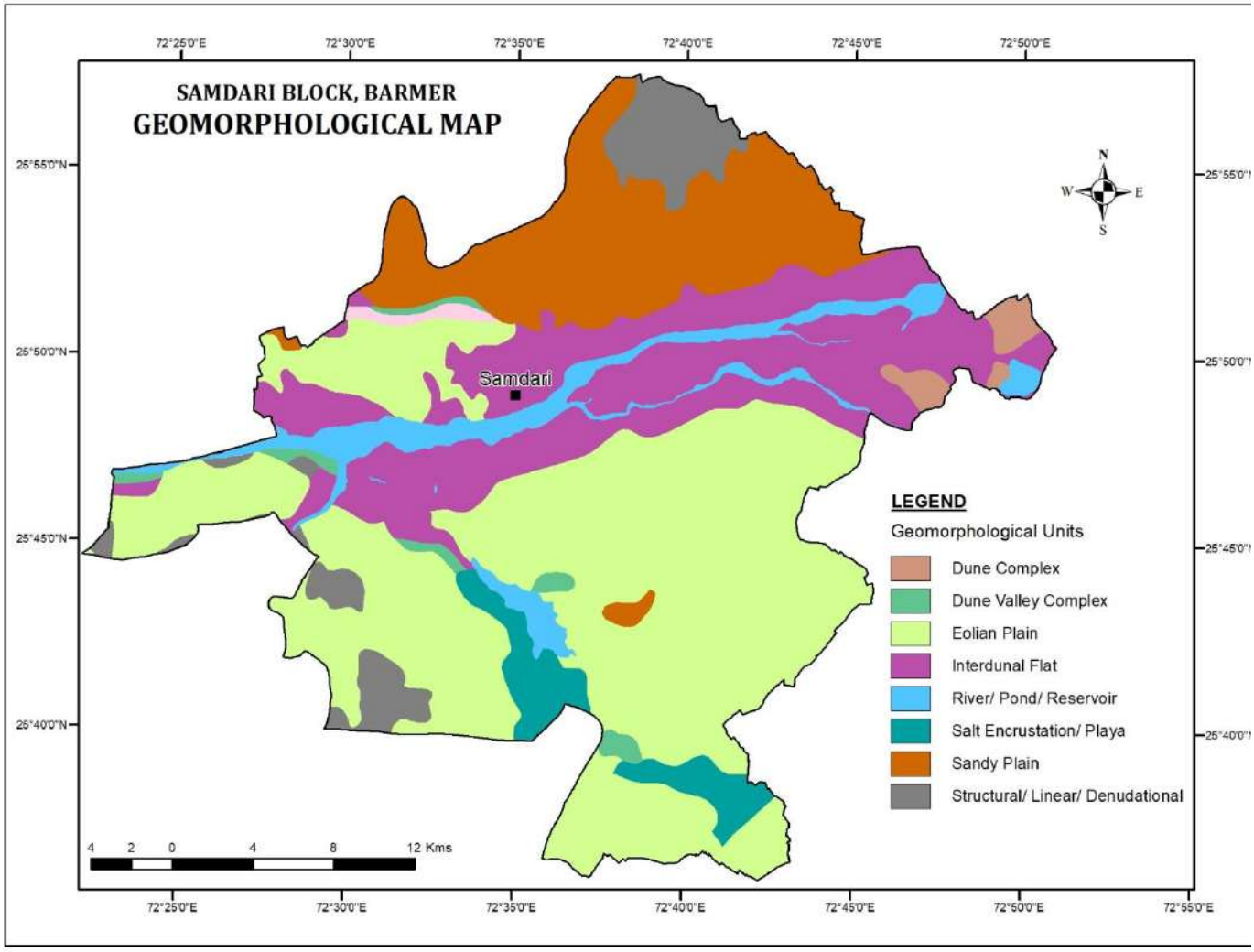
Existing Ground Water Draft for All Purposes (mcm)	10.0124
Existing Ground Water Draft for All Purposes (mcm) after intervention	10.0124
Present stage of Ground Water Development (%)	138.57
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	137.16

SAMDARI BLOCK

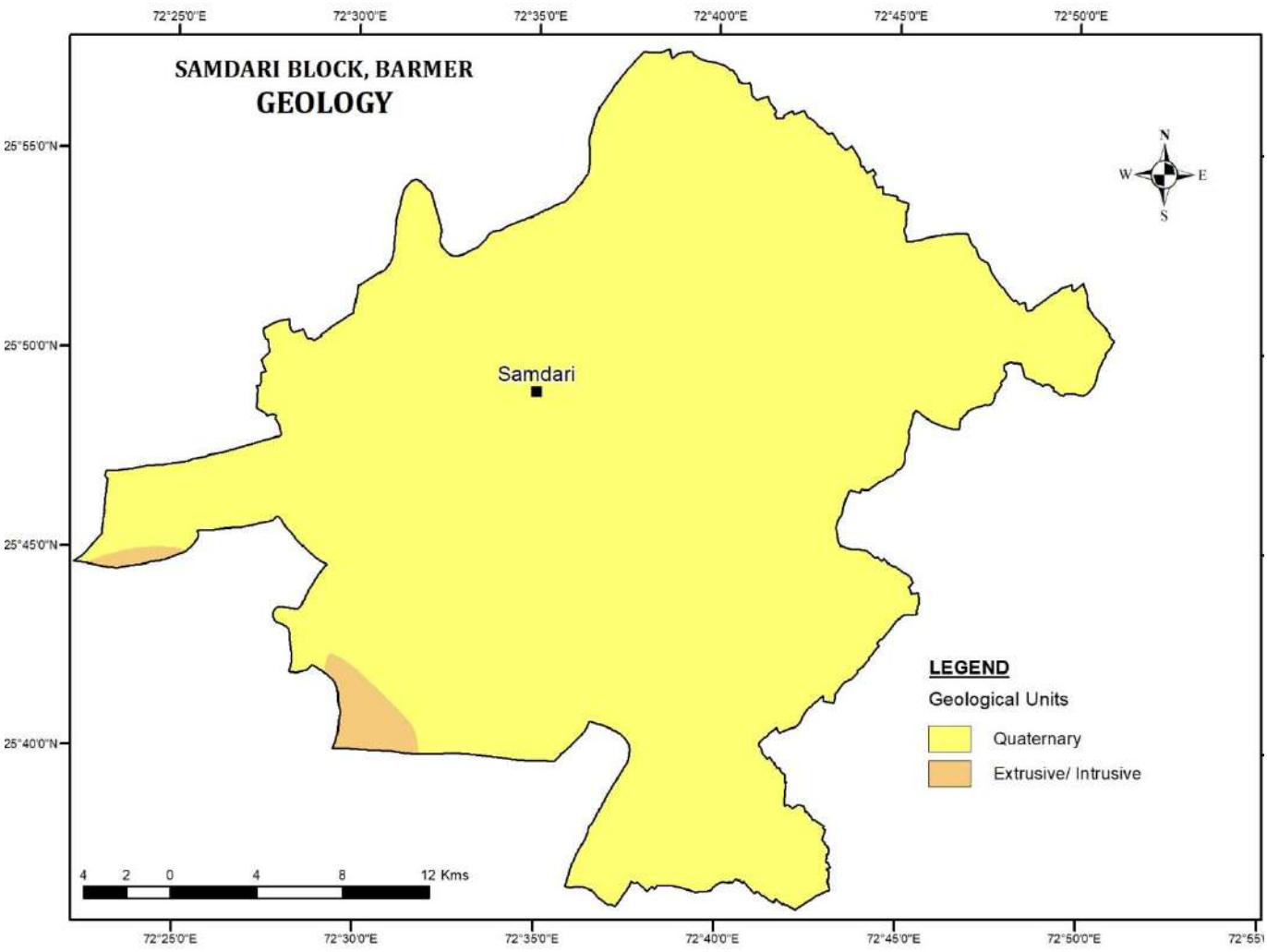
SALIENT INFORMATION	
Block Name	**SAMDARI**
Longitude	72°22'26" to 72°50'49"
Latitude	25°36'0" to 26°57'32"
Geographical Area Sq.km	836.87
Hilly Area (Sq.km)	0
Population (2011)	103180 (Human) 19239 (Cattle)
Climate	
Average Temperature range (°C)	06 to 48
Rainfall Analysis	
Normal Rainfall (mm)	353.9
Mean Annual rainfall (mm) (from Rain Gauge of Siwana)	399.467
Highest annual rainfall with year (mm)	780 (2016)
Lowest annual rainfall (mm) with year	125 (2004)
Standard deviation (mm)	130.7
Coefficient of Variation (%)	39.40
Drought Analysis	
Mild (0 to -25%)	05
Normal (-25% to -50%)	07
Severe (-50% to -75%)	02
Most severe (-75% to -100%)	00



