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

SIROHI DISTRICT
RAJASTHAN

पश्चिमी क्षेत्र, जयपुर

Western Region, Jaipur

Central Ground Water Board
Ministry of Jal Shakti,
Department of Water Resources,
River Development and Ganga Rejuvenation,
Government of India

Report on

AQUIFER MAPPING AND GROUND WATER MANAGEMENT PLAN

SIROHI DISTRICT, RAJASTHAN

(5136.0 sq.km)

Submitted By:
Rajeev Saxena
Scientist D

Kailash
(Young Professional)

Under The Supervision of:

Shri Vipin Kumar Malik
Scientist B

पश्चिमी क्षेत्र, जयपुर
Western Region, Jaipur

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District at a Glance

SALIENT INFORMATION	
District Name	Sirohi
Longitude	72°16’ and 73°10’ East
Latitude	24°20’ and 25°17’ North
Geographical Area sq.km	5136.00
Hilly Area (sq.km)	803.10
Population (2011)	1036346
Climate	
Average Temperature range (°C)	Maximum: 18 to 45
	Minimum : 10 to 20
Rainfall Analysis (as on 2021)	
Normal Rainfall (mm)	646.086
Mean Annual rainfall (mm)	571.42
Highest annual rainfall (mm)	1294.7
Lowest annual rainfall (mm)	407.4
Geomorphology	Alluvial Plain of Luni, West Banas, Jawai, Bandi, Sukri, Sagi, Khari Rivers their valley fills, Aeolian sediments, Pediments (normal and Burried), Structural and Denudational Hills
Elevation (m amsl)	184 - 1689
Geology	• Alluvium (sand/ silt and clay alternating beds). Age: Recent to Sub-recent
	• Malani Igneous Suite i.e. Granitic rocks Age: Upper Proterozoic
	• Metamorphic formation of Delhi Supergroup i.e. Schist, Phyllite, Gneiss Age: Lower to Middle Proterozoic
Drainage & Hydrology	
Drainage Basin/Sub-Basin	Luni, West Banas and Sukli
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN	
Total Geographical Area in ha.	517947
Forest Area in ha.	155726
Net Sown Area in ha.	164976
Area sown more than once in ha.	59869
Rain-fed Crop	Pearl millet-Mustard, Fallow-Mustard/ Gram, Pearl millet-gram Black gram/ Cowpea / Cluster-bean - Mustard/ Gram
Irrigated Crop	Pearl millet-Mustard/ Wheat / Barley / Gram, Sesame - Mustard/ Wheat
Area under Irrigation (Net) in ha	

Surface Water		1489	
Ground Water		111640	
Other sources		00	
Season wise crop area in ha.			
	Kharif	Rabi	Zaid Rabi
Sown	161726	69418	8557
Irrigated	42102	62476	8551
Principal Crops			
Crop Type	Cereals	76510	
Oil Seeds		90091	
Pulses		13600	
Spices		9403	
Hydrogeology			
Monitoring Stations (May 2021)			
CGWB		15	
SGWD		281	
WATER LEVEL BEHAVIOUR		Pre-Monsoon (May-2021)	Post-Monsoon (November-2021)
Water Level (m bgl)		3.33 – 26.4	3.13 – 16.65
AQUIFER DISPOSITION			
Number of Aquifers (Major)		One	
Number of Zones		Two	
I		Alluvium/Weathered (23-36 mbgl)	
II		Fractured (	
Status of GW Exploration		CGWB	GWD
		19	123
CHEMICAL QUALITY OF GROUND WATER			
Electrical ConductivityµS/cm at 25°C		580 - 5670	
pH		7.21 – 8.45	
Suitability for Drinking			

TDS	**Range**	**% samples**
Fresh	0-3000	80 %
Brackish	>-3000	20 %
Hardness	**Range**	**% samples**
Soft	0 – 75	0
Moderately Hard	75 – 150	20
Hard	150 – 300	20
Very Hard	>300	60

NO_3 in mg/l>45 mg/l	Permissible Limit	50%
F in mg/l – 1 to 1.5 mg/l	Between DL & PL	20 %
>1.5 mg/l	> Permissible Limit	20 %

Suitability for Irrigation

EC			**RSC (meq/l)**	
Type of Water	Classification	% samples	Range	% samples
			< 1.25	90.0%
Low Saline< 250 mg/l	Excellent	0%	1.25 - 2.0	0%
Medium Saline 250–750 mg/l	Good	10%	2.0 - 2.5	0%
Highly Saline 750 –2250 mg/l	Permissible	60%	2.5 - 3.0	0 %
Very Highly saline>2250 mg/l	Doubtful	10%	> 3.0	10.0 %

Na%			**SAR**		
Water Class	Range	% samples	Water Class	Range	% samples
Excellent	< 20	0 %	Excellent	<10	70.0%
Good	20 - 40	10.0%	Good	10 to 18	30%
Medium	40 - 60	40.0%	Medium	18 to 26	0 %
Bad	60 - 80	40.0%	Bad	>26	0%
Very Bad	> 80	10.0%			

GROUND WATER ISSUES	
1. Quality Deterioration	In >40% villages & habitats have Fluoride more than permissible limit(>1.5 mg/l)
2. Over-Exploitation – Resource Availability	At present the Ground water Draft is more than Annual Availability .

GROUND WATER RESOURCE & EXTRACTION	
Ground Water Recharge Worthy Area (in Ha)	407570
Total Annual Ground Water Recharge (mcm)	274.48
Natural Discharge (mcm)	27.45
Net Annual Ground Water Availability (mcm)	247.03
Existing Gross Ground Water Draft for All uses(mcm)	315.45
Stage of Ground Water Development %	127.70
Category	Over Exploited

SUPPLY SIDE MANAGEMENT	
Water Supply (mcm)	
Surplus Surface water Availability (mcm)	20.89
Catchment Area Treatment	
Area proposed for catchment area treatment in ha	6327
Water conserved in catchment area treatment (mcm)	14.79
Water Conservation Structures	

Proposed No. of Structures	8070
Mini Percolation Tanks	5164
Percolation Tank	1585
Pacca Check Dams	790
Anicut	531
Volume of Water expected to be conserved (mcm)	14.79
DEMAND SIDE MANAGEMENT	
Micro irrigation techniques	
Use of Sprinklers for Irrigation	
Irrigation Area (ha) proposed for irrigation through Sprinkler	27656.70
Water Saving by use of Sprinklers (mcm)	22.12
Cropping Pattern change	
Cropping Area (ha) proposed for change in crop	11455.12
Water Saving by Change in Cropping Pattern (mcm)	11.45

Report on National Aquifer Mapping and Management
Sirohi District, Rajasthan (5136.0 sq.km)

1.0 Introduction

1.1 Objectives

Various developmental activities over the years have adversely affected the groundwater regime in the state. There is a need for scientific planning in development of groundwater under different 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

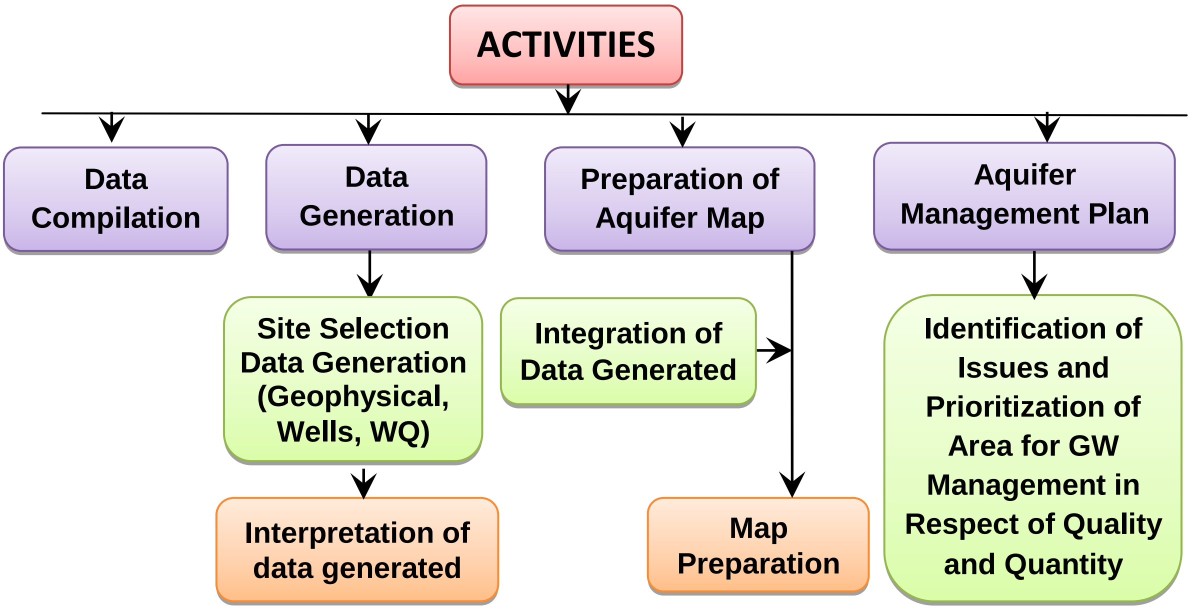
Aquifer mapping can be understood as a scientific process wherein a combination of geological, geophysical, hydrological & chemical fields and laboratory analyses are applied to characterize the quantity, quality, and sustainability of ground water in aquifers. Aquifer mapping is expected to improve our understanding of the geological framework of aquifer, their hydrologic characteristics, and 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.

Methodology

Various activities of NAQUIM are as follows:



1.4 Study Area

The Sirohi District is located in the south-western part of Rajasthan State at a distance of about 180 Kms to south of Jodhpur, the sun city of the state and covers total area of 5136 SqKm. It lies between latitudes north 24°20' and 25°17' and longitudes east 72°16' and 73°10' falls under Survey of India's toposheets no. 45C/16, 45D/9, 45D/13, 45D/10 and 45D/14. It is bounded in the NE by Pali district, in the SE by Udaipur district, in the NW by Jalore district, in the S and SW by Gujarat State.

Administratively, the district is divided into 3 sub-divisions namely Sirohi, Reodar, Mt. Abu, 5 tehsils and 5 development blocks viz. Sirohi, Pindwara, Reodar, Abu Road and Sheoganj. District has 477 villages, 9 towns.

As per census 2011, it is the third least populous district of Rajasthan after Jaisalmer and Pratapgarh. Total population of the district is 1036346 including male 534231 (51.55%) and female 502115(48.45%) with population density as 202 person/sqKm. The Rural and Urban population of the district is 870126 and 166220 respectively. Administrative map of the district showing block boundaries, block headquarters, physical features is presented as figure-1.1

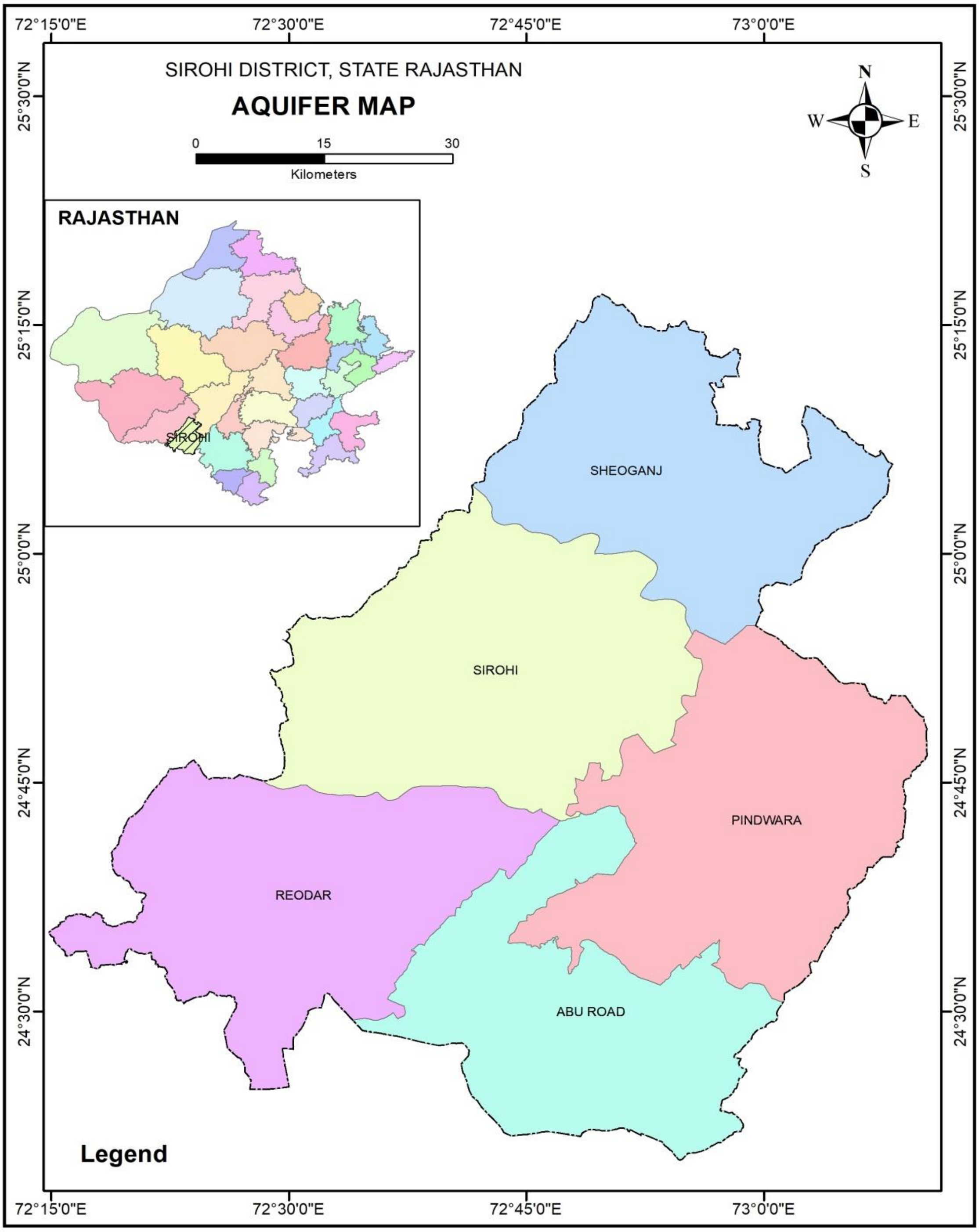


Fig 1.1: - Administrative map of Sirohi District

2.0 Climate and Rainfall

Agriculture in the area depends mainly on the rainfall from south-west monsoon. The climate of the District is semi-arid to partially sub-humid type and is subject to extremes of cold and hot at different places. The minimum and maximum temperatures recorded in Sirohi District are below 10°C in the month of January and above 40°C in the month of May respectively. The average temperature ranges between 20° and 40°C in the district.

2.1 Rainfall

The normal annual IMD (1901-1950) rainfall of the area is 638.4 mm which is unevenly distributed over the area in 29 days. The south west monsoon sets in from last week of June and withdraws in end of September, contributed about 94% of annual rainfall. July and August are the wettest month of the year. Rest 6% rainfall is received during non-monsoon period in the wake of western disturbances and thunder storms.

The annual rainfalls of 48 years from 1971 to 2018 have been analyzed to know the behavior of rainfall (Fig.2). The analysis indicates that annual variation of rainfall is large and significant. The average annual rainfall from 1971 to 2018 is 804.0 mm. The highest rainfall of 151% more than the average was recorded in 1973 whereas the lowest (234mm) of 70% less than the average was experienced in 1987 as show in Figure 2.1 and Annexure-1.

The standard deviation of rainfall from 1971 to 2018 is 377 mm which indicates that 427 mm rainfall is assured. The coefficient of variation of rainfall is 50%. It indicates that rainfall in the area is highly variable.