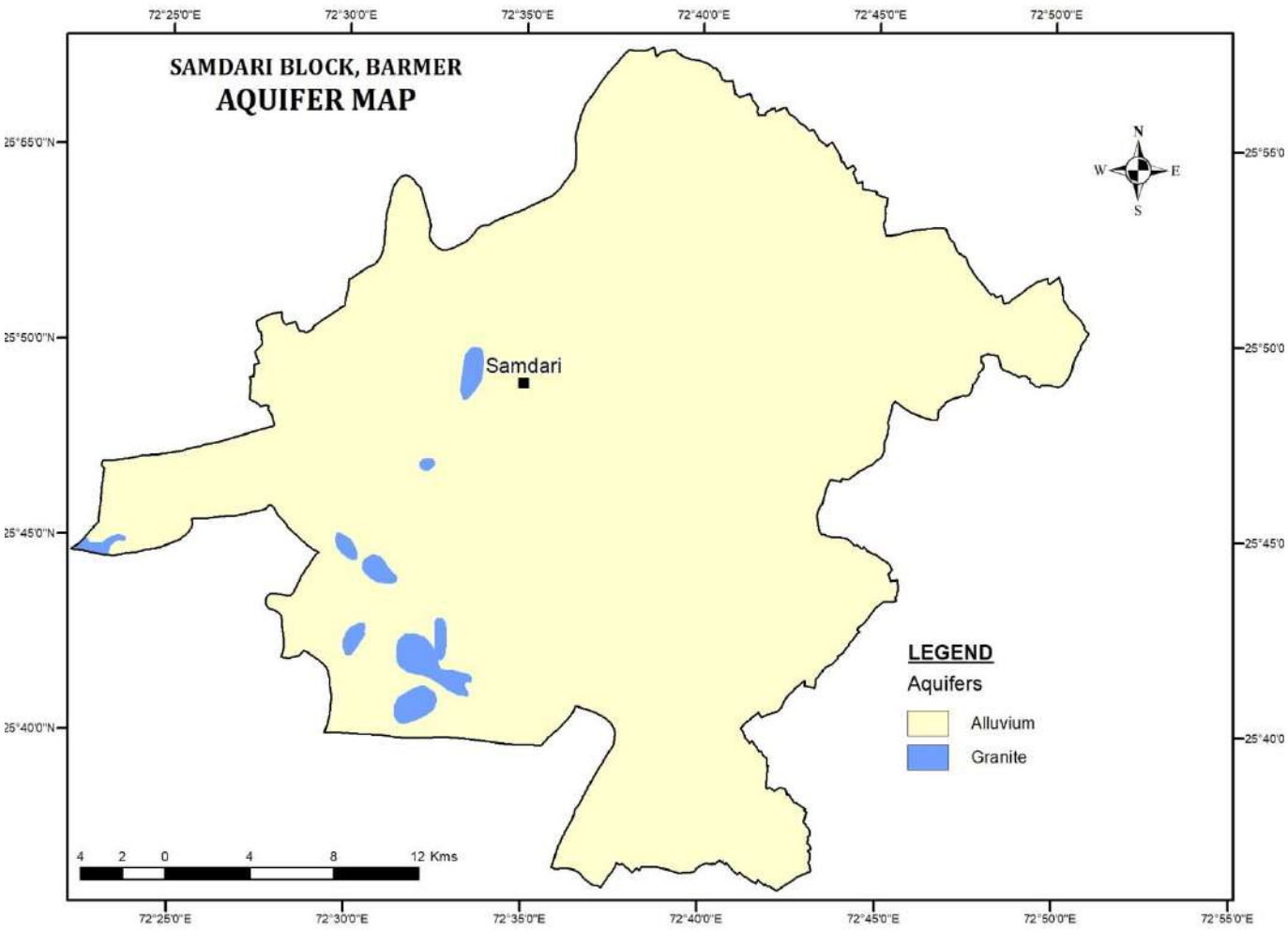
Geomorphology	
Geomorphic Unit	undulating planes, eolian plains,, interdunal flats and few abruptly rising hills of rhyolite and granites