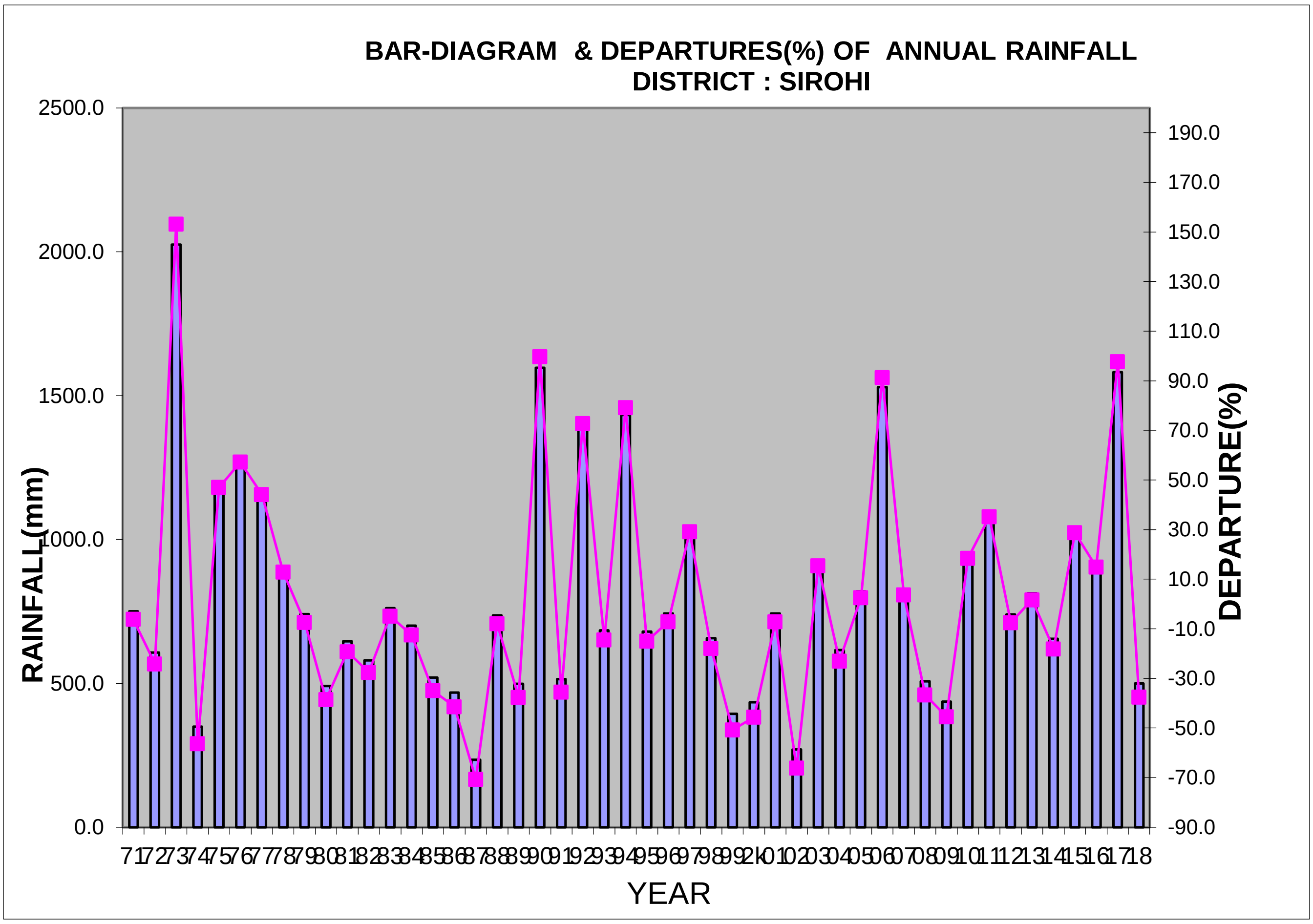


Fig 2.1:- Average annual Rainfall (1971-2018) Distribution map of Sirohi District

3.0 Physiographic Set Up

3.1 Physiography

The district is in the shape of an irregular triangle and is greatly broken up by hills and rocky ranges. The main feature is the almost isolated mountain of Abu, the highest peak of which, Guru Sikhar, rises 5,650 feet (1,722m.) above the sea level. The mountain is situated near the southern border. It is separated by a narrow pass from an adjacent range of narrow hills which runs in a north-easterly direction almost as far as Sheoganj, and divides the district into two almost equal parts. Most of the area of the tehsils of Reodar, Sirohi and Sheoganj lies in the western part of these hills.

The south and south-east part of the district, which lies between Mt. Abu and the main spines of the Aravalli, is mountainous and rugged, and is drained by the West Banas River.

3.2Geomorphology

Geomorphologically, the district contains hills and valleys of the Delhi super group. The area has Denudational, structural and linear ridge of the Delhi Supergroup rocks and Batholiths of granitic rock at Mount Abu which is the highest peak in Rajasthan state. The district has ravines and valley fills in between the hills. There are some buried pediments under the Aeolian and alluvial sand. The geomorphology of the district is described in table 3.1 and map 3.1.

Table3.1:- Geomorphologic units, their description and distribution

Origin	Landform Unit	Description
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.
	Valley Fill	Formed by fluvial activity, usually at lower topographic locations, comprising of boulders, cobbles, pebbles, gravels, sand, silt and clay. The unit has consolidated sediment deposits.
	Ravine	Small, narrow, deep, depression, smaller than gorges, larger than gulley, usually carved by running water.
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.

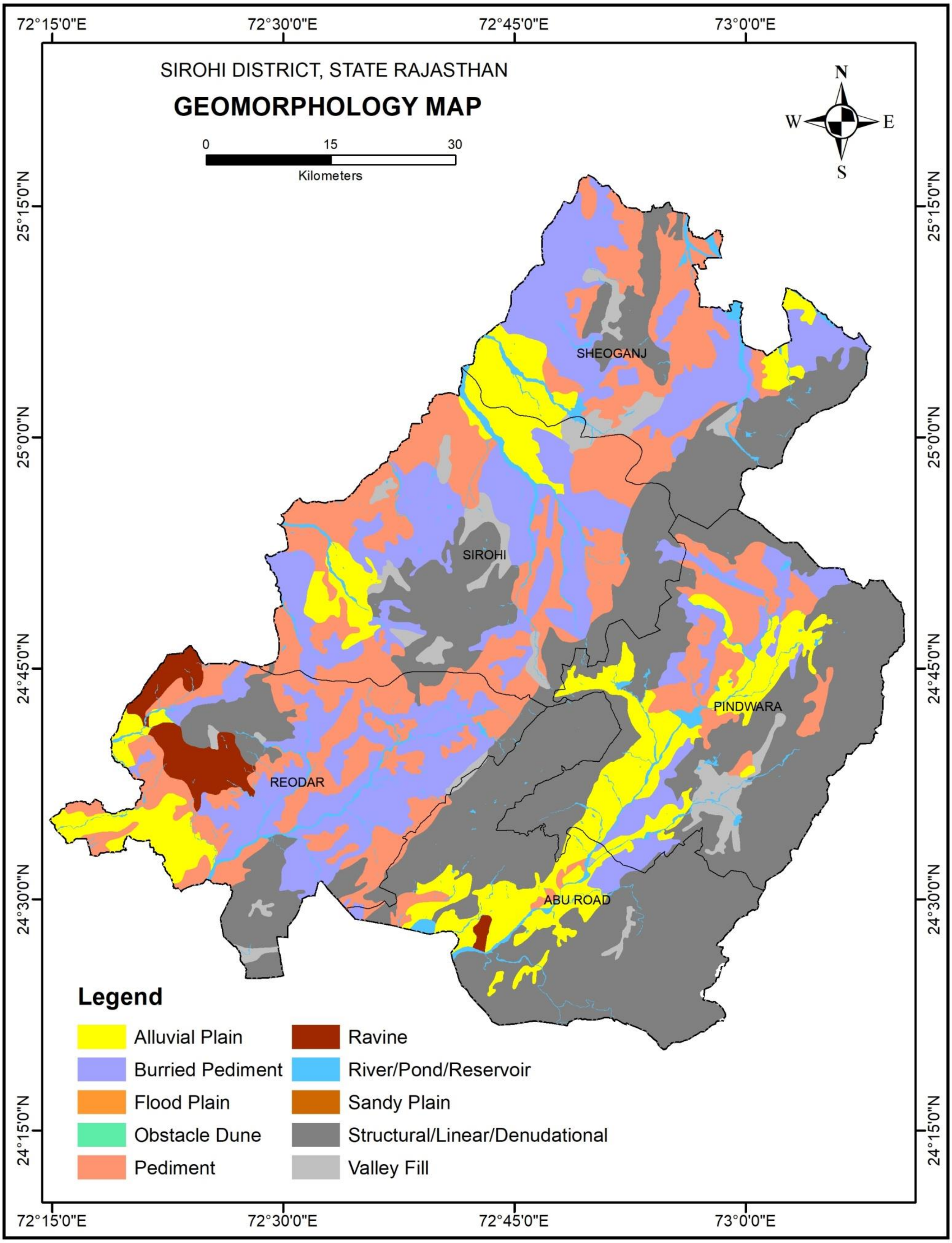


Fig 3.1: - Geomorphological map of Sirohi District

3.3 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 2015, published by Government of Rajasthan and is presented in Table 3.2 and figure 3.2.

Table 3.2:- Land Use Pattern of Sirohi District

S.No.	Land Use	Area in hectare	%
1	Total geographical area (as per village papers)	517947	
2	Forest	155726	30.06
3	Uncultivable land	99961	19.30
4	Land not cultivated including pasture land; barren land; trees, grooves & orchards	42134	8.13
5	Fallow and current fallow land	55150	10.65
6	Actual sown area (subtracting double)	164976	31.85
7	Gross sown area	224845	43.41
8	Area sown more than once	59869	11.56

Source: https://aps.dac.gov.in/LUS/Public/Reports.aspx.

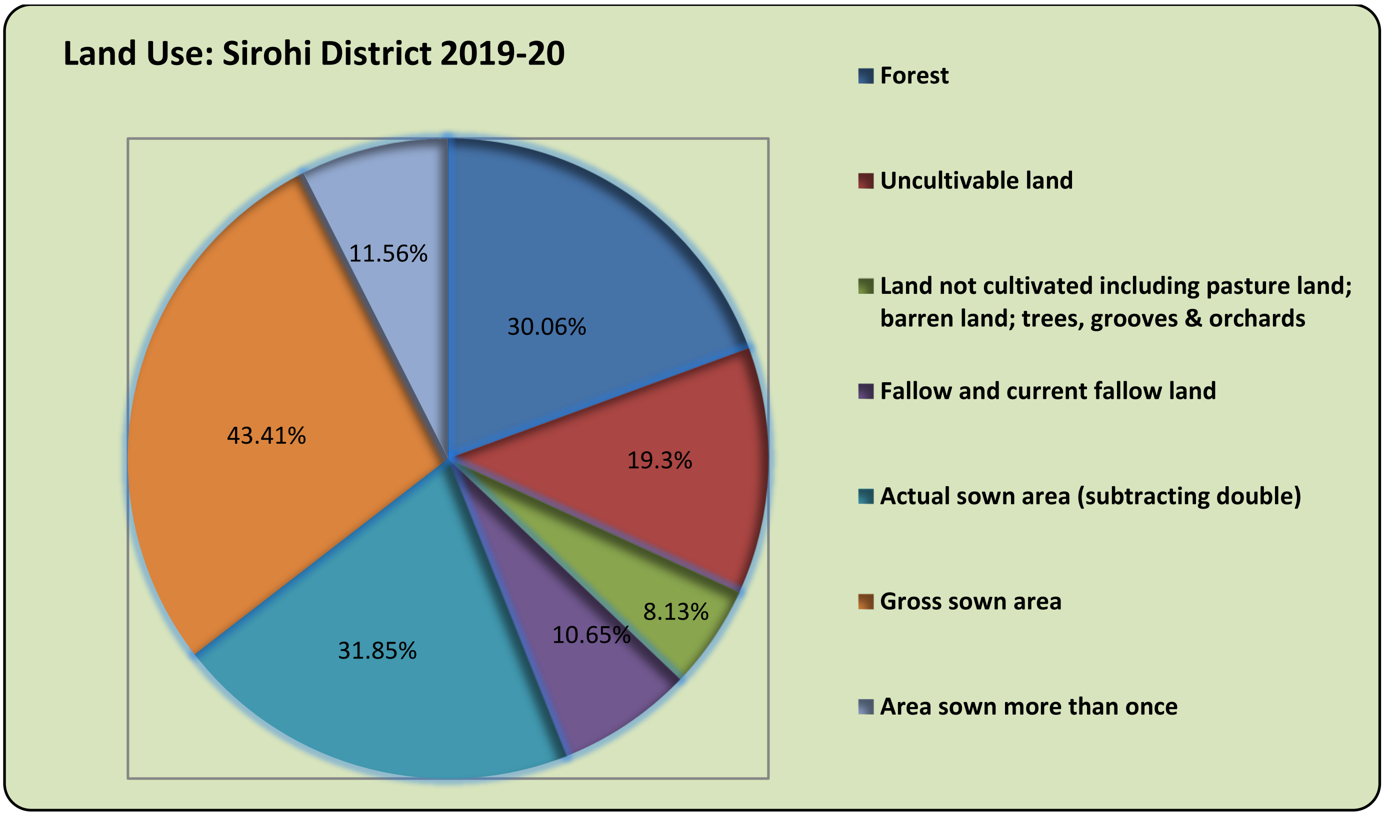


Fig 3.2:- Land Use Pattern in Sirohi District

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. 3.3 and season-wise crops are presented in table 3.4.

Table 3.3: Major crops of Sirohi District

Food Grain	Jowar, Bajra, Wheat, Barley, Maize
Cereals	Gram, other kharif cereals,Tur, other rabi cereals
Oil seeds	Rai & Mustard, Til, Ground Nut, Arandi/Taramira
Non-food grains	Isabgol, Chilli, Fenugreek(Methi),Potato, Cumin, Souf, Cotton

Table 3.4: Season-wise crops Pattern of Sirohi District

Season	Crops covered
Kharif	Jowar, Bajra, Maize, Cotton, Tur, Seasum, Castor seed, Moong
Rabi	Wheat, Barley, Gram, Rape Seed Mustard, Taramira and Linseeed
Zaid	Gram, Urad, Chaula, Fruits and Vegetable, Small Millets

Irrigation

The principal means of irrigation in the district are through wells though very small areas irrigated by canals (8.5 sq.km.). Ground water plays an important role for irrigation contribute almost 100% and is utilized through dug wells, dug cum bore wells, tube wells and bore wells run almost by electricity in the area. Out of gross sown area of 1131.29sq. km only 825.31Sq.km. (72.95%) areas are irrigated. Net and gross sown area as per source is given in table 3.5

Table 3.5: Details of Area (in Ha) irrigated with sources in Sirohi District

	Dugwells	Tubewells	Ponds	Canals	Other	Total
Net Sown Area	78321	2721	639	850	-	82531
Gross Sown Area	108142	3498	639	850	-	113129

Source: District Outline, Sirohi, 2015

Cropping Pattern

Gross sown area is 239341 ha with net sown area is 165710 ha. and area sown more than once is 73631 ha in the district of which total Kharif Crops are sown in 161726ha of irrigated area is 42102, Rabi Crops in

69418 ha and irrigates area is 62476 haand Zaid crops in 8557 ha and whole 8551 ha was irrigated. Area wise crops grown in the district are food grains (76509 ha), Tilhan/oil seeds (90091 ha), Pulses (13602ha), spices (3492ha), Cotton (1693 ha) and Souf (5699 ha). Area under total food and non-food crops is 191298 ha in the year 2013-14.

Forest

The area under forests in the district is 1312.51 sq. km out of which the reserved area under forest is about 510.03 sq. km, conserved forest area is about 785.89 sq.km and unclassified forest area is about 53.89 sq.km. The forest covers an area of about 25.56 % of the total area of the district Dhokara, Khair, Bambu, Neem, Peepal, Sisam etc. are the major trees of these forest. Major forest products are cooking wood, Charcoal, Tendu leaves, Guegal, Gum, Kattha, Honey etc.

3.4 Drainage

The drainage system of the district is well developed as Jawai is the main river of north-west part of the district, which eventually meets Luni River. West Banas is another most important river of the district. Other rivers which flow in the district are Khari, Sukli, Bandi, Kapalganga and Krishnavati (Figure-3.3). There are no natural lakes in the district. Artificial Lake named Nakki Lake in Mt.Abu is picturesque and has become place of pride.

Sirohi district falls in parts of Luni (41.2 %), West Banas (35.5 %), Sukri (18.7%), other nallah (3.2%) and Sabarmati (1.3%) basins. Tehsil wise distribution of basin area is given below in Table 3.6.

Table 3.6:- Tehsil wise distribution of basin area in Sirohi district

S.No	Name of Tehsil	Area in Sq. Km.				
		Luni	West Banas	Sukli	Sabarmati	Other nallah
1	Sirohi	910.9	141.6	63.8	-	-
2	Pindwara	45.5	781.3	-	-	163
3	Reodar	31.3	223.5	88.3	-	-
4	Abu Road	0.4	647.4	-	-	-
5	Sheoganj	1094.4	1.7	-	-	-

Jawai: Jawai River originates in Udaipur district with its main tributary Sukri in the western slopes of the Aravalli's. It joins Khari River in Jalore district near Sayala. This river flows in a north-west direction for about 96 km before that. Its catchment area is 2,976 km².

West Banas: The West Banas River originates near Pindwara village in Sirohi district at an elevation of 372.5 m above mean sea level. The river flows in a south-westerly direction and after travelling length of 266 Kms, empties into little Rann of Kutch. Its total catchment area is 8674 sq km out of which nearly 38%

lies in Rajasthan. Their right bank tributary is Sipu River and left bank tributaries are Batria, Sukli, Sewaran, Balaram and Khari.

The Dantiwada dam and Sipu dam are the main irrigation structures existing on the main channel of West Banas River.

Sukli: The Sukli River rises from Aravalli hills near Pindwara village of Sirohi district and drains into the Banas River downstream of Swaroopganj and 9 km upstream of Abu road**.**

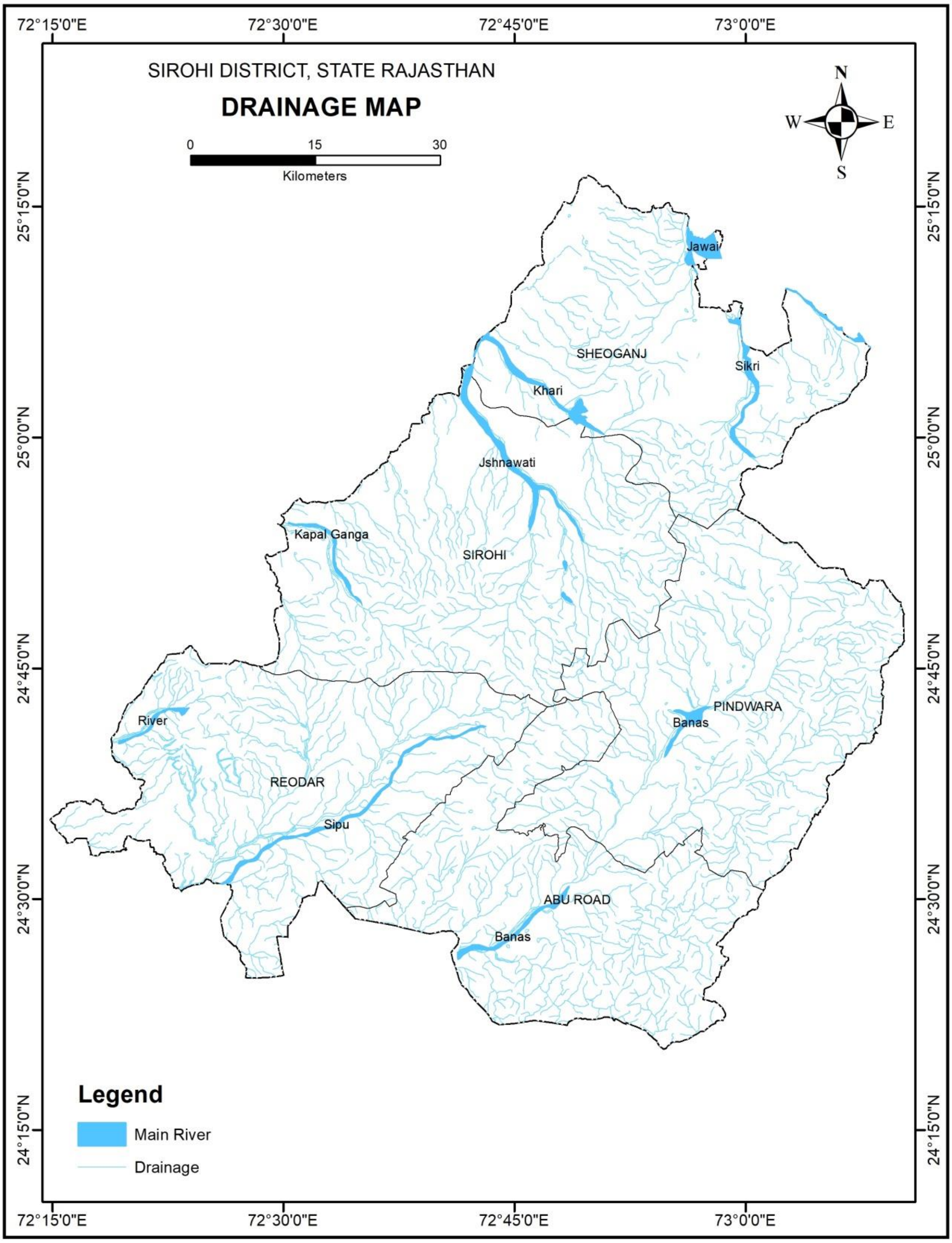


Fig 3.3:- Drainage map of Sirohi District

3.5 Soil

The soils of the district fall under the following broad categories:

Mattiyar (Stiff Clay):-

Black colored soil found in Pindwara and parts of Sheoganj blocks. This soil is more suitable for growing Wheat, Barley and Cotton.

Gorat or Bhuri (Sandy):-

Light brown colored soil found in Reodar, some parts of Sirohi and Sheoganj tehsils. It is fertile and suitable for growing Bajra.

Reti (sand):-

It occurs in river beds and is suitable for growing Tomatoes and watermelon.

Kankari (hard and stony mixed with sand):-

It occurs around the base of the hills.

Khari (saline soil):-

Unsuitable for crops occurring in western parts of the district.

Inceptisols:-

Inceptisol is a soil of semiarid to humid environments which usually reflect only moderate degree of soil erosion and development. Inceptisol soil is a weakly-grown soil. These soils expose minimal horizon development. With inceptisol, some color changes may be conspicuous between the transpiring horizons, and the beginnings of a B horizon may be observed with the deposit of small amounts of salts, clay, and organic substance. Inceptisols take place under a wide range of environmental conditions. They are most commonly found on fairly steep slopes, wet sites, offspring geomorphic surfaces, and on resistant parent substances. This soil is covering about 60% area of the district with two linearly patches in the district.

Entisols:-

Entisols are commonly found at the site of recently deposited materials (e.g., alluvium), or in parent materials resistant to weathering (e.g. sand). Entisol soils also occur in areas where a very dry or cold climate limits soil profile development. Productivity potential of Entisols varies widely, from very productive alluvial soils found on floodplains, to low fertility/productivity soils found on steep slopes or in sandy areas. (Figure- 3.4).

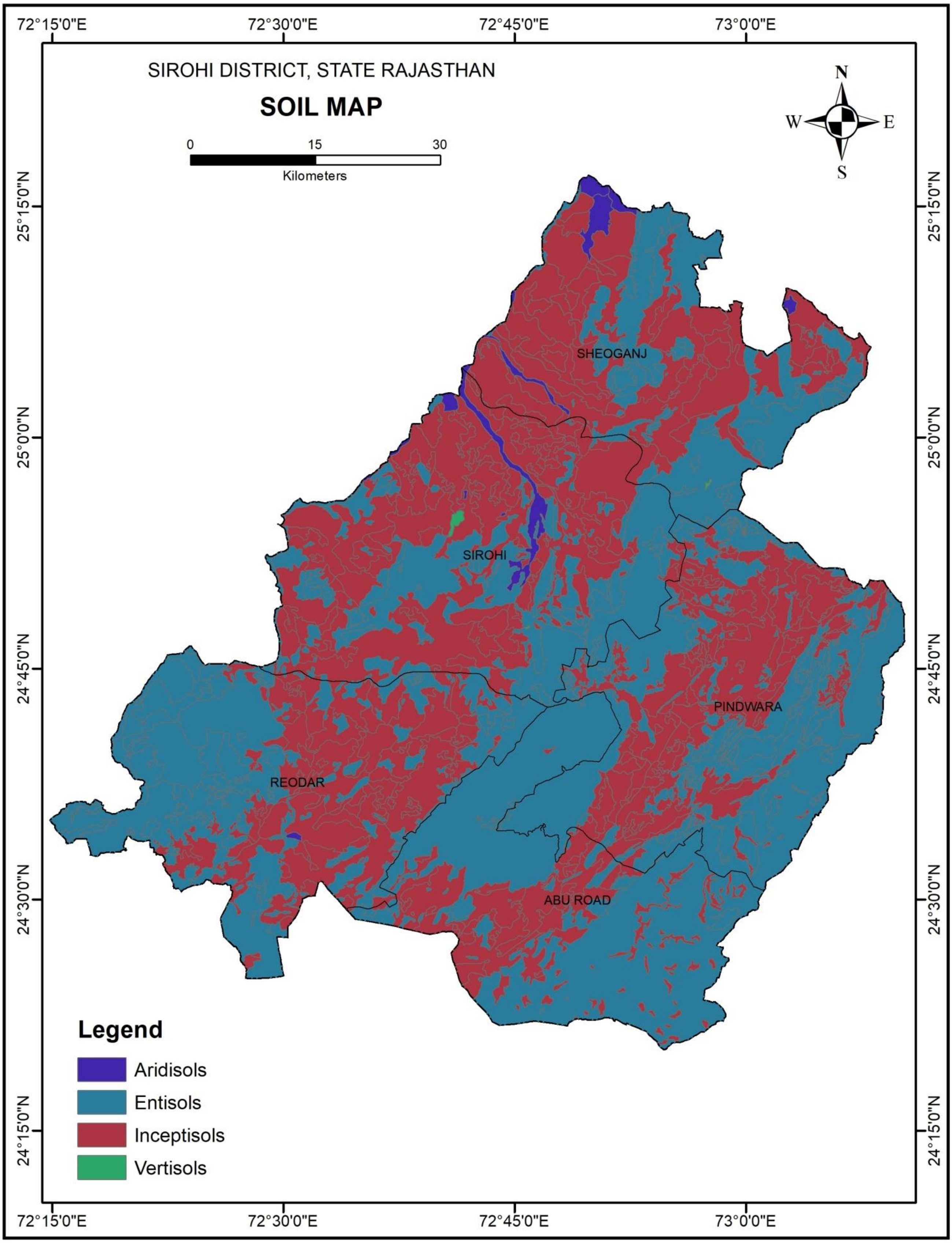


Fig 3.4 – Soil Distribution map of Sirohi District

4.0 Hydrogeological Framework

4.1 Geology

Geologically, the Sirohi district forms the southwestern part of the Delhi Supergroup and Malani rocks. The eastern and the central parts of the district are occupied by the metasediments of the Delhi Supergroup and Sirohi Group , These are intruded by mafic and ultramafic rocks and granites of different ages i.e. Sendra-Ambaji Granite (~1000 Ma to 850 Ma.), Erinpura Granite (~1000 to 735MA.) and Malani Igneous Suite of rocks (~750 Ma.). Near Mer-Mundwara in Sirohi block younger igneous rocks (~65 Ma) have also been reported. Further, major part of the Sirohi district is also covered with quaternary and recent alluvium and blown sand. Geology of the Sirohi reveals that the basement rocks are older granitic gneisses having tectonised sheared contact with cover metasediments. The detailed geological succession of the Sirohi district is described in table 4.1 and figure 4.1.

Table 4.1: Detailed Geological Succession of Sirohi District

Supergroup and Age	Group	Formation
Recent	Quaternary	Alluvium and Aeolian sand
	Mundwara Ultramafic Alkaline Suite (Tertiary)	Pyroxene, picrite, tuff, basalt, Gabbro, syenite
Intrusives and Extrusive (Upper Proterozoic)	Malani Igneous Suite	Granite porphyry
		Rhyolite porphyry
		Dolerite, basalt
		Jalore Granite, Mirpur Granite
		Rhyloite with ash bed, tuff, Dellenite
	Erinpura Granite	Granite, granitic-gneisses, Syenite
Delhi Supergroup (Lower to middle Proterozoic)	Sindreth Group	Basic metavolcanics, Quartzite
		Conglomerate, Quartzite, Slate, Phyllite
	Sirohi Group	Phyllite, mica-schist, quartzite, migmatite gneiss
		Mica schist, Phyllite, calcitic marble, calc-gneiss, calc-schist
		Biotite Schist, migmatite
	Sendra Ambaji Granite	Granite, granite gneiss, syenite
	Phulad Ophiolite Suite	Epidiorite, Hbl schist, amphibolites, Pyroxene granulite and Gabbro
	Kumbhalgarh Group	Calc-gneiss, calcitic marble, Biotite-schist and Quartzite

Source: GSI & District Survey Report, DMG Sirohi, 2018

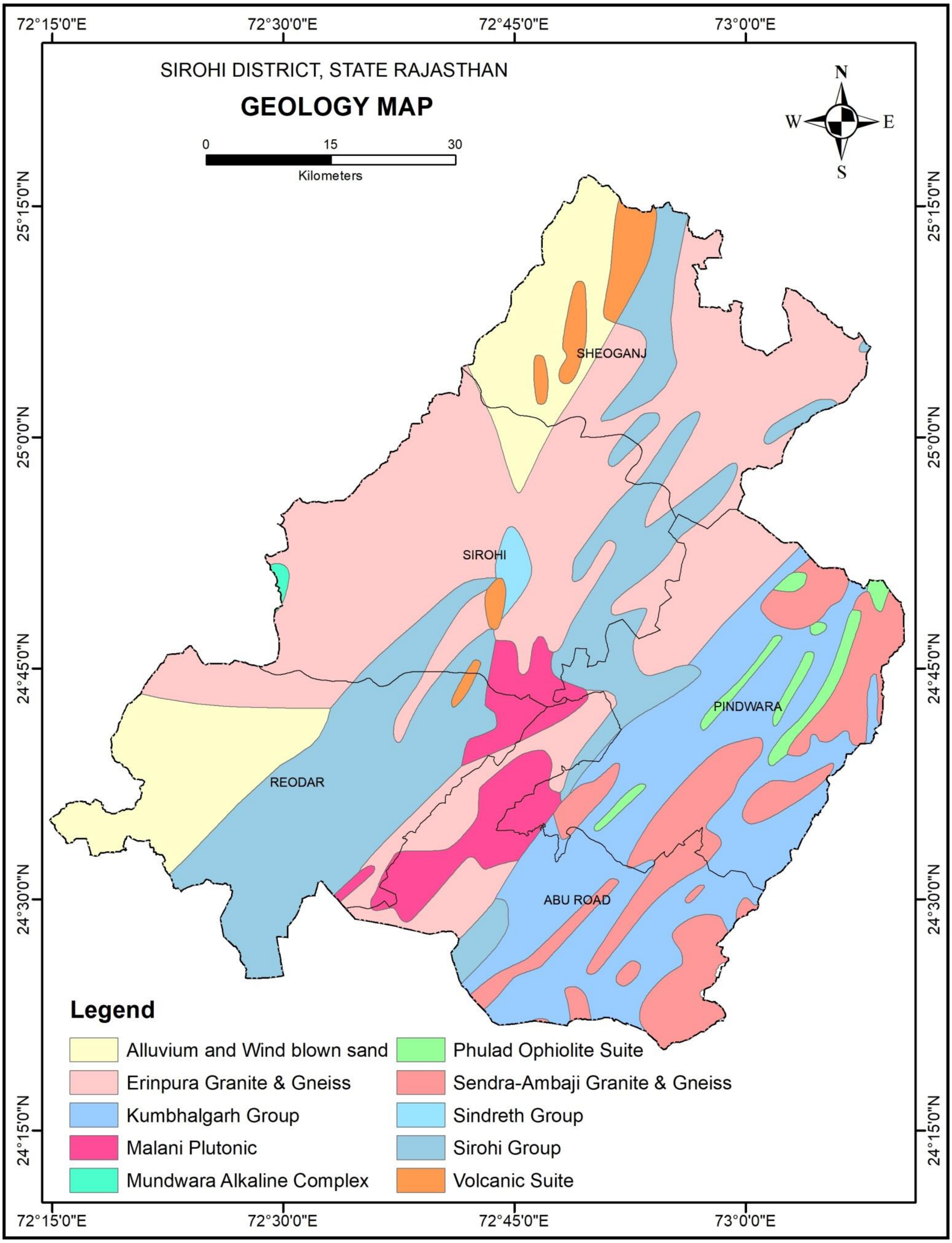


Fig 4.1:- Geological map of Sirohi District

4.2 Hydrogeology

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.

Ground water occurs under water table conditions both in unconsolidated and consolidated formations. Its occurrence is controlled by topography, physiography and structural features of the geological formations. The movement of ground water in hard rock areas is governed by size, openness, interconnection and continuity of structurally weak planes while in unconsolidated rocks, ground water movement takes place through pore spaces between grains. Water bearing properties of different aquifers are described below in table 4.2 and fig 4.2.

Table 4.2:-aquifer potential zones there, area and their description

Aquifer in Potential Zone	Area (sq km)	%age of district	Description of the unit/Occurrence
Younger Alluvium	1,022.2	19.9	It is largely constituted of Aeolian and Fluvial sand, silt, Clay, gravel and pebbles in varying proportions.
Phyllite	841.2	16.4	These include meta sediment sand represented by Carbonaceous Phyllite.
Schist	616.7	12.0	Medium to fine grained compact rock. The litho-units are soft, friable and have closely spaced cleavage.
Granite	1,855.9	36.1	Light grey to pink colour, medium to course grained, and Characteristically have porphyritic texture.
Hills	803.1	15.6	
Total	**5,139.1**	**100.0**	

Source: - District Atlas Report, Sirohi 2013.

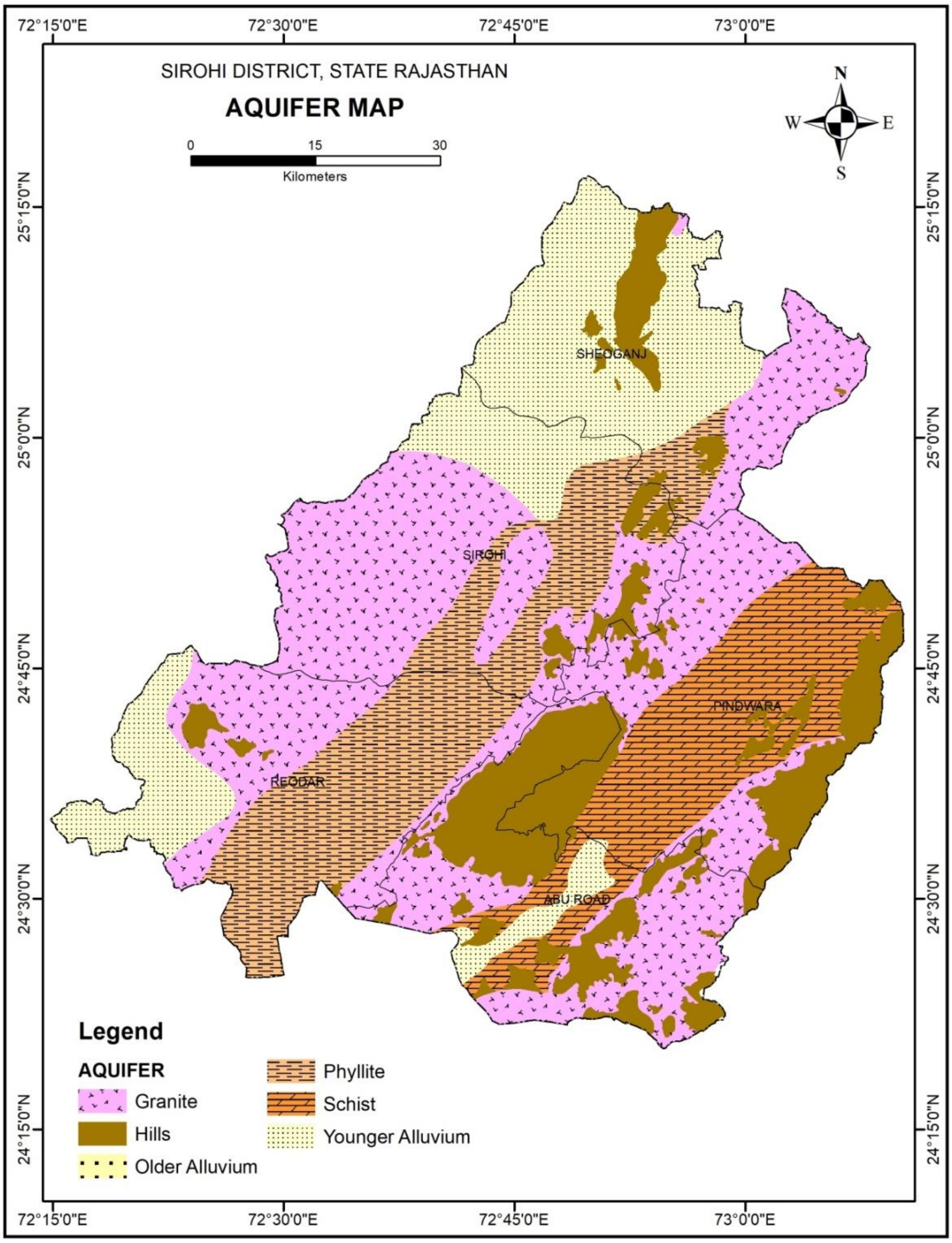


Fig4.2:- Hydrogeological Map of Sirohi District

The principal source of ground water recharge in the district is rainfall. The major part of the rain goes under surface run off and evapo-transpiration and only a small part of rain water infiltrates and recharge the ground water. In the district, groundwater mainly occurs in the alluvium and voids and fissures of hard rocks (granites/ gneisses, phyllites and schists). Granite, Phyllite and Schist are the major water bearing formation covering major portion of the district area, in which there are weathered and fractured zones (joints and fractures) through which the ground water moves. Groundwater circulation is mainly controlled by the extent, degree of weathering, number of fractures and their intensity per unit area. Thickness of weathered and fractured zone varies considerably. Another water bearing formation is younger alluvium and Aeolian deposits where ground water occurs in pores of sand, silt and clayey sand. The younger alluvium occurs in the basin zone of rivers namely Jawai, West Banas, Sipu, and Sukli etc.