Geology	Older alluvium, younger alluvium and granites

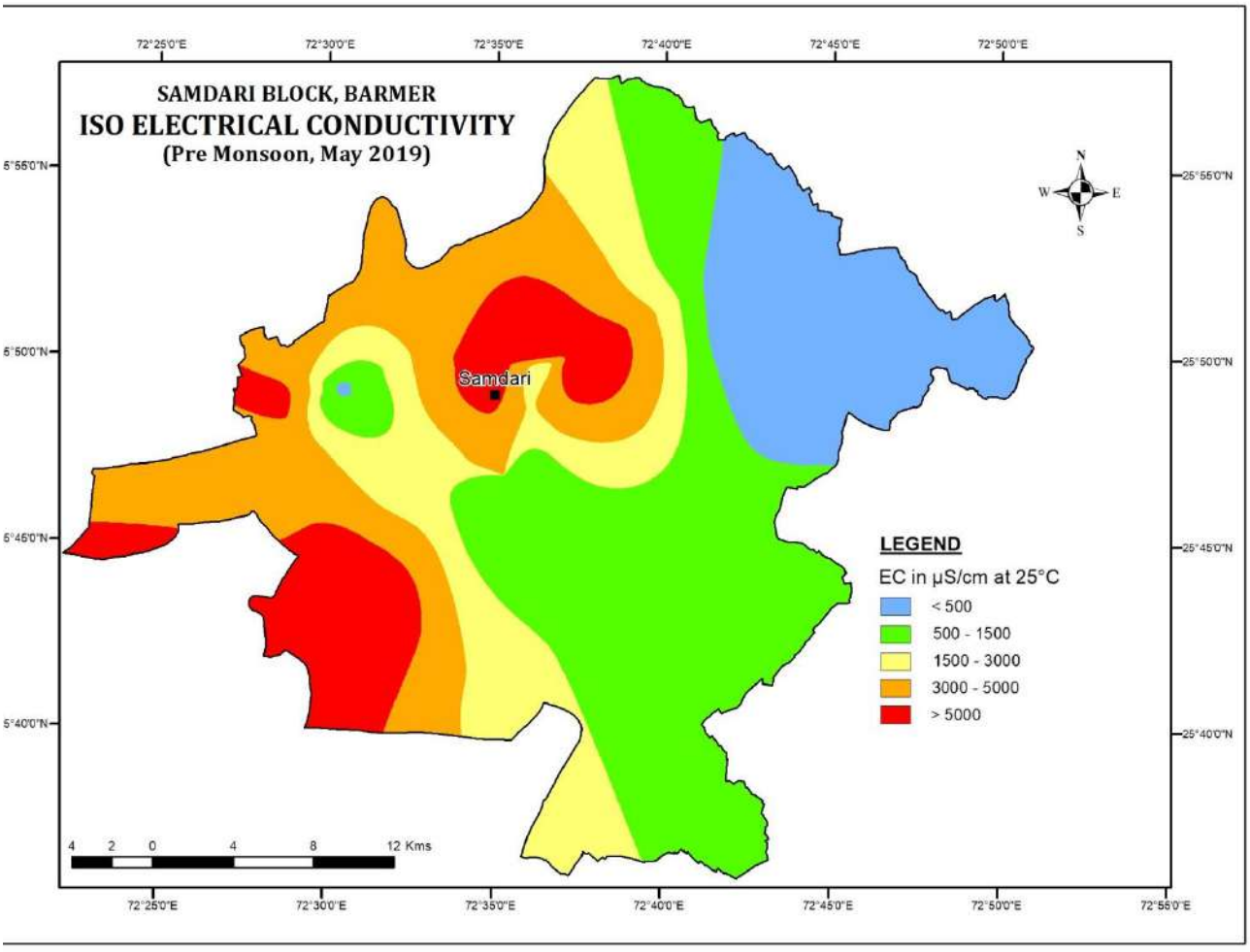


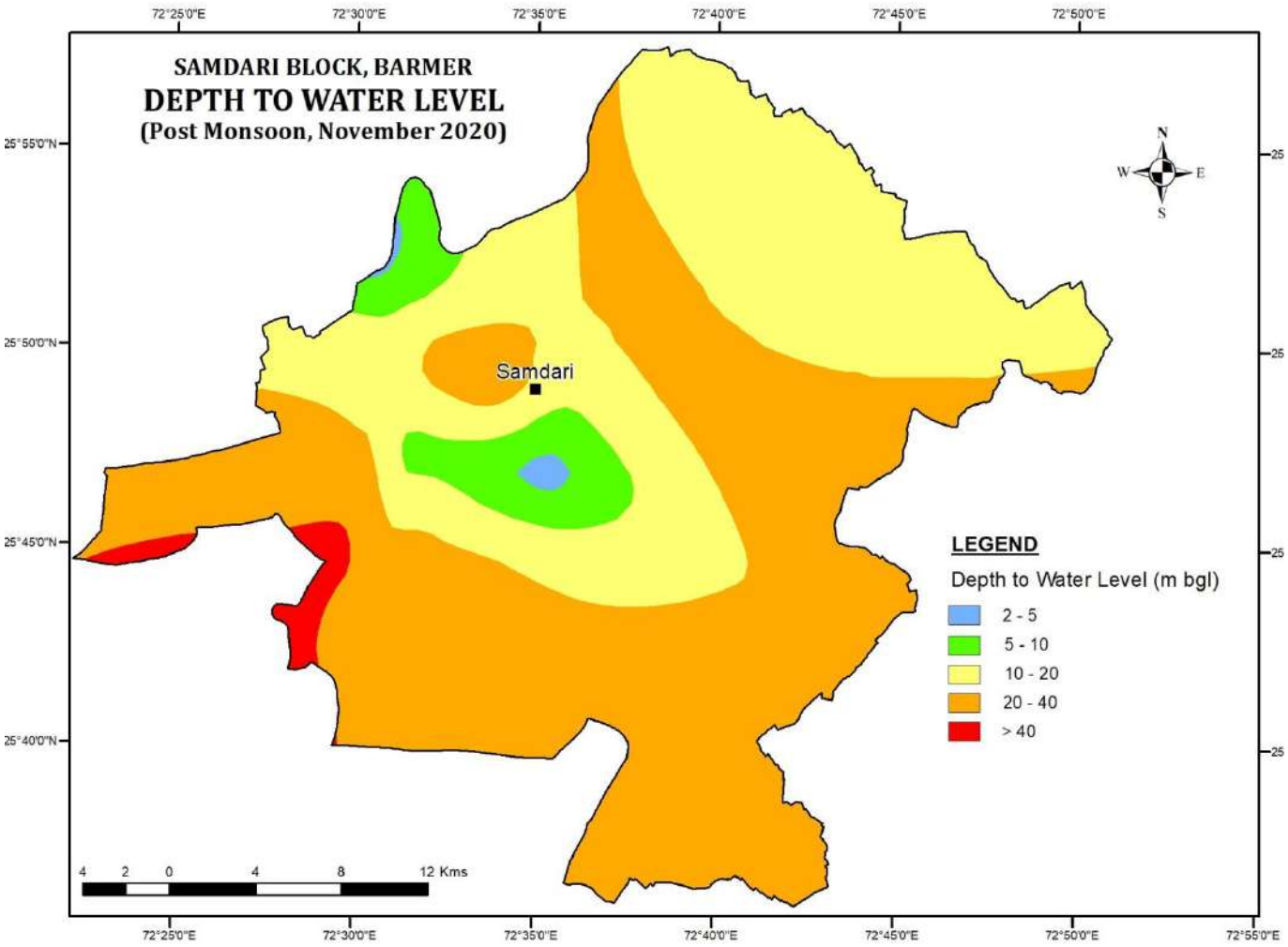
Drainage & Hydrology	
Drainage/Basin/Sub Basin	Luni River flows across the west-east direction of block and few small rivulets joins the Luni river during rainy season. Part of Luni River Basin
Hydrology	Alluvium is major aquifer.