4.2.1 Ground Water in Unconsolidated Rocks:-

Alluvium

Alluvium overlies the weathered hard rock formation in the northern and western parts of the district. It has limited thickness and areal extent. It is confined to catchments of Jawai, Sukli and Khari rivers. The depth to water level is less than 10 mbgl near river courses but exceeds 35m in other areas. Depth of wells ranges from 25m to 40m.Yield of wells ranges from 150 to 1000 m3/day.

4.2.2 Ground Water in Consolidated Rocks:-

Phyllites and Schists

These aquifers occur predominantly in Abu Road, Pindwara and central part of Sirohi tehsil. A few intrusives are also found which have low permeability. Ground water is retained in weathered zones, fractures, joints etc. Depth of open wells tapping these aquifers ranges from 25 to 40 m. Yield of wells varies from 30 to 250 m3/day. The depth to water level in the area tapping these aquifers ranges from 20 m to 40m in the northern part and 10m to 20m in the western part.

Rhyolite and granite (Malani igneous suite) and Erinpura granite & gneiss

Groundwater occurs as localized, disconnected phreatic regolith aquifers, essentially under unconfined to semi-confined conditions. Groundwater occurrence in these formations is largely limited to shallow weathered overburden units and degree of fracturing of the bedrocks. It is this weathered and fractured zone, which forms potential groundwater zone. These serve as the main sources of freshwater supply for domestic and industrial purposes, especially in the rural and sub-urban areas of the district.

Over a large part of the area, Erinpura granite forms the principal aquifer but to a small extent. Malani rhyolite and granite form aquifers especially in the northern and western parts of the district. Idar granite also exists in the central part of the district. This aquifer is tapped by open wells ranging in depth from 20 to 50m. The depth to water level varies from 20 to 40 mbgl in the northern part and 10 to 20 mbgl in the western part of the district. Yield of wells ranges from meager to 250 m3/day.

4.3 Ground Water Dynamics

Central Ground Water Board periodically monitors National Hydrograph Network Stations (NHS) stations in the Sirohi District, four times a year i.e. in January, May (Pre-monsoon), August and November (Post monsoon). The total number of hydrograph stations in the district is 15 comprising of 10 dug wells and 05 piezometer. State Ground Water Department monitors water levels in 281 wells two times in a year i.e. in May and November. The monitoring wells of state GWD comprise 166 dug wells and 115 piezometers in the district. The comparative block-wise details of wells analysed during both the seasons is tabulated in table 4.3.

Table4.3:- Block-wise Depth to water Level Ranges in May 2021 and Nov 2021 in Sirohi District

S. No	Blocks	Season	Water Level Ranges in meters					Total
			0 to 2	2 to 5	5 to 10	10 to 20	> 20	
1.	Abu Road	Pre monsoon 2021	0	2	17	26	0	45
		Post monsoon 2021	4	11	15	15	0	45
2.	Pindwara	Pre monsoon 2021	0	5	20	46	3	74
		Post monsoon 2021	0	15	26	31	2	74
3.	Reodar	Pre monsoon 2021	0	1	6	31	24	62
		Post monsoon 2021	1	3	9	28	20	61
4.	Sheoganj	Pre monsoon 2021	0	2	1	8	34	45
		Post monsoon 2021	0	1	0	6	28	35
5.	Sirohi	Pre monsoon 2021	0	0	3	34	26	63
		Post monsoon 2021	0	0	5	36	21	62
	Total	Pre monsoon 2021	0	10	47	145	87	289
		Post monsoon 2021	5	30	55	116	71	277

4.3.1 Depth to Water Level Pre-Monsoon (May 2021)

Depth to water level varied from 3.33m to 26.40 m during , pre-monsoon 2021 (Figure 4.3) . Deeper water level i.e. more than 20 m have been located in 2 wells lying in the north, central and south-eastern part of the district consisting in small portions of Reodar, Sheoganj and Sirohi blocks. Depth to water level between 10 to 20 m has been observed in mainly Abu road, Sirohi, Reodar and small portion of the Sheoganj block consisting about 55% of the district. Water level between 5 to 10 m has been recorded in major portion of the Abu road, Pindwara and small area of Sirohi and Sheoganj block. It is covering an area of about 30 % of the district. Water level below 5 m has recorded in the north-east part of Sheoganj block of the district only. No area has water level below 2 m in the district. (Annexure-2)

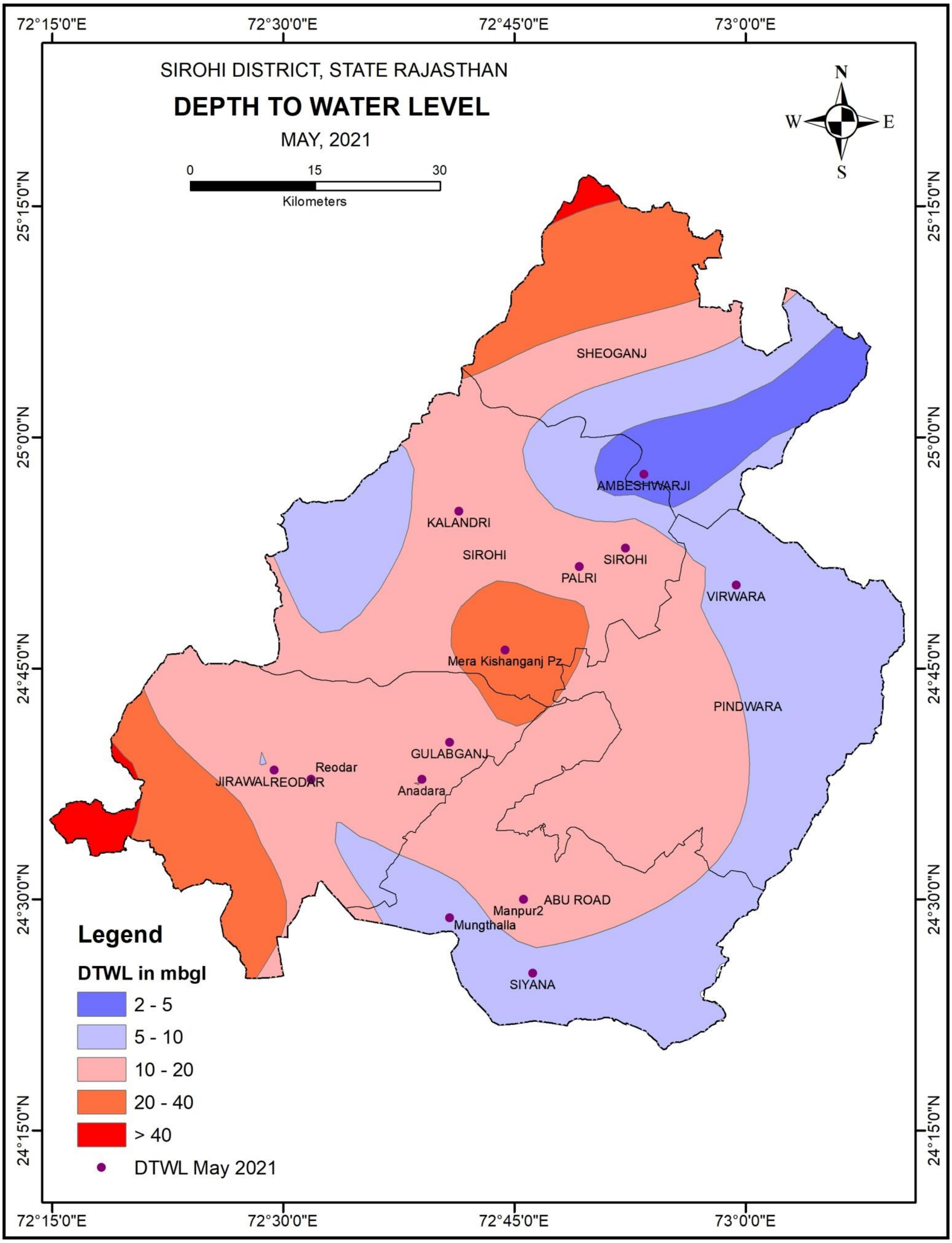


Figure4.3:- Depth to Water Level Map of Pre-Monsoon (May 2021) in Sirohi District.

4.3.2 Depth to Water Level Post-Monsoon (Nov 2021)

The depth to water level in Sirohi district during Nov. 2021 ranges from 3.13 at Ambashewarji village of Sheoganj block to 16.65 m at Reodar village of Reodar block below ground level in all the blocks of the district. Water level between 10 and 20 m has observed mainly in Pindwara. Reodar and Sirohi blocks with small portion of Sheoganj block. The water level between 5 to 10 m bgl has been recorded in the Abu road and Pindwara block. Deeper water level i.e. below 20m has not recorded during the post-monsoon in the Sirohi district. Depth to water level during post-monsoon is depicted in figure 4.4.(Annexure-2)

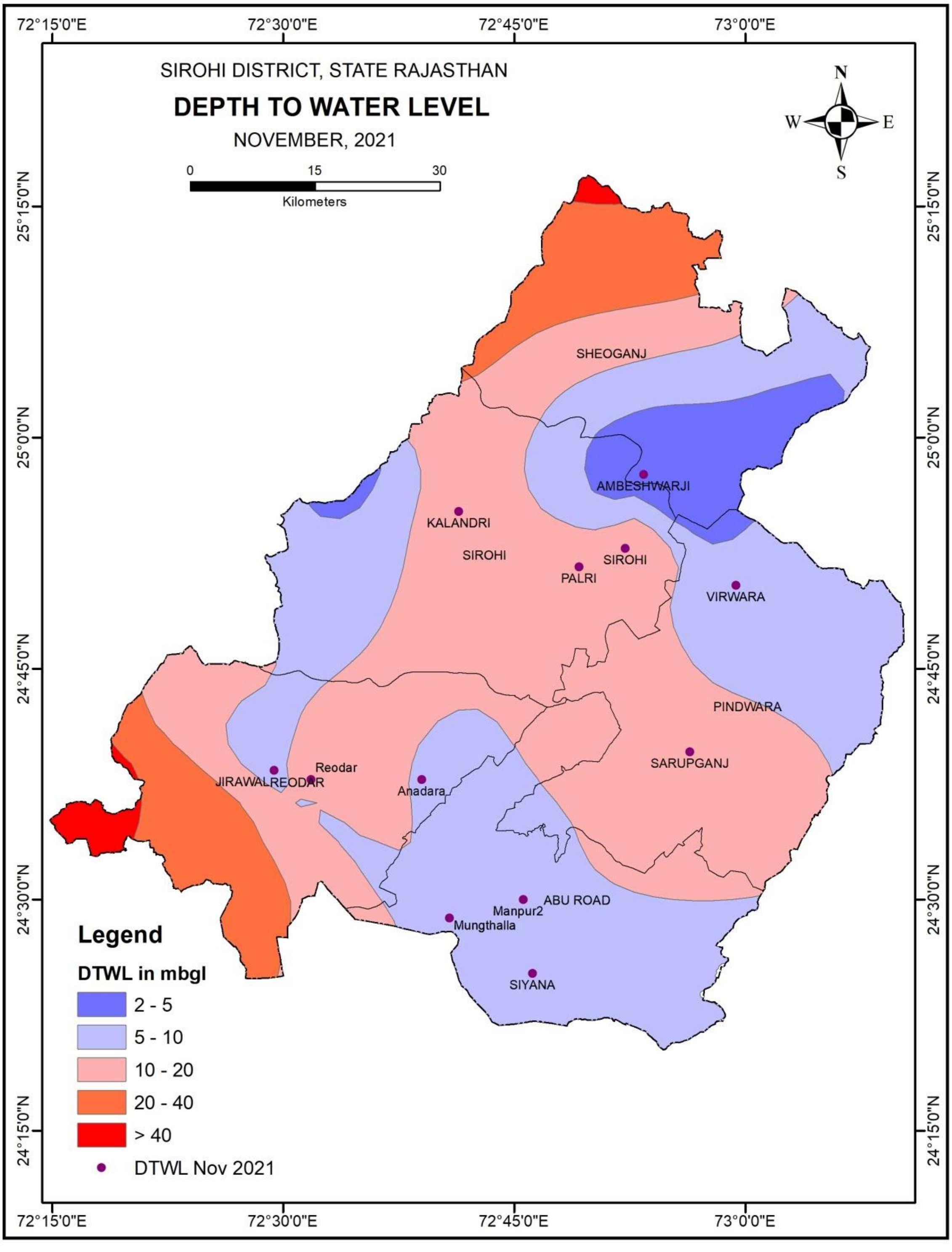


Fig 4.4- Depth to Water Level Map of Post-Monsoon (Nov. 2021) in Sirohi District.

4.3.3 Water Level Fluctuation (Pre- and Post-Monsoon, 2021)

Analysis of water level data of Pre and Post-monsoon 2021 indicates that there has been rose in water level in major part of the district (figure 4.5, Annexure-2). A perusal of water level fluctuation data indicates that rise in water level of more than 4m has been recorded in the central and eastern part of the district. Rise in water level of 2-4 m has been recorded in the eastern in Pindwara block and fringes around more than 4 m rise in central part of district. Rise in water level of 0-2 m has been encountered in the north-western part of the district mainly in Sirohi block. Decline in the pre and post monsoon water level has been observed in corners of the north-eastern and south-western portion of the district mainly in Sheoganj block.(Annexure-3)

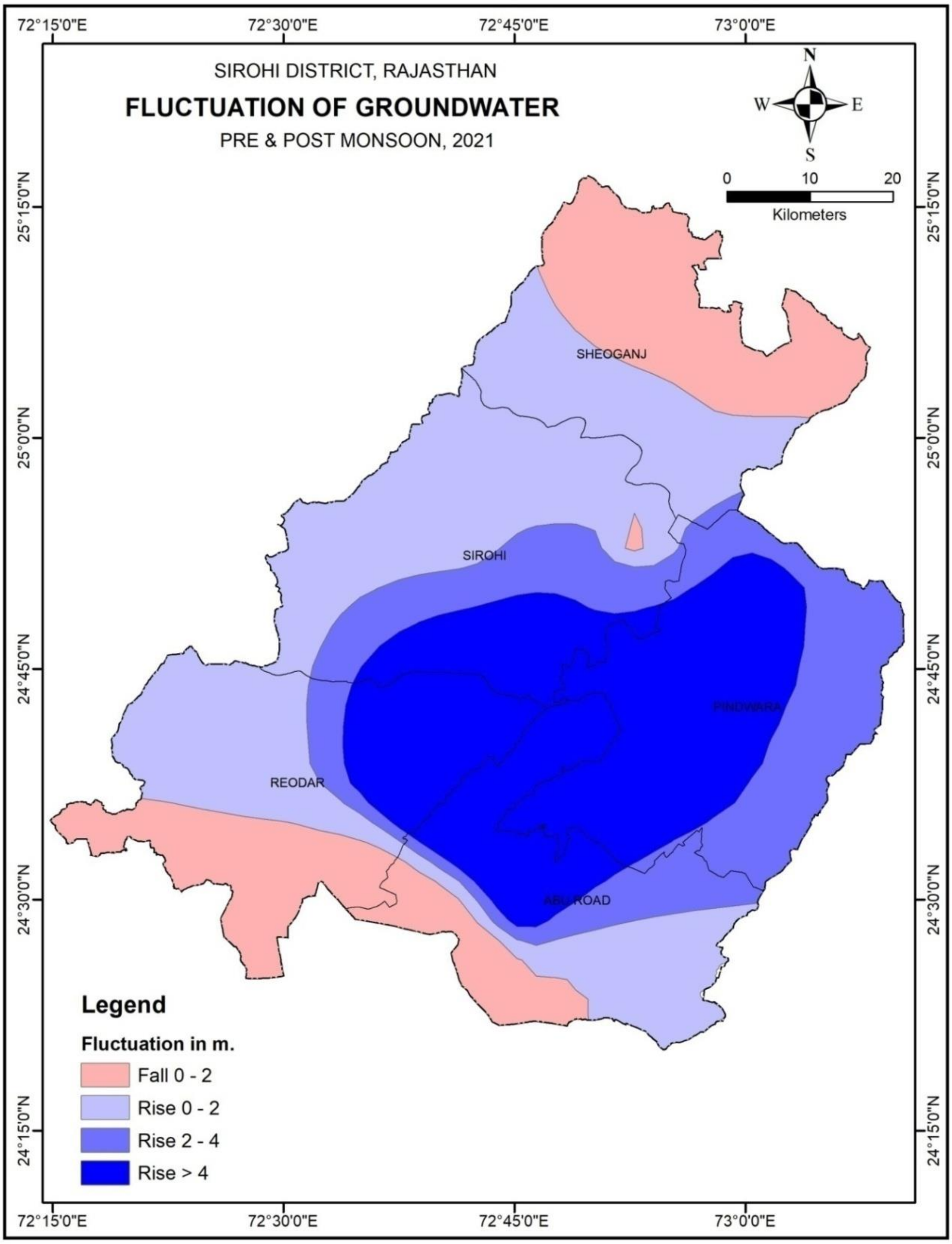


Fig 4.5:- Water Level Fluctuation Map during Pre- and Post-Monsoon, 2021 of Sirohi District.