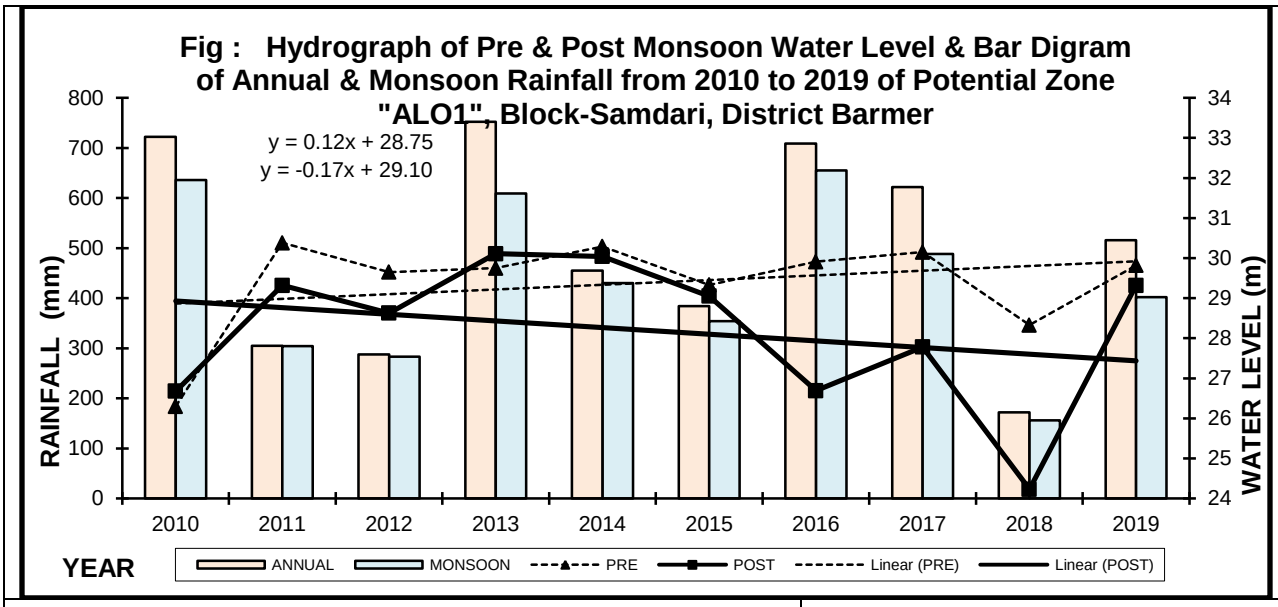
Ponds			
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN			
Geographical Area in ha.		83687	
Forest Area in ha.		825	
Net Sown Area in ha.		46163	
Area sown more than once in ha.		6797	
Rainfed Crop			
Area under Irrigation (Net) in ha			
Rainfed/ Surface Water		37952	
Ground Water		6215	
Other sources		0	
Season wise crop area in ha.			
	Kharif	**Rabi**	**Zaid Rabi**
sown	39269	6797	97

Irrigated	259	5859	97
Principal Crop Area (ha)			
Crop Type			
Cereals	21525		
Oil Seeds	5730		
Pulses	15721		
Masala	3035		
Hydrogeology			
Monitoring Stations			
CGWB	2 (1 EW were monitored once)		
SGWD	10		
NAQUIM Key Wells	3		
WATER LEVEL BEHAVIOUR (of NHS monitoring points, EW and key wells)			
Pre-Monsoon (May-2020) Water level		Post-Monsoon (November-2020)Water level	
4,2 (DW) – 48.03 (Pz)m bgl		3.1 (DW) – 43.7 (Pz) m bgl	

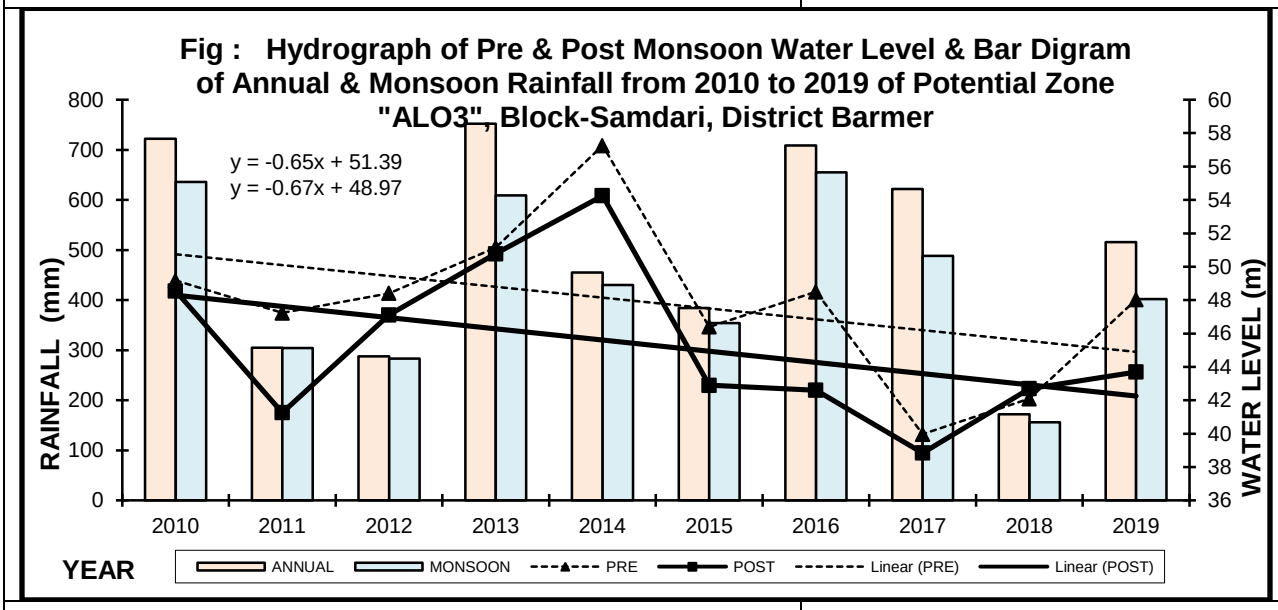




WATER LEVEL BEHAVIOUR (Zone wise)	
Pre-Monsoon (May-2019) Water level (AlO1 Zone)	Post-Monsoon (November-2019)Water level(AlO1 Zone)
26.30 – 30.28 m bgl	24.23 – 30.11 m bgl