4.3.4Decadal Water Level Fluctuation (Pre-monsoon, 2021)

Analysis of pre-monsoon decadal water level fluctuation from May, 2012 to May, 2021 is described in the figure 4.6.Decadal ground water level rise more than 4m is observed in the south-western part of the district. Water level rise 2-4 m is observed in the south-western fringe of the district. Water level rise 0-2 m is recorded in most part of the district mainly Pindwara, Sheoganj and Sirohi blocks.

Decadal water level fall is mainly observed in the central part of the district. Water level falls more than 4 m is recorded in the central core part of district. Water level fall between 2m and 4 m is observed in the small circular portion of district mainly in Sirohi block. Water level fall 0-2 m is analyzed in central and scattered portion of northern and south-western part of district.

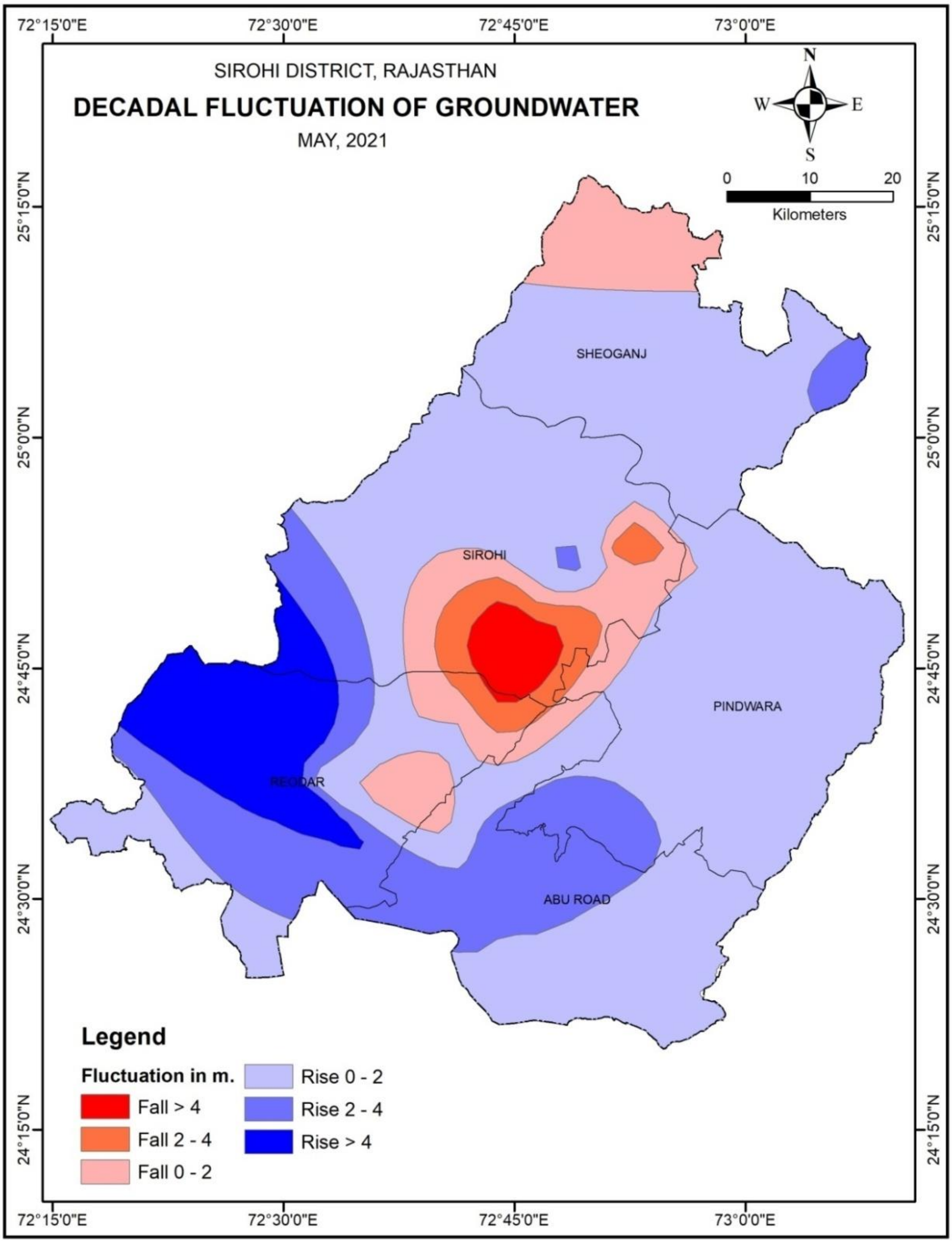


Fig 4.6:- Decadal Water Level Fluctuation of Pre-Monsoon 2021 in Sirohi District.

4.3.5 Decadal Water Level Fluctuation (Post-monsoon, 2021)

Analysis of post-monsoon decadal water level fluctuation from Nov, 2012 to Nov, 2021 is described in the figure4.7.Decadal ground water level rise more than 4m is observed in the north-eastern part of the district mainly in Sirohi block. Water level rise 2-4 m is observed in the arcuate fringe of north-eastern part of the district. Water level rise 0-2 m is recorded in scattered part of the district mainly Pindwara, Sheoganj and Abu Road blocks.

Decadal water level fall is mainly observed in the central part of the district. Water level falls more than 4 m is not recorded in district. Water level fall between 2m and 4 m is observed in the small circular portion of district mainly in Reodar block. Water level fall 0-2 m is analyzed in south-western part of district, almost in Reodar block and small fringes of Abu road and Sirohi blocks.

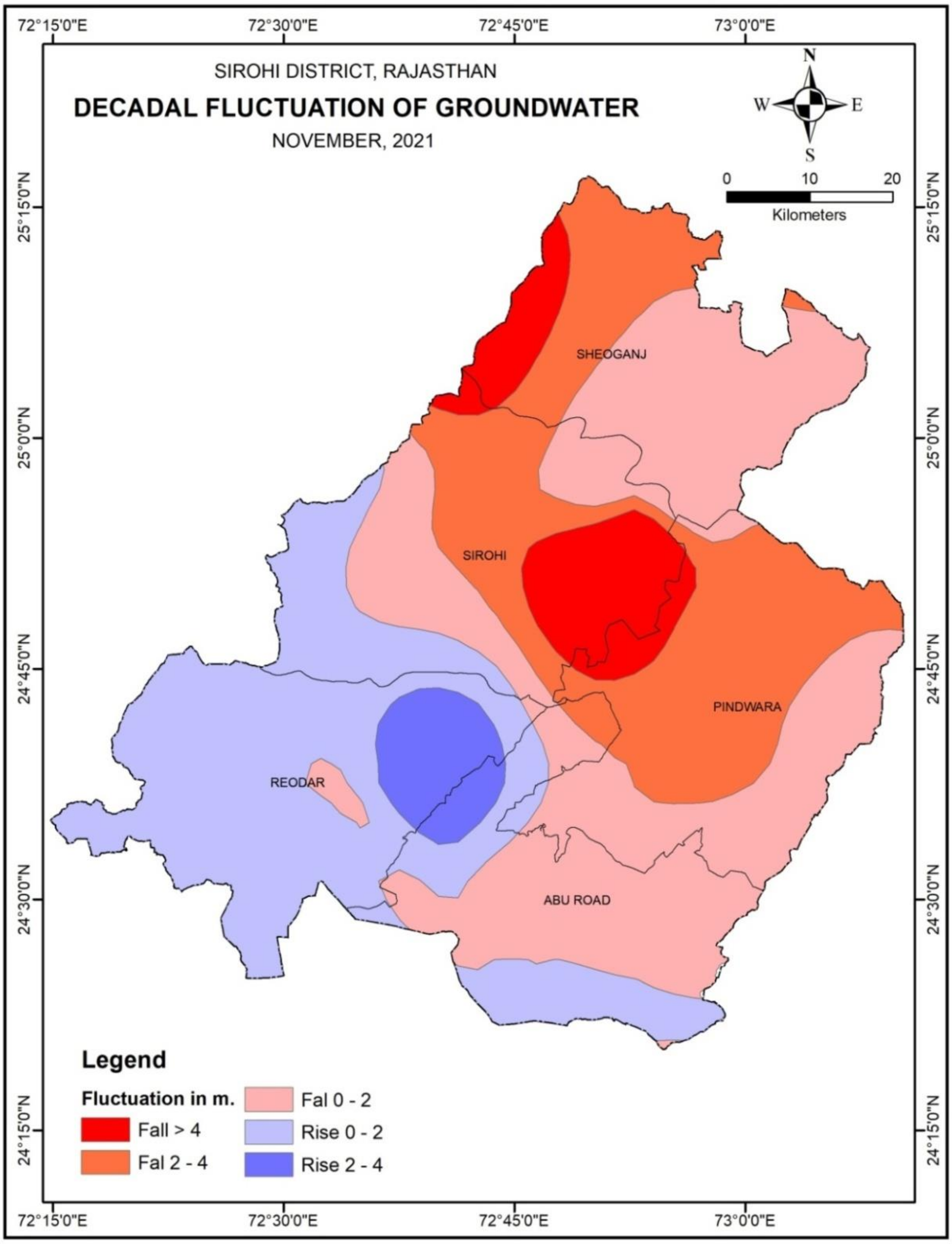


Fig 4.7:- Decadal Water Level Fluctuation of Post-Monsoon 2021 in Sirohi District.

5.0 Aquifer Maps and Aquifer Characteristics

5.1 Aquifer Disposition

The data generated during ground water exploration by constructing exploratory wells, observation wells, slim holes and piezometers was utilized to decipher the aquifer disposition in the area. The map below particularly includes the information on geometry of aquifers and hydrogeological information of these aquifer zones (figure 5.1& 5.2). Two main types of formations are observed in the area i.e. Alluvium, igneous rocks i.e. granitic rock or metamorphic like phyllites, schists depending upon the geology of the area. Single aquifer system exists in the area where ground water occurs in two zones one is alluvium or weathered near the surface and the second one is deep in the hard and compact formation where secondary porosity has developed. (Annexure-4)

Aquifer System: Single

Zone 1: Alluvium/weathered (depth ranging from 23-36 mbgl)

Zone 2: Hard with isolated fractures (36-45 mbgl)

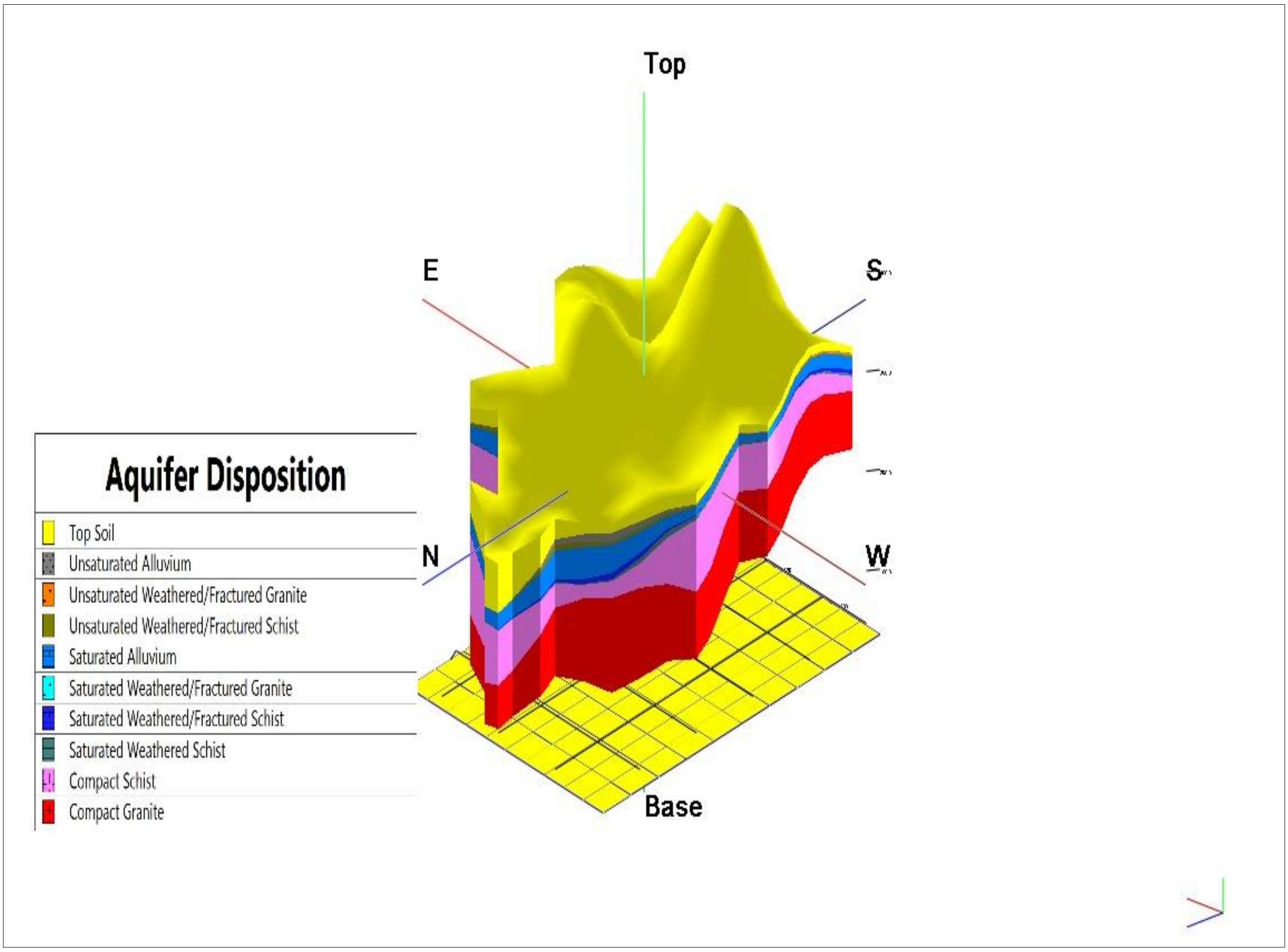


Figure 5.1: - 3 D Representation of Aquifer Disposition in Sirohi District

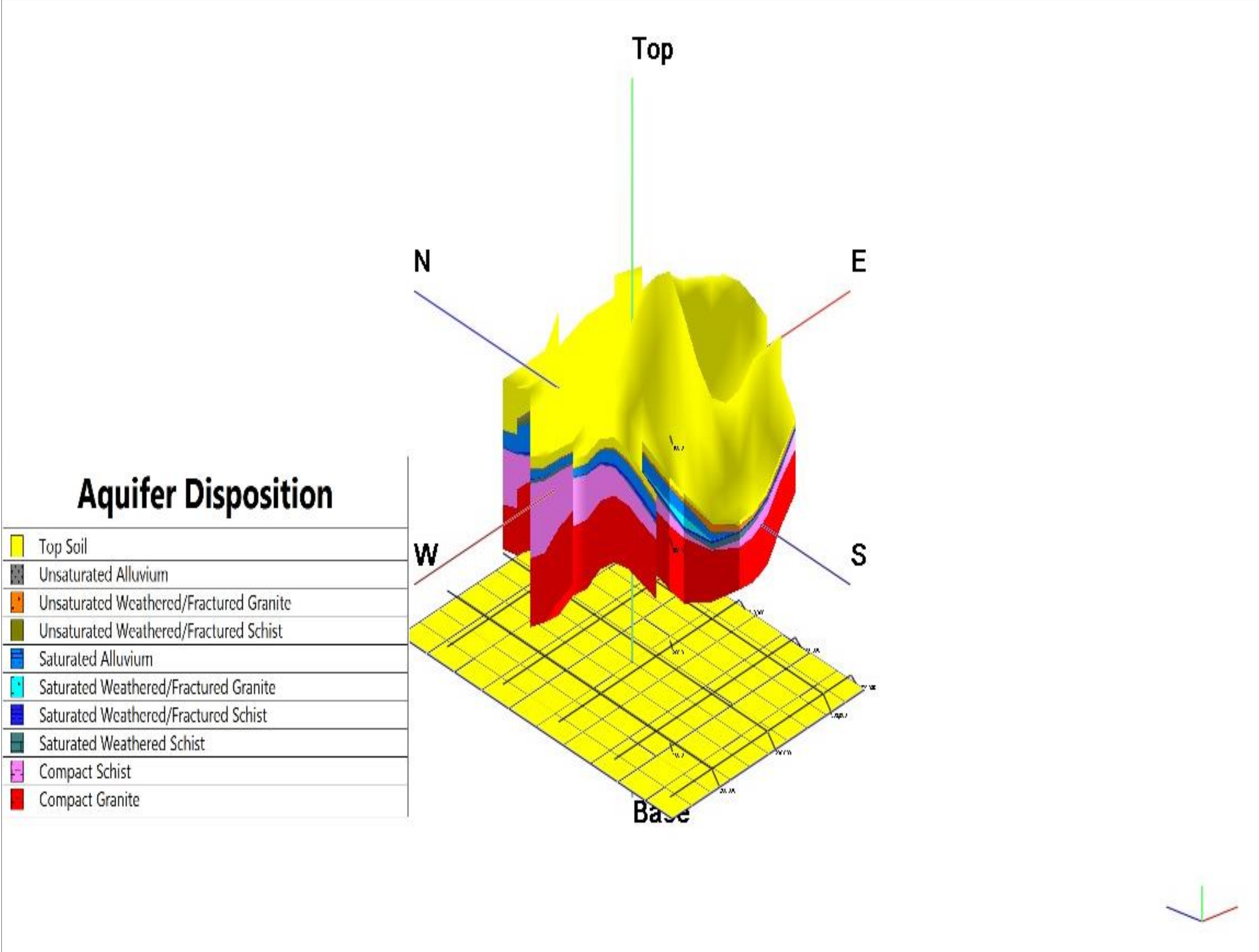


Figure 5.2: - 3 D Representation of Aquifer Disposition in Sirohi District

Hydrogeological Cross Sections

To study the aquifer disposition in detail, various hydrogeological cross section indicating aquifer geometry has been prepared viz. A- A' representing E –W direction and A-A' representing N - S direction. East- West direction cross-section is representing from Futela in the east to Hirapur in the west. Similarly North- South direction cross-section is representing from Jubliganj in the North to Girwar in the South. (Figure 5.3)

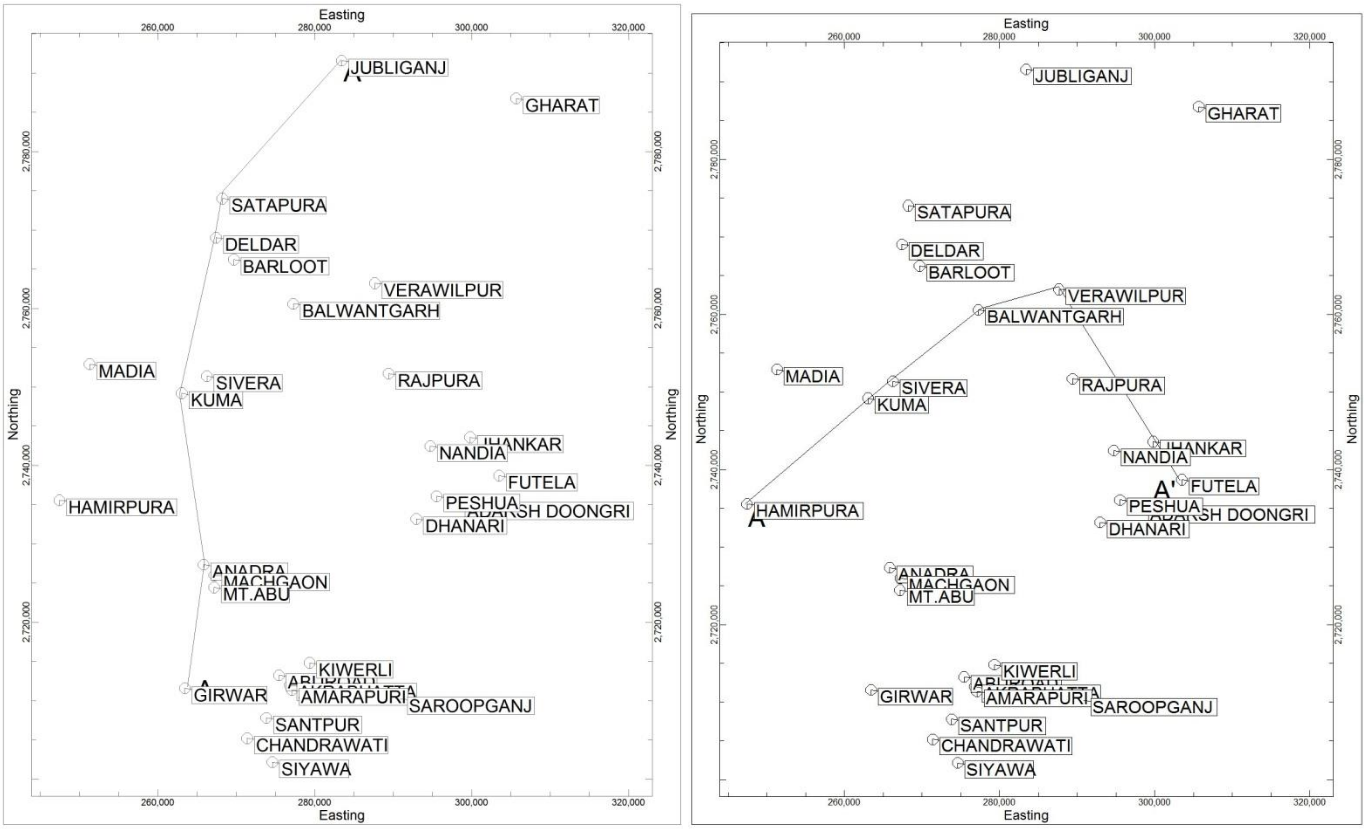


Figure 5.3:- Sections lines of both the 2D sections represented above

Cross Section E-W:-

Cross section E-W direction represents data of 7 exploratory wells i.e. Futela, Jhankar, Verawilpur, Balwantgarh, Sivera, Kuma and Hamirpura has been utilized (Fig 5.4). At Hamirpur, Futela and Siveraupto 6 mbgl top soils, 6- 24 m bgl fractured granitic rock and below this compact granitic rock was encountered. At Kuma hard and compact rock is encountered at 9m bgl.

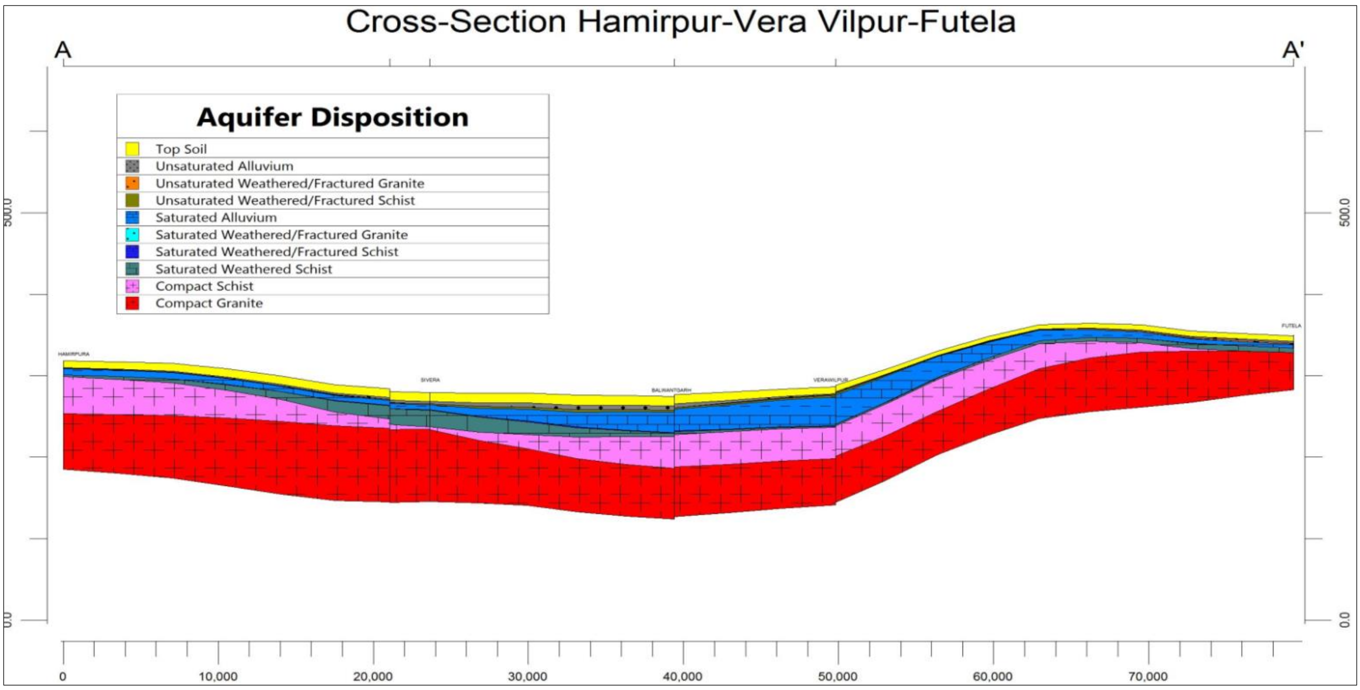


Figure 5.4: - 2 D cross-section of E-W direction from Futela to Hamirpur

Cross Section N-S:-

Cross section N-S direction represents data of 6 exploratory wells i.e. Jubliganj, Satapura, Deldar, Kuma, Anadra and Girwar has been utilized (Figure 5.5). At Deldar and Girwarupto 3 m bgl top soil , 3-47.8 m bgl fractures/ weathered granitic rocks and below this hard and compact rocks are encountered. At Satapuraupto 2 m top soil, below this 2-12.25 m bgl weathered/ fractures granite and below this upto 100 m compact granitic rock is encountered. Maximum top soil upto 60 m bgl and 60-72 m bgl fractures/ weathered granitic rocks were found at Jubliganj.

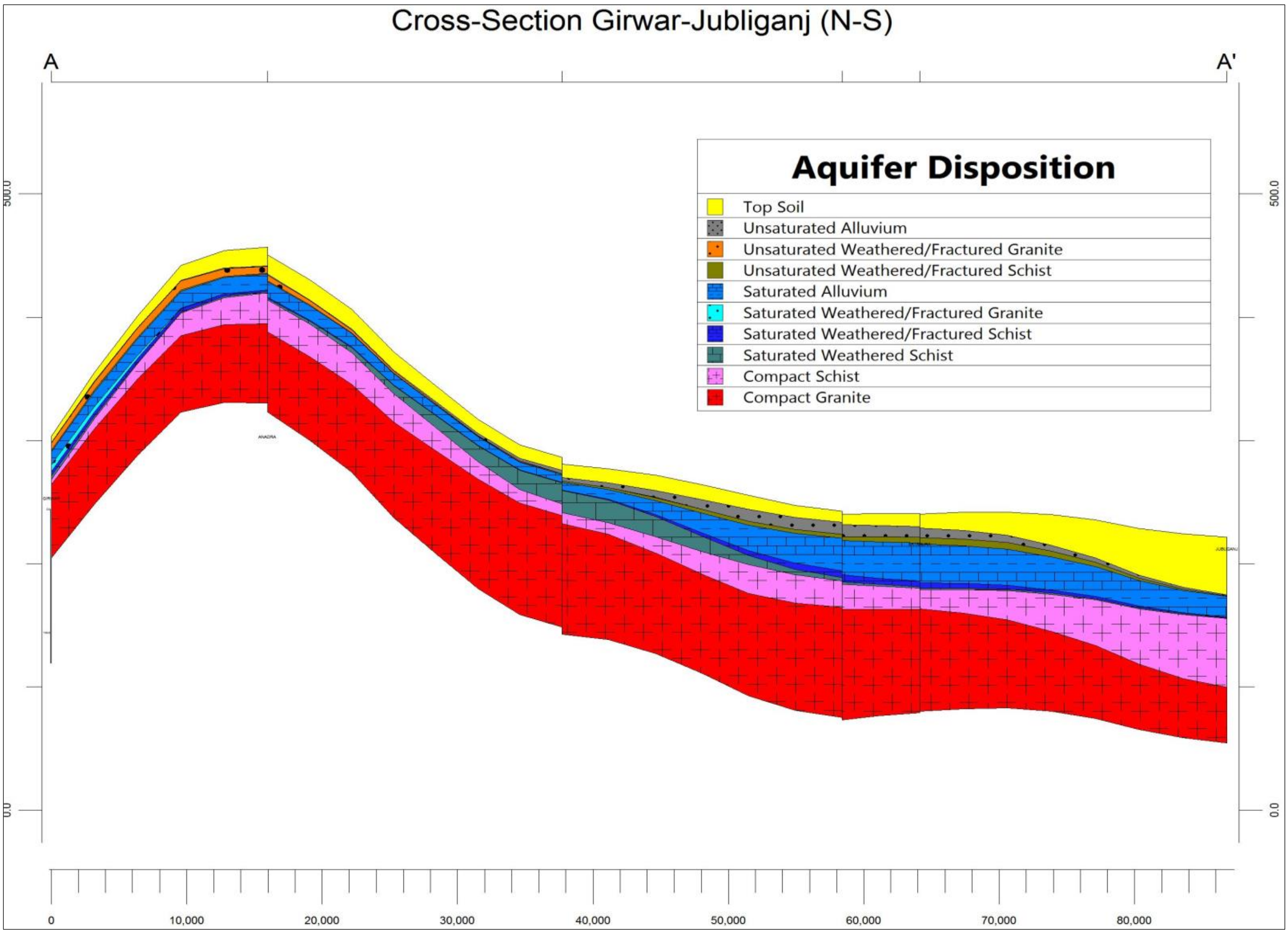


Figure 5.5: - 2 D cross section N-S direction from Jubliganj to Girwar

6.0 GROUND WATER QUALITY

In Groundwater assessment studies the quality of groundwater is of great significance. Groundwater study involves a description of the occurrence of the various constituents in groundwater and the relationship of these constituents to water use. The quality of water is defined as its acceptability with respect to its specific uses. The concentrations of various gases and ions dissolved in water from the atmosphere, soil strata and minerals and rocks with which it comes are the characteristics of water. This ultimately decides the quality of ground water. The concentration of CO_3^{2-}, HCO_3^-, OH^- and H^+ ions and dissolved CO_2 gases in water decide the acidic or basic nature of water while the salts of ions like Ca^{2+} and Mg^{2+} in water makes it soft or hard. Water with high Na^+ and Cl^- concentration can make the water saline. Nitrate ions percolated from anthropogenic sources can become predominant major anion in ground water. The excess fluoride concentration in ground water from fluoride bearing minerals may be related to the concentration of $Ca^{2+,}$ Na^{2+} and HCO_3^- ions present in ground water. (Annexure-5)

In brief, the collected samples during pre-monsoon 2021 were analyzed involving use of different instruments such as pH meter, EC meter, Flame Photometer, UV/ Visible Spectrophotometer and Titrimetric methods, for generating the map and to study the spatial variation of ground water quality. The concentrations of the variables were reported in milligram per liter (mg/l) except for EC (micro Siemens per centimeter, µS/cm at250C) and pH. This unit of measurement of variable concentrations was converted to meq/l for hydro-geochemical analysis, wherever necessary.

6.1 Suitability of Ground Water for Drinking Purposes

- **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 values of groundwater samples in the area is found to vary within the ranges 580 to 5670 µS/cm at 25°C with the minimum and maximum values being found at Posaliya village of Sheoganj block and Sarupganj village of Pindwara block respectively (Figure 6.1).

Spatial variation map shows that the high electrical values are noted towards the eastern part of the district i.e. mainly in the central portion of Pindwara block. EC values ranges 3000 to 5000 µS/cm at 25°C are recorded mainly in the entire Pindwara block and small western fringe of the Sirohi block. Other than Pindwara block almost all district has EC value less than 3000 µS/cm at 25°C.

From the analysis of chemical quality data map, it is clear that the salinity hazard is found only in small central portion of Pindwara block. The entire district except Pindwara block has EC values less than 5000 µS/cm at 25°C that show the water quality is fresh and useable for drinking and domestic purposes.