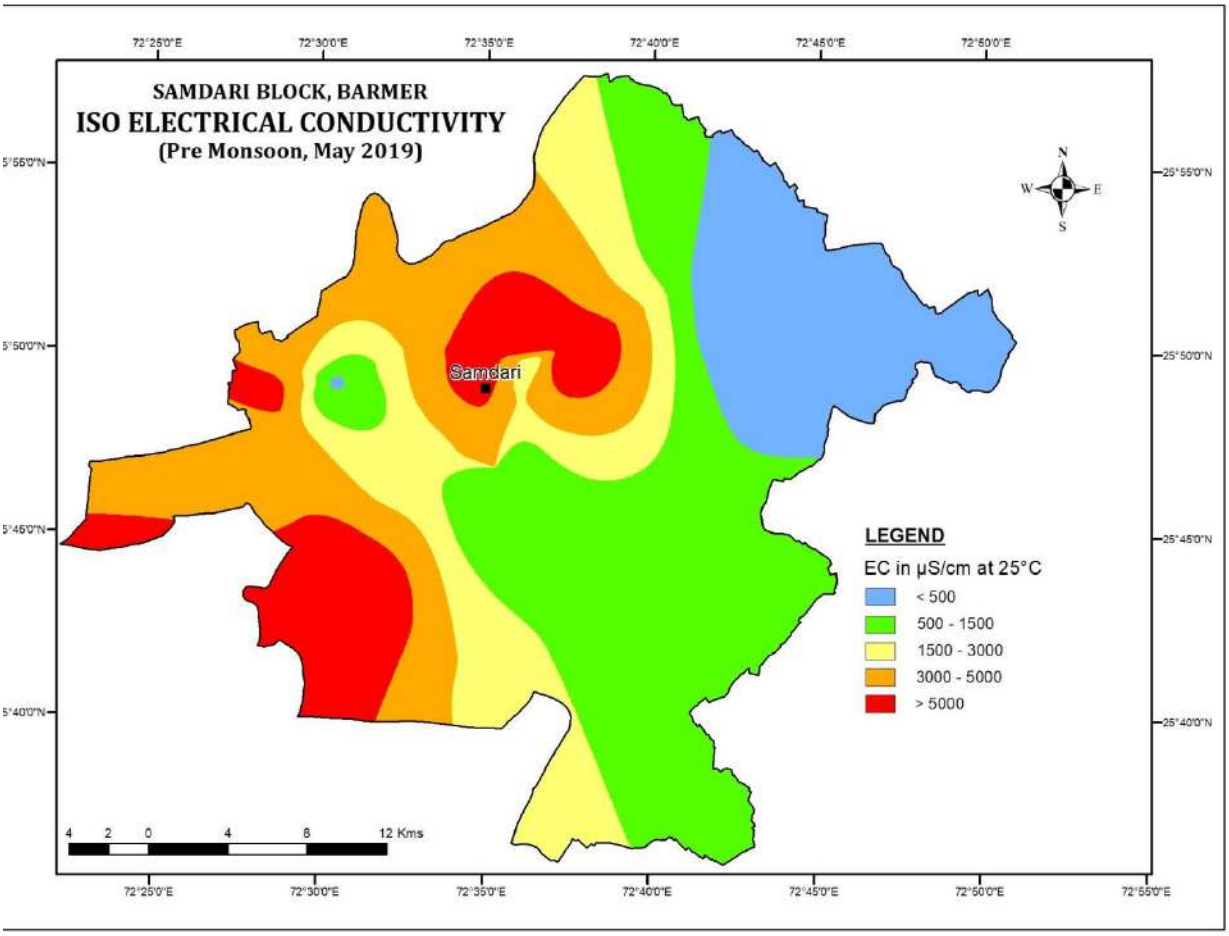
Pre-Monsoon (May-2019) Water level (AlO3 Zone)	Post-Monsoon (November-2019)Water level(AlO3 Zone)
39.97 – 57.26 m bgl	38.85 – 47.12 m bgl