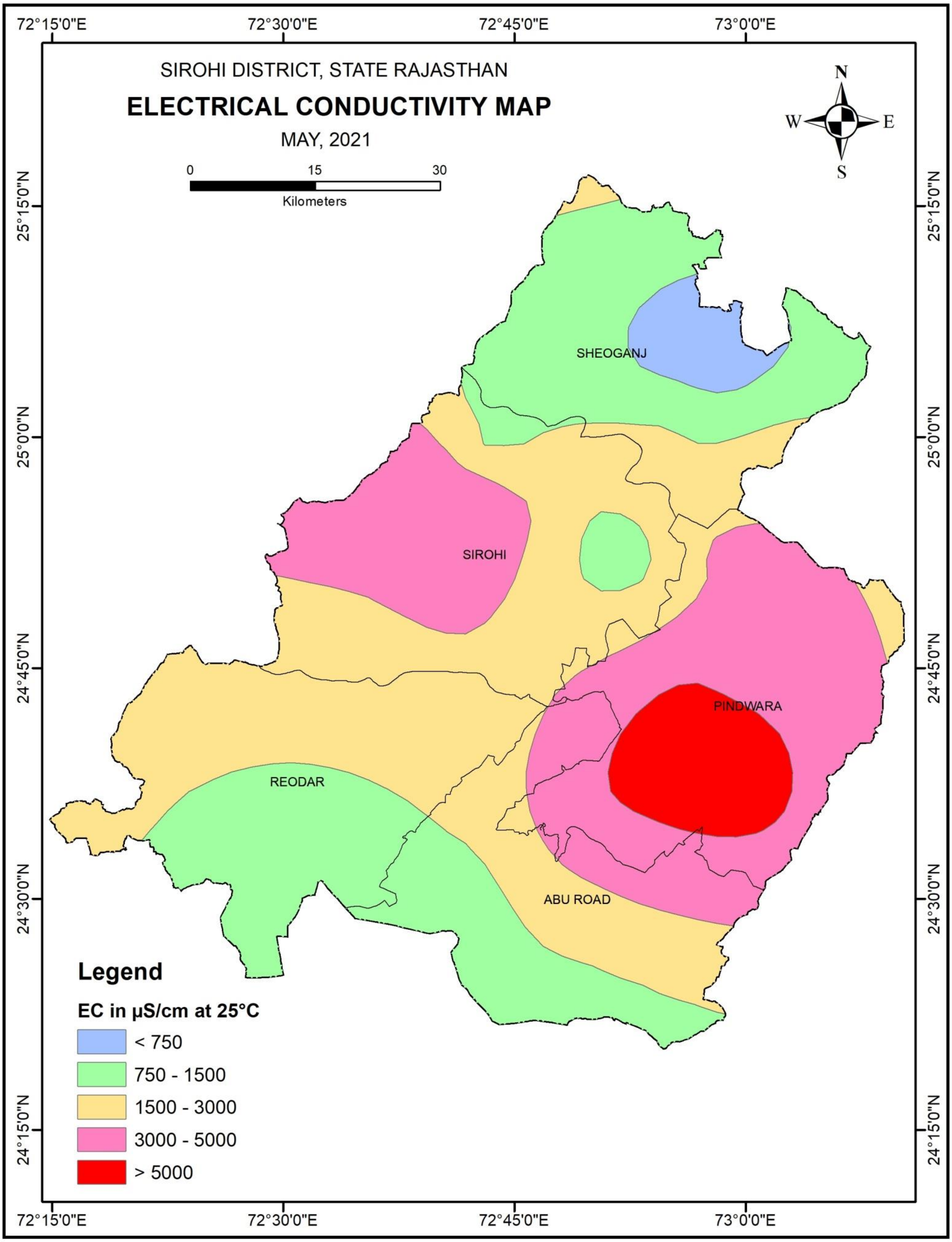


Figure 6.1: - Map of Electrical Conductivity of groundwater in Sirohi District

- **Total Dissolved Solids (TDS)**

Total Dissolved Solids (TDS) in water includes 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 TDS in the ground water has been recorded between 377 mg/l at Posaliya, Sheoganj block and 3686 mg/l at Sarupganj, Pindwara block.

- **Nitrate**

Concentration of nitrate (NO_3^-) has been found to vary from 21 mg/l to 225 mg/l. Nitrate concentration marginally exceeds the maximum Permissible Limit of 45 mg/l in drinking water prescribed by BIS (IS-10500:2012) in around 50% of the total ground water samples. Nitrate in excess of maximum Permissible Limit has been reported mainly from localised in Pindwara, Reodar Blocks on the eastern and south-western end of the district and at a very few places in Abu Road and Sirohi 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.

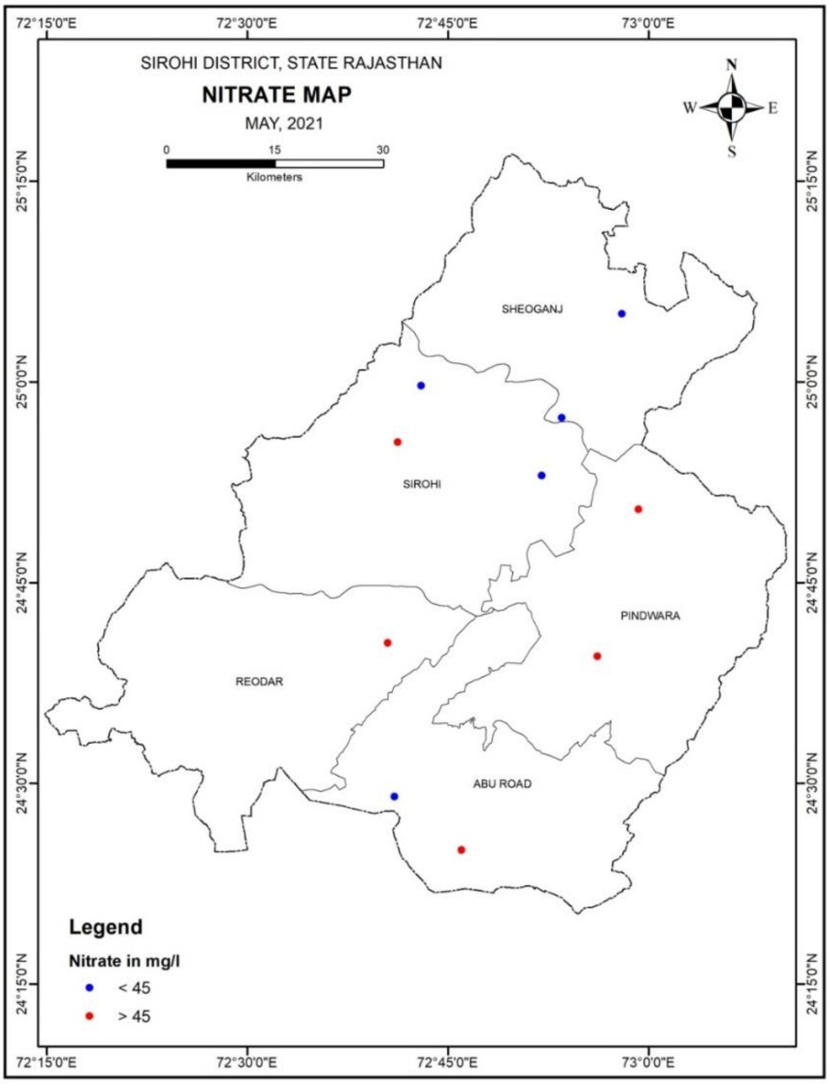


Figure6.2: - Map of Nitrate Distribution in groundwater of Sirohi District

- **Fluoride**

Fluoride (F^-) is an essential element for maintaining normal development of healthy teeth and bones. However, higher F^- concentration causes dental and skeletal fluorosis such as mottling of teeth, deformation of ligaments and bending of spinal cord. Concentrations of fluoride in groundwater samples have been found to vary between 0.25mg/l at Veerwara, Pindwara block and 4.45 mg/l at Kalandri, Sirohi block. Concentration of F is within desirable limit of 1 mg/l BIS (IS-10500:2012) in 60% of samples whereas it is between desirable and Permissible Limits in 20% samples and exceeds the maximum Permissible Limit of 1.5 mg/l (IS-10500: 2012) in 20% of the total analysed samples (figure6.3).

The fluoride contamination in ground water may be either due to weathering of rocks i.e. mainly granitic (geogenic) containing fluorine bearing minerals like fluorite, apatite and micas or due to excessive use of phosphatic fertilizers and fluoride containing insecticides and herbicides in agricultural fields.

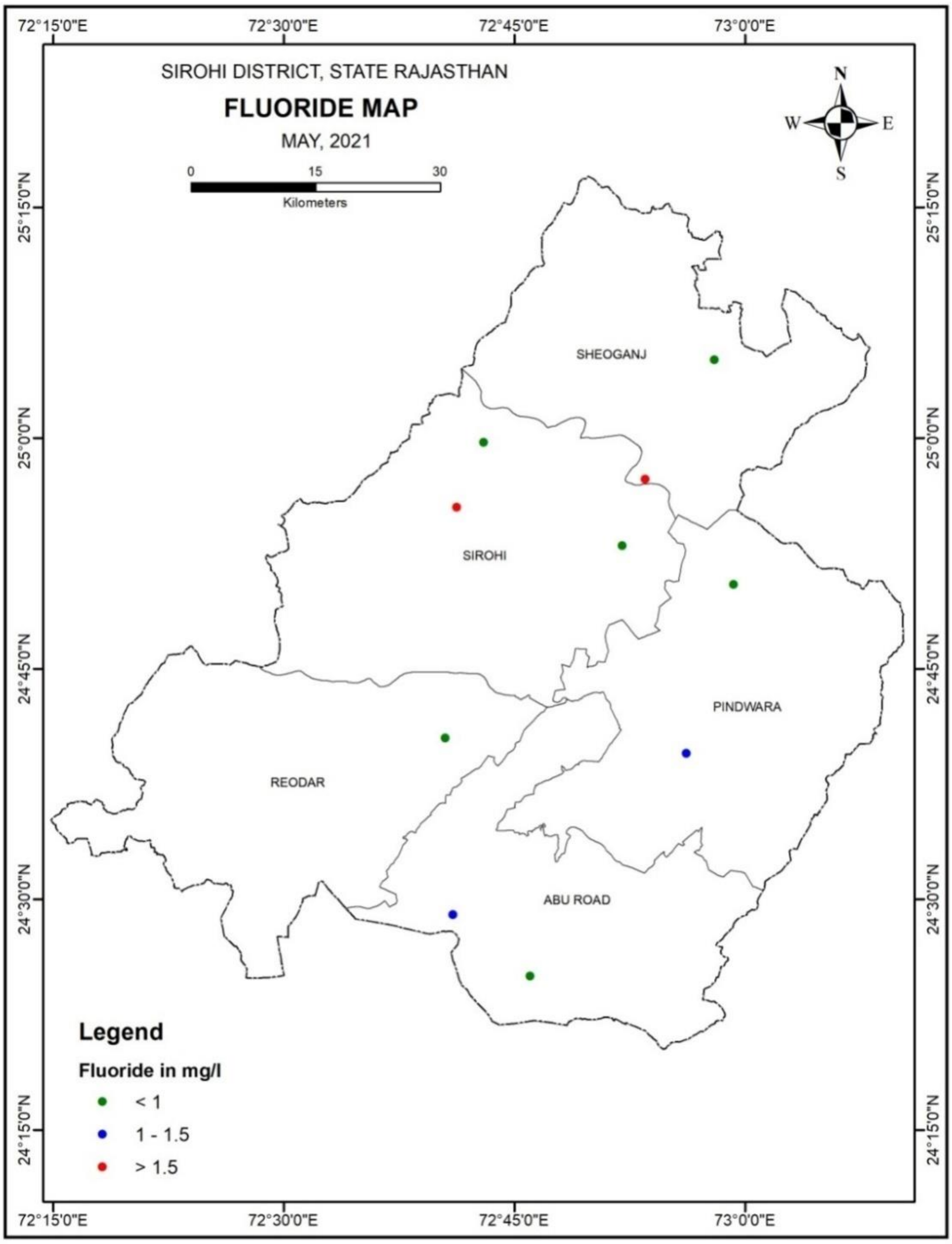


Figure 6.3: - Map of Fluoride Distribution of groundwater in Sirohi District

- **Total Hardness (TH)**

Total Hardness (TH) has been found to vary between 135 mg/l and 1205 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. As per drinking water standards of BIS the acceptable limit of total hardness is 200 mg/l and maximum Permissible Limit is 600 mg/l (IS-10500: 2012).

In Sirohi District, total hardness exceeds the recommended maximum permissible limit in around 30% of total analysed ground water samples. Total hardness in excess of the maximum Permissible Limit has been reported from parts of Pindwara and Sirohi Blocks of the district.

Table 6.1: Hardness Classification of water

Hardness (mg/l)	Water Class	% Sample
0 – 75	Soft	0.0
75 – 150	Moderately Hard	20.0
150 – 300	Hard	20.0
>300	Very Hard	60.0

6.2 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 table6.2 & 6.3 respectively.

Table 6.2: Classification of Ground Water Samples based on EC

	Classification of water		Activity required	
Type of Water	Range	% of Samples	GW Class (Irrigation Uses)	
Low Saline	<250	0	Excellent	Good for all crops little likelihood of development of salinity
Medium Saline	250-750	10	Good	Plants with moderate salt tolerance No special practices for salinity control required. Moderate amount of leaching occurs.
Highly Saline	750-2250	60	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	30	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

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.

Sodium Adsorption Ratio (SAR):

High concentration of sodium in water produces undesirable effects of changing soil properties and reducing soil permeability and thus reduces the supply of water needed for the crops. It is calculated from the ratio of sodium to calcium and magnesium by the following formula:

SAR= $Na^{+}/ [(Ca^{2+}+Mg^{2+})/2]^{0.5}$ **where** all ionic concentrations are expressed in meq/l.

Cumulative effect of salinity and sodium hazard in the study area can be study by plotting sodium-adsorption ratio and electrical conductivity (Figure) data on US Salinity Laboratory diagram (USSL, 1954).

Table 6.3:- Classification of Ground Water Samples based on SAR

Type of Water	Sodium Adsorption Ratio		Classification of water
	Range	% of Samples	
Low Sodium Water	< 10	70	Excellent
Medium Sodium Water	10 to 18	30	Good
High Sodium Water	18 to 26	0	Doubtful
Very High Sodium Water	>26	0	Unsuitable
		100	

Sodium Percent (Na %):

The sodium in irrigation waters is usually denoted as percent of sodium. According to Wilcox (1955), in all natural waters Na% is a common parameter to assess its suitability for irrigational purposes. The sodium percent (Na %) values were obtained by using the following equation:

Na%= $[Na^{+}+K^{+}] \times 100/ [Ca^{2+}+Mg^{2+}+Na^{+}+K^{+}]$ all ionic concentrations are expressed in meq/l.

Table 6.4:- Classification of Ground Water Samples based on Na%

Water Class	**Na%**	
	Range	% of samples
Excellent	< 20	0
Good	20 - 40	10
Medium	40 - 60	40
Bad	60 - 80	40
Very Bad	> 80	10

Source: Wilcox 1955

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.

Residual Sodium Carbonate (RSC):

Residual Sodium Carbonate (RSC) has been used to determine the harmful effect of carbonate and bicarbonate on the quality of water for agricultural purpose and is estimated by the formula.

RSC = $(HCO^{-3}+CO^{-3}) - (Ca^{2+}+Mg^{2+})$ where all ionic concentrations are expressed in meq/L.

According to the RSC classification for irrigation purposes, the water samples with values greater than 2.5 meq/l are unsuitable for irrigation.

Table 6.5: Classification of Ground Water Samples based on SAR

Residual Sodium Carbonate (RSC) (Eaton 1950; Wilcox et al. 1954)	Range	GW Class	% of Samples
	<1.25	Safe	90
	1.25-2.50	Marginal	0
	>2.50	Unsuitable	10

7.0 Ground Water Resources

The ground water resources have been assessment 2020 based on the methodology recommended by Groundwater Estimation Committee, 2015 (GEC 15). The block wise resources for Sirohi district are depicted in table 7.1.

Table 7.1:- Block wise GW Resources of Sirohi (as on March 2020) (in ham)

Block	Potential Zone	Annual Extractable Ground Water Resource	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
Abu Road	33106	2581.43	2773.397	428.16	3201.557	124.02	OE
Pindwara	88290	5140.47	3422.626	397.80	3820.426	74.32	SC
Reodar	98580	6338.19	11504.10	331.68	11835.782	186.74	OE
Sheoganj	77289	5003.74	6178.77	264.76	6443.53	128.77	OE
Sirohi	110305	5639.55	5780.902	463	6243.902	110.70	OE
District	407570	24703.38	29659.796	1885.40	31545.197	127.70	OE

Among the 5 blocks of Sirohi district, 4 blocks falls under Over Exploited (OE) category and 1 block falls under Semi-Critical (SC) category. Groundwater resources estimation data of Sirohi district shows that an annual extractable groundwater resource is 24703.35 ham whereas gross groundwater draft for all uses is 31545.197 ham. Due to this, the stage of groundwater development of the district has reached to 127.70% i.e. shows Over Exploited category.

As per comparison of Stage of Groundwater Development between GWRE 2017 and GWRE 2020, it was found that stage of groundwater development has exceed in all 4 blocks among 5 blocks of district except Pindwara block. The comparison between GWRE 2017 and GWRE 2020 is given in table 7.2 and figure 7.1.

Table 7.2:- Comparison of Stage of GW Development between GWRE 2017 and 2020

Block	**Stage of GW Development (%)**	
	2017	2022
ABU ROAD	99.9	124.02
PINDWARA	83.92	74.32
REODAR	159.3	186.74
SHEOGANJ	103.88	128.77
SIROHI	91.3	110.72
District	104.25	127.7

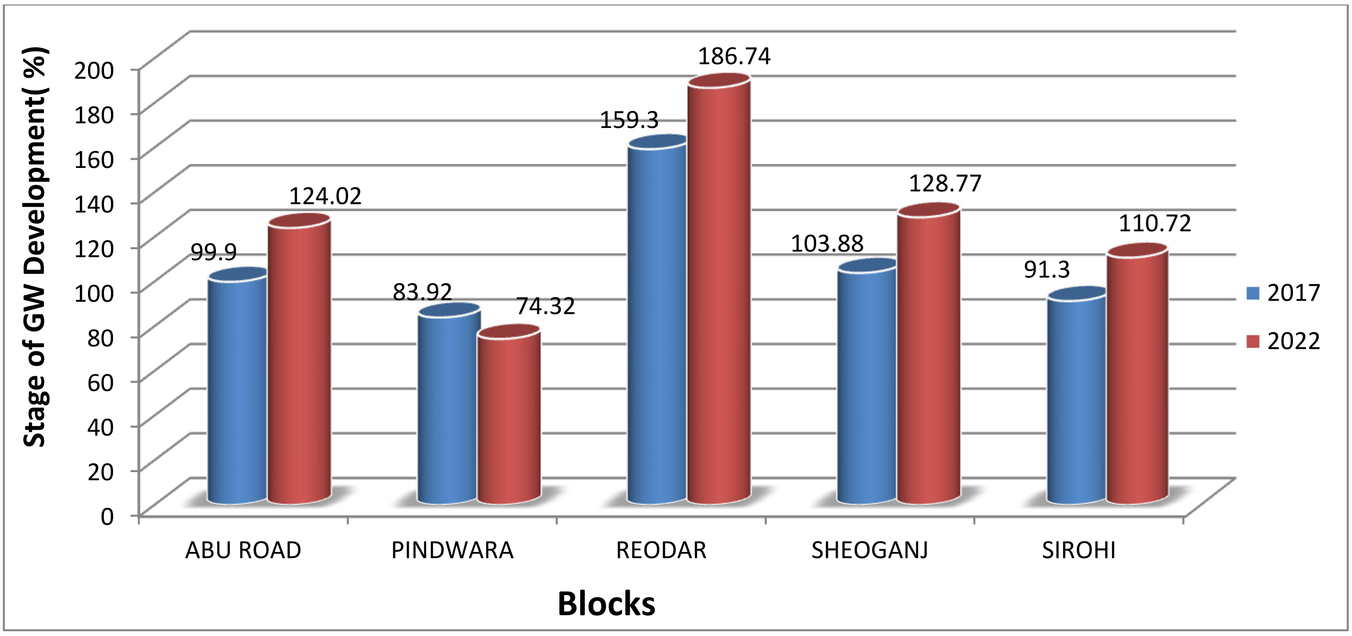


Figure 7.1: - Block wise stage of groundwater development through the years in Sirohi District

8.0 Aquifer Management Plan

8.1 Ground water Related Issues

Decline in Water Level:

Long term water level data (pre and post monsoon, 2011-21) indicate declining trend in all the blocks during pre-monsoon period and post-monsoon period. Decadal water level fall is mainly observed in the central part of the district. Water level falls more than 4 m is recorded in the central core part of district. Water level fall between 2m and 4 m is observed in the small circular portion of district mainly in Sirohi block. Water level fall 0-2 m is analyzed in central and scattered portion of northern and south-western part of district.