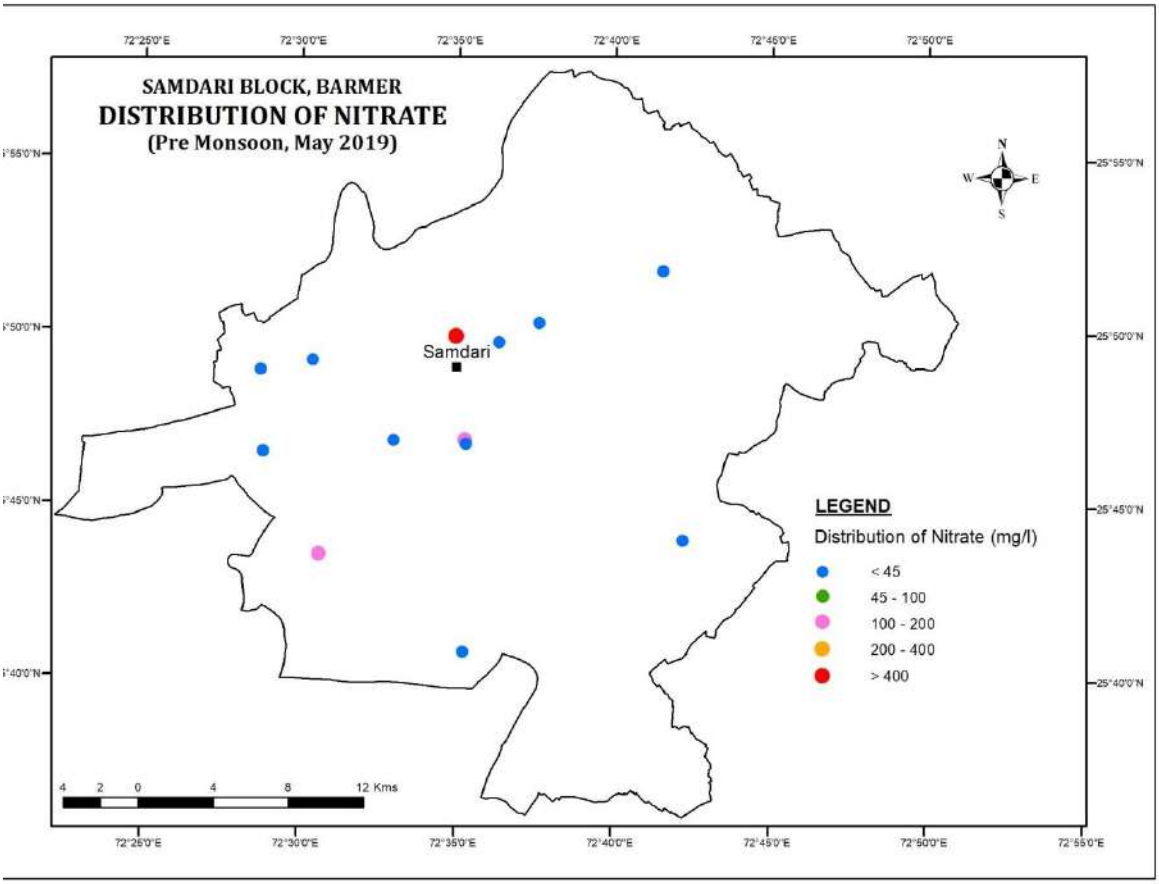


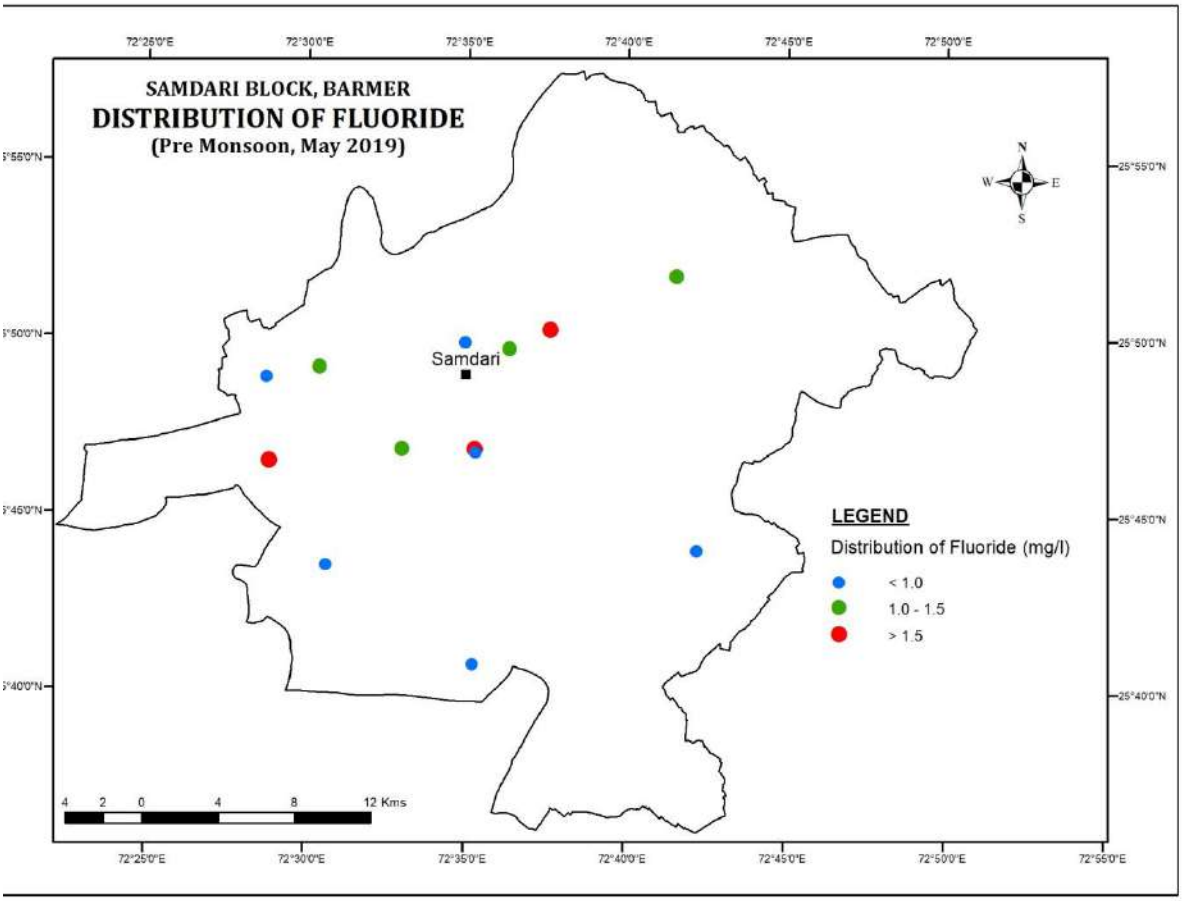
AQUIFER DISPOSITION

Status of GW Exploration	Exploratory Wells-1 Observation Wells-0 Piezometers - 00 Slim hole -00
Aquifer Characteristics	The older Alluvium, and younger alluvium forms the most important aquifer in the block, Specific Yeild value is 0.06 for older alluvium and 0.1 for younger alluvium
GW Quality	EC varies from 350 µS/cm to 7750 µS/cm

CHEMICAL QUALITY OF GROUND WATER			
Suitability for Drinking			
TDS	mg/l	No. of Samples	% of Samples
Fresh	0-3000	10	71.43
Brackish	3000-10000	4	28.57
Saline	> 10000	0	0
Brine	>35000	0	0
Hardness (mg/l)	Water Class	No. of Samples	% Sample
0 – 75	Soft	0	0
75 – 150	Moderately Hard	0	0
150 – 300	Hard	0	0
>300	Ver Hard	13	100
Nitrate	(mg/l)		
	< 45	10	71.42%
	> 45	4	28.57%
Fluoride	mg/l		
	1-1.5	10	71.42%
	>1.5	4	28.57%




SAMDARI BLOCK, BARMER
DISTRIBUTION OF NITRATE
(Pre Monsoon, May 2019)
Samdari
LEGEND
Distribution of Nitrate (mg/l)
< 45
45 - 100
100 - 200
200 - 400
> 400
4 2 0 4 8 12 Kms
N
W
E
S
72°25'0"E
72°30'0"E
72°35'0"E
72°40'0"E
72°45'0"E
72°50'0"E
72°55'0"E
25°55'0"N
25°50'0"N
25°45'0"N
25°40'0"N



Suitability for Irrigation

EC

Type of Water	Classification	% Samples
Low Saline< 250 mg/l	Excellent	0
Medium Saline 250 – 750 mg/l	Good	28.57
Highly Saline 750 – 2250 mg/l	Permissible	7.14
Very Highly saline> 2250 mg/l	Doubtful	64.28

Na%

Water Class	Range	% Samples
Excellent	< 20	
Good	20 - 40	
Medium	40 - 60	
Bad	60 - 80	
Very Bad	> 80	

GROUND WATER ISSUES

1. Salinity		High EC and declining water level trend
1. Inland Salinity	area in sq.km	580.87
2. Ground Water Resource=Net availability - Draft		-5.4038
2. Rainfall and Drought		Mild Droughts in 30% years Normal Droughts in 20% years Severe Drought in 7.00% years
3. Decadal Water Level Trend (2009-2019)		Declining (-0.24)
GROUND WATER RESOURCE & EXTRACTION(GWRE-2017)		
Total Annual Ground Water Recharge (MCM)		13.0982
Natural Discharge (MCM)		1.3098
Net Annual Ground Water Availability (MCM)		11.7884
Existing Gross Ground Water Draft for All uses(MCM)		17.1922
Provision for domestic and industrial requirement supply to 2025(MCM)		4.2585
Stage of Ground Water Development %		145.84
Category		Over Exploited
In-Storage Resource		
Total Area		25600 ha m
Aquifer		Older Alluvium
Sy		0.06
Aquifer		Younger ALuuvium
Sy		0.1
GROUND WATER RESOURCE ENHANCEMENT		
Artificial Recharge & Water Conservation Structures constructed by State Govt		
Existing Structures constructed by State Govt.		244
Farm Pond / Khet Talai		01
Water Harvesting Structure		12
Tankas		231
SUPPLY SIDE MANAGEMENT		
Water Supply(mcm)		
Agricultural Supply -GW		14.0376
Domestic Supply - GW		3.1545
Total Supply		17.1922
Area suitable for Artificial recharge & Water Conservation Structures(sq.km)		

Type of Aquifer	Specific yield
"ALO1"	0.1
"ALO3"	0.06
Tanks (Nos) Capacity 50.000 lts	1972
Volume of water to be conserved (mcm)	0.0986
Volume of Sub surface Storage Space available for Artificial Recharge (mcm)	142.46
Surplus Surface water Availability (mcm)	0.62
DEMAND SIDE MANAGEMENT:	
DEMAND SIDE MANAGEMENT	
Irrigitation by permitted TW almost already using Micro irrigation techniques like irrigation through Sprinkler. No more scope is feasible	
Cropping Pattern change: The sown crops are already less water consuming crops like Bajra, Mung etc. The change in cropping pattern is not feasible.	
EXPECTED BENEFITS	
Net Ground Water Availability (mcm) 2017	11.7884
Additional GW resources available after Supply side interventions (MCM)	0.0986
Net Ground Water Availability after Supply side intervention	11.887
Existing Ground Water Draft for All Purposes (mcm)	17.1922
Existing Ground Water Draft for All Purposes (mcm) after intervention	17.1922
Present stage of Ground Water Development (%)	145.84
Projected Stage of Ground Water Development after Supply Side and demand side interventions (%)	144.63

Sindhri

General Information

Geographical area	1629.84 sq km
Basin/Sub basin	Luni Basin
Principal Aquifer system	Younger and Older Alluvium (Principle) , Rhyolite
Major Aquifer System	Younger and Older Alluvium (Principle)
Normal Annual Rainfall	303.6 mm
Latitude	25.3175 to 25.8122
Longitude	71.6359 to 71.1769
Geology	• Alluvium (sand/ silt and clay alternating beds). Age: Recent to Sub-recent • Rhyolites
Images / Photo	• Geology Map • Geomorphology Map • Physiography Map

Aquifer Disposition

Aquifer Disposition	The major aquifers of the district are younger and older Alluvium and Rhyolite
Status of GW Exploration	Exploratory Wells-6 Observation Wells-1 Piezometers - 03 Slim hole -00
Aquifer Characteristics	The Alluvium (Older and younger) forms the most important aquifer in the block, Specific Yeild value in the range of 0.10 to 0.06. (The data is annexed as Annexure)
CGWB Monitoring Status	04 NHS Wells (01 DW; 03 Pz)
Key Well Monitoring Status	08 points Wells (07 DW; 01 Tw)
Ground water level	9.4 m bgl to 40.8 m bgl (Pre monsoon) 10.2 m bgl to 41.5 m bgl
GW Quality	AS per the analysis of ground water sample collected from key wells the pH varies from 7.72 to 8.46; EC varies from 3400 to 11130 µS/cm at 25°C; Chloride varies from 709 to 3323.3 mg/l; Nitrate from 0 to 2010 mg/l and Fluoride from 1.7 to 10.8 mg/l.
Aquifer Potential	06 EW constructed.
Images1	Aquifer Potential Map of Sindhari
Images2	Key well and NHS point map of Sindhari Block
Image 3	EC Map of Sindhari block

Option Image	Nitrate Map of Sindhari block

Management Plan

GW Management Issues	• Over exploitation and Decline in water levels. • EC varies from 3400 to 11130 µS/cm at 25°C • Area is devoid of sustainable fresh surface water bodies.
Ground Water Resources	
Ground Water Recharge Worthy Area (Sq. Km.)	701.09 sq km
Total Annual Ground Water Recharge (MCM)	30.0104
Natural Discharge (MCM)	3.001
Net Annual Ground Water Availability (MCM)	27.0094
Existing Gross Ground Water Draft for All uses(MCM)	26.8743
Provision for domestic and industrial requirement supply to 2025(MCM)	5.2469
Stage of Ground Water Development %	99.08
Category	Critical
Static Ground Water resources	Al01- 28.424 mcm Al03- 41.685 mcm
	Under MJSA Scheme, 01 Farm Pond and 955 tankas have been constructed in the Sindhari block of Barmer district
GW Management Plan	Supply Side Management – Artificial Recharge • No surplus water is available for artificial Recharge • No supply side interventions proposed • Construction of 2601 Tanka (Nos.) (Capacity 50,000 liters). • Total rain water conserved through proposed tankas: 0.13005 mcm Demand Side Management – Use of Sprinklers

	<table><tr><td>Block</td><td>Irrigated Area by ground water (ha)</td><td>Irrigated Area (ha) proposed for irrigation through sprinkler</td><td>Water Saving by sprinkler in MCM (@0.08 m)</td></tr><tr><td>Jaisalmer</td><td></td><td></td><td></td></tr></table> Demand Side Management – Change in cropping Pattern <table><tr><td>Block</td><td>Irrigated Area of wheat (ha)</td><td>Irrigated Area (ha) under wheat proposed for Gram cultivation</td><td>Water Saving by change in cropping pattern in MCM (@0.1 m saving)</td></tr><tr><td>Sindhari</td><td></td><td></td><td></td></tr></table>
AR & Conservation Possibilities	Ground water resources should be augmented by means of artificial recharge through various techniques feasible in alluvial terrains. In alluvial area recharge techniques like Roof top/paved area rainwater harvesting for recharge to ground water in urban areas and construction of House hold tankas. Due to quality issues, emphasis on conservation structures will be given and no recharge can be given.

Summary of expected benefits of Management Plan

Block	Net G.W. Availability (MCM)	Additional Recharge from RWH & conservation (MCM)	Total Net G.W. Availability after intervention (MCM)	Existing G.W Draft for all purpose (MCM)	Saving of Ground water through demand side intervention (MCM)	Net GW draft after interventions (MCM)	Present stage of G.W. development (%)	Projected stage of G.W. Dev. (%)
Sindhari	27.0094	13.05	40.0594	26.8743			99.05	

Management Options:

Supply Side Management

- Low rainfall and no surplus runoff available and thus no recharge possible.
- Rain water can be used for conservation through household tankas

Demand Side Management

- Water saving -------- /yr possible through use of sprinklers.
- Already water deficit crops are sown so crop diversification or change in crop pattern cannot be used in the area

Other Options

- Huge brackish/saline ground water resources available
- Can be used after desalinisation

State	Rajasthan
District	Barmer
Block	Sindhari

General Information

Geographical area	1629.84 sq km
Basin/Sub basin	Luni Basin
Principal Aquifer system	Younger and Older Alluvium (Principle) , Rhyolite
Major Aquifer System	Younger and Older Alluvium (Principle)
Normal Annual Rainfall	303.6 mm
Latitude	25.3175 to 25.8122
Longitude	71.6359 to 71.1769
Geology	• Alluvium (sand/ silt and clay alternating beds). Age: Recent to Sub-recent • Rhyolites
Images / Photo	• Geology Map • Geomorphology Map • Physiography Map

Aquifer Disposition

Aquifer Disposition	The major aquifers of the district are younger and older Alluvium and Rhyolite
Status of GW Exploration	Exploratory Wells-6 Observation Wells-1 Piezometers - 00 Slim hole -00
Aquifer Characteristics	The Alluvium (Older and younger) forms the most important aquifer in the block, Specific Yeild value in the range of 0.10 to 0.06. (The data is annexed as Annexure)
CGWB Monitoring Status	04 NHS Wells (01 DW; 03 Pz)
Key Well Monitoring Status	08 points Wells (07 DW; 01 Tw)
Ground water level	9.4 m bgl to 40.8 m bgl (Pre monsoon) 10.2 m bgl to 41.5 m bgl
GW Quality	AS per the analysis of ground water sample collected from key wells the pH varies from 7.72 to 8.46; EC varies from 3400 to 11130 µS/cm at 25°C; Chloride varies from 709 to 3323.3 mg/l; Nitrate from 0 to 2010 mg/l and Fluoride from 1.7 to 10.8 mg/l.
Aquifer Potential	06 EW constructed.

Images1	Aquifer Potential Map of Sindhari
Images2	Key well and NHS point map of Sindhari Block
Image 3	EC Map of Sindhari block
Option Image	Nitrate Map of Sindhari block

Management Plan

GW Management Issues	• Over exploitation and Decline in water levels. • EC varies from 3400 to 11130 µS/cm at 25°C • Area is devoid of sustainable fresh surface water bodies.
Ground Water Resources	
Ground Water Recharge Worthy Area (Sq. Km.)	701.09 sq km
Total Annual Ground Water Recharge (MCM)	30.0104
Natural Discharge (MCM)	3.001
Net Annual Ground Water Availability (MCM)	27.0094
Existing Gross Ground Water Draft for All uses(MCM)	26.8743
Provision for domestic and industrial requirement supply to 2025(MCM)	5.2469
Stage of Ground Water Development %	99.08
Category	Critical
Static Ground Water resources	Al01- 28.424 mcm Al03- 41.685 mcm
	Under MJSA Scheme, 01 Farm Pond and 955 tankas have been constructed in the Sindhari block of Barmer district
GW Management Plan	Supply Side Management – Artificial Recharge • No surplus water is available for artificial Recharge • No supply side interventions proposed • Construction of 2601 Tanka (Nos.) (Capacity 50,000 liters). • Total rain water conserved through proposed tankas: 13.05 mcm

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<td>Demand Side Management – Use of Sprinklers
<table>
<tr><th>Block</th><th>Irrigated Area by ground water (ha)</th><th>Irrigated Area (ha) proposed for irrigation through sprinkler</th><th>Water Saving by sprinkler in MCM (@0.08 m)</th></tr>
<tr><td>Jaisalmer</td><td></td><td></td><td></td></tr>
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Demand Side Management – Change in cropping Pattern
<table>
<tr><th>Block</th><th>Irrigated Area of wheat (ha)</th><th>Irrigated Area (ha) under wheat proposed for Gram cultivation</th><th>Water Saving by change in cropping pattern in MCM (@0.1 m saving)</th></tr>
<tr><td>Sindhari</td><td></td><td></td><td></td></tr>
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<td>AR & Conservation Possibilities</td>
<td>Ground water resources should be augmented by means of artificial recharge through various techniques feasible in alluvial terrains. In alluvial area recharge techniques like Roof top/paved area rainwater harvesting for recharge to ground water in urban areas and construction of House hold tankas. Due to quality issues, emphasis on conservation structures will be given and no recharge can be given.</td>
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</table>

Summary of expected benefits of Management Plan

Block	Net G.W. Availability (MCM)	Additional Recharge from RWH & conservation (MCM)	Total Net G.W. Availability after intervention (MCM)	Existing G.W Draft for all purpose (MCM)	Saving of Ground water through demand side intervention (MCM)	Net GW draft after interventions (MCM)	Present stage of G.W. development (%)	Projected stage of G.W. Dev. (%)
Sindhari	27.0094	13.05	40.0594	26.8743			99.05	

Management Options:

Supply Side Management

- Low rainfall and no surplus runoff available and thus no recharge possible.
- Rain water can be used for conservation through household tankas

Demand Side Management

- Water saving -------- /yr possible through use of sprinklers.
- Already water deficit crops are sown so crop diversification or change in crop pattern cannot be used in the area

Other Options

- Huge brackish/saline ground water resources available
- Can be used after desalinisation