Declining trend has resulted due to the overdraft of ground water resources than its natural replenishment. Ground water resources data indicate that out of 5 blocks, only 1 block (Pindwara) is semi-critical and reaming all four blocks are over exploited. The stage of ground water development ranges from 74.32% (in Pindwara block) to 186.74% (in Reodar Block). It has resulted in decline in water level. Deeper water level causes more consumption of power to draw ground water and deterioration in ground water quality.

Ground Water Quality Deterioration:

In most parts of the district, fluoride (>1.5 mg/lit) is found in more than 40% villages and habitations. Fluoride hazard is mainly in central and western parts of the district. The total salt concentration more than 2000 mg/l is observed in 20% villages. Salinity is scattered in central and eastern parts of the district.

8.2 Ground Water Management Strategy

As a whole the district is comes under OE category thereby, leaving no/limited scope of further ground water development for various consumptions. In order to manage the ground water resources and to control further decline in water levels, a management plan has been proposed. The management plan comprises two components - supply side management and demand side management.

8.2.1 Supply Side Management:

The supply side management of ground water resources can be done through the artificial recharge of surplus runoff available within river sub basins and micro watersheds. Also it is necessary to understand the de-saturated aquifer volume available for recharge. The unsaturated volume of aquifer for the Sirohi district is computed based on following; the area feasible for recharge, unsaturated depth below 5 m bgl and the specific yield of the aquifer. The block-wise volume available for the recharge is given below in Table 8.1.

Table 8.1:- Block-wise Proposal of Water Conservation Structures in Sirohi District

District	Block	Volume of sub surface storage space available for artificial recharge (MCM)	Surface water Surplus (mcm)	Mini Percolation Tank (No. proposed)	Percolation Tank (No. proposed)	Pucca Check dam (No. proposed)	Anicut (No. proposed)	Surplus water utilized by (MPT/PT/PCD/Anicut/MST) (mcm)	Area recommended for Catchment area treatment (ha) (10% of PL+BL)
Sirohi	Abu Road	38.42	6.71	1769	505	213	148	4.56	455
Sirohi	Pindwara	362.71	8.66	2286	550	362	258	6.39	1358
Sirohi	Reodar	522.15	3.44	756	346	142	78	2.53	1831
Sirohi	Sheoganj	441.52	0.65	105.5	49	12	9	0.31	1244
Sirohi	Sirohi	753.48	1.43	248	135	61	38	1.00	1439

8.2.2 Demand Side Management

The demand side management includes water saving by using interventions such as use of sprinkler irrigation in the areas where Rabi crop is being irrigated through ground water and changing the area under more water intensive i.e. wheat crop to gram. The water saving by adopting micro irrigation practices has been proposed in all the blocks whereas the change in cropping pattern has been proposed in the blocks where the Stage of Ground Water Development falls in Over Exploited and Critical Category for the sustainable development of the groundwater. 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. It can be seen that hardly any enhancement in ground water resources can be conserved through artificial recharge due to constraints of availability of surplus/non-committed surface water. However, considerable improvement in ground water situation can be achieved with implementation of the suggested demand side management interventions.

Table 8.2:- Block-wise water saving through change in cropping pattern and irrigation practice

Block	Net Irrigated Area (ha)			Gross Irrigated Area through Ground Water (Ha)			50% of Gross Irrigated Area Changed to Sprinkler Irrigation	Area Under Wheat	50% of Area Under Wheat Changed to Gram	Water Saving in mcm		
	DW	TW	Total	DW	TW	Total				Through Sprinkler Use	Through Crop Change	Total saving
Abu Road	14820	244	15064	9108	244	9352	4676	5246	2623.00	3.74	2.62	6.36
Pindwara	14238	0	14238	16740	0	16740	8370	9660	4830.00	6.70	4.83	11.53
Reodar	31431	0	31431	51757	0	51757	5175.7	9934	1241.75	4.14	1.24	5.38
Sheoganj	10158	1517	11675	12639	2282	14921	0	4899	612.38	1.19	2.44	3.63
Sirohi	14820	960	15780	17898	972	18870	9435	4296	2148.00	7.55	2.15	9.70
District	85467	2721	88188	108142	3498	111640	27656.7	34035	11455.12	22.12	11.45	33.58

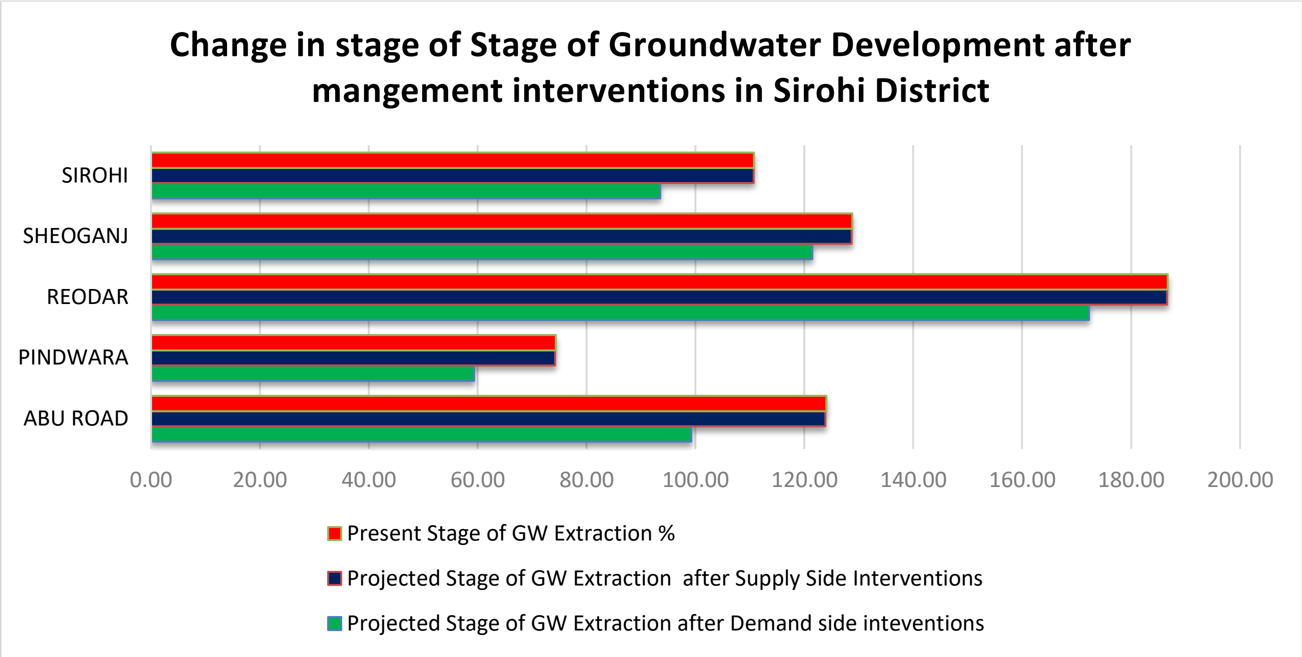


Figure 8.1: Expected Change in Stage of Ground Water Extraction after Proposed Interventions.

Recommendations

- Issues related to water management in the district are highly complex and need to be resolved through the involvement of government departments, research institutions, NGOs and other stakeholders.

- Planning for the development and management of ground water in any area in the state must address the factors like erratic rainfall, limited ground water storage availability, excessive fluoride, high nitrate concentration and declining water levels.

- These aspects should be taken as a core consideration for planning and implementing ground water development and management programs. A holistic approach taking all aspects into consideration shall therefore, need to be adopted.

- The present study is an effort to assess the available water resources, current demand and future projection and technological options for water management to improve water availability and management efficiency for various uses.

Conclusions and points for future action are summarized below.

- The interventions discussed above needs to be implemented to bring down the Stage of Ground Water Development and put a halt to further decline of ground water levels. In irrigation sector sprinkler and drip system of irrigation should be promoted and made mandatory in phased manner, wherever feasible.

- Water efficient crops are needed to be promoted at suitable rates and markets should be developed by the district administration for them accordingly. The interventions above need to be supported by regulation on extraction from deeper aquifer. So, the deeper ground water resources can be protected for future generation and also serve as ground water reserve in times of distress/drought. Agricultural and urban runoff tainted with chemical pesticides and fertilizers are the sources of waste water from domestic and agriculture sites.

- Effluents from industries, mining sites etc. are also responsible for huge amount of waste water generation. Domestic waste water can be for gardening and cleaning. Judicious and economic use of water in bathing, cleaning and cooking should be promoted. Further leakage from domestic taps and pipelines for water supply to urban areas need to be checked.

- Wastewater generated from hotels and resorts can be considered as a resource if it can be cleaned to such standards that it can be reused in for flushing toilets, laundry machines or irrigation of crops. The waste water from these industrial areas can also be reused after defined treatment from effluent treatment plant. Effective solid waste disposal mechanism needs to be properly developed and monitored. This can be utilized for manufacturing biogas.

- Paving of surface for providing civic amenities in the towns & cities has led to reduced infiltration and increased run-off water during the rainy season. Rainwater harvesting structures should therefore be adopted to intercept and recharge the roof-top run-off from individual households in feasible areas.

- The traditional systems of water harvesting, like the bawari, jhalara, nadi, tanka, khadin, etc., prevalent in the region over centuries, are still viable and cost-effective. If these systems are improved and utilized on a large scale, they can meet the requirements of drinking water of the rural population and mitigate the availability of water in lean season at least partially.

- In addition, modern rainwater technologies, such as anicuts, percolation tanks, injection wells and subsurface barriers, are highly effective in rejuvenating depleted groundwater aquifers and ensuring stagnation of water at a place. Local municipal bodies should encourage such provisions. Such structures must be located and designed keeping in view the geology, geomorphology and hydrogeological set-up prevailing in the area.

- Water and soil conservation through agronomic and engineering measures need to be integrated. Other measures of water conservation like contour cultivation, different kinds of bunding, bench terracing in conjunction with cover cropping and appropriate land use practices enhance water conservation and productivity and also recharge the aquifer over a long period. They have to receive more focus in an integrated fashion. Since ground water abstraction structures are individually owned, operated and managed, it is difficult to have an account of ground water abstraction by volume.

- Voluntary registration of structures needs to be encouraged so as to obviate the requirement for enactment and enforcement of any legal measures. Whereas restrictions must be laid on the construction and electrification of individually owned structures for drinking and domestic use with a view to avoid wastage of water, but also, adequate supply from municipal water supply system shall have to be ensured in such areas. In terms of the critical issues for the drinking water such as source sustainability, water quality management and better operation and maintenance, it is important that strong grassroots awareness is generated. Thus, IEC activities and capacity building activities needs to be aggressively propagated to establish the institutional framework for participatory ground water management.

Annexure-1 Rainfall Data

YEAR	Mean RF (mm)	DEP. (%)	YEAR	Mean RF (mm)	DEP. (%)
1971	750.63333	-6.14737	1995	679.8	-15.0038
1972	606.88333	-24.12061	1996	743.066667	-7.09344
1973	2025.05	153.19455	1997	1032.93333	29.14895
1974	349.18333	-56.34117	1998	656.783333	-17.8816
1975	1176.0167	47.038843	1999	394.266667	-50.7043
1976	1257.6333	57.243478	2000	434.95	-45.6177
1977	1153.2167	44.18813	2001	742.6	-7.15179
1978	902.98333	12.901142	2002	270.383333	-66.1936
1979	740.66667	-7.393515	2003	922.733333	15.37051
1980	491.36667	-38.56381	2004	616	-22.9807
1981	646.31667	-19.19021	2005	820.516667	2.590231
1982	579.6	-27.53188	2006	1529.58333	91.24573
1983	761.2	-4.826207	2007	829.316667	3.690506
1984	700.25	-12.44686	2008	507.183333	-36.5862
1985	520.71667	-34.89414	2009	436.666667	-45.403
1986	468.51667	-41.42077	2010	947.683333	18.49004
1987	234.63333	-70.6635	2011	1081	35.15879
1988	736.66667	-7.89364	2012	739.833333	-7.49771
1989	498.9	-37.62191	2013	813.266667	1.683754
1990	1597.0667	99.683254	2014	654.966667	-18.1087
1991	515.38333	-35.56097	2015	1029.5	28.71968
1992	1382.1333	72.809869	2016	919.05	14.90998
1993	683.96667	-14.48279	2017	1581.83333	97.77861
1994	1433.1667	79.190631	2018	500.166667	-37.4635

Annexure -2

Water level data of May 2021 and Nov 2021 of Sirohi District

S No	BLOCK	VILLAGE	TYPE	AGENCY	LONG	LAT	MP	DEPTH	ELEVATION	MAY_2021	NOV_2021
1	Sheoganj	AMBESHWARJI	Dug	CGWB	72.8917	24.9556	0.07	25.43	279	3.33	3.13
2	Reodar	Anadara	PZ	CGWB	72.65	24.6333	1	150	272	20.1	9.5
3	Sirohi	BARLOT	Dug	CGWB	72.7167	24.9953	1.03	35	230	0	0
4	Reodar	GULABGANJ	Dug	CGWB	72.675	24.675	1.01	22	287	11.09	0
5	Reodar	JIRAWAL	Dug	CGWB	72.4917	24.6389	0.94	30	257	9.76	8.36
6	Sirohi	KALANDRI	Dug	CGWB	72.6875	24.925	0.52	18	262	13.58	12.58
7	Abu Road	Manpur2	PZ	CGWB	72.7592	24.5044	0.74	150	250	14.77	8.12
8	Sirohi	MeraKishanganjPz	PZ	GWD	72.7361	24.7694	1	120	317	26.4	0
9	Abu Road	Mount Abu	Dug	PUBLIC WELL	72.7102	24.5918	0	11.6	1146	0	0
10	Abu Road	Mungthalla	PZ	CGWB	72.6833	24.4833	0.35	150	252	6.95	8.1
11	Sirohi	PALRI	Dug	CGWB	72.8175	24.8644	0.83	30	349	16.27	12.47
12	Sheoganj	Palri M	Dug	Public Well	72.925	25.0153	1	48	260	0	0
13	Pindwara	Pindwara(Sirohi Road)	PZ	GWD	73.0462	24.7921	0	60	368	0	0
14	Sheoganj	Posaliya	PZ	CGWB	72.9667	25.0847	1.1	150	253	0	0
15	Reodar	Reodar	PZ	CGWB	72.5333	24.6333	1	150	256	18.6	16.65
16	Pindwara	SARUPGANJ	Dug	CGWB	72.9361	24.6583	1.22	25	334	0	12.53
17	Sirohi	SIROHI	Dug	CGWB	72.8667	24.8833	1.39	27.26	319	15.31	15.71
18	Abu Road	SIYANA	Dug	CGWB	72.7667	24.4167	0.42	11.08	264	8.18	8.28
19	Pindwara	VIRWARA	Dug	CGWB	72.9875	24.8414	1.15	19.55	403	9.55	5.25

Annexure- 3

Water level decadal (2012-2021) fluctuation of Pre and Post Monsoon

S No	BLOCK	VILLAGE	TYPE	AGENCY	LONG	LAT	MP	DEPTH	ELEVATION	Decadal Pre 2021	Decadal Post 2021
1	Sheoganj	AMBESHWARJI	Dug	CGWB	72.8917	24.9556	0.07	25.43	279	-1.056	0.662
2	Reodar	Anadara	PZ	CGWB	72.65	24.6333	1	150	272	5.48	-1.16
3	Sirohi	BARLOT	Dug	CGWB	72.7167	24.9953	1.03	35	230	-18.29	-18.5
4	Reodar	GULABGANJ	Dug	CGWB	72.675	24.675	1.01	22	287	0.525	-4.98
5	Reodar	JIRAWAL	Dug	CGWB	72.4917	24.6389	0.94	30	257	-5.448	-0.26
6	Sirohi	KALANDRI	Dug	CGWB	72.6875	24.925	0.52	18	262	-0.899	2.422
7	Abu Road	Manpur2	PZ	CGWB	72.7592	24.5044	0.74	150	250	1.994	2.94
8	Sirohi	MeraKishanganjPz	PZ	GWD	72.7361	24.7694	1	120	317	20.33	-3.27
9	Abu Road	Mount Abu	Dug	PUBLIC WELL	72.7102	24.5918	0	11.6	1146	0	0
10	Abu Road	Mungthalla	PZ	CGWB	72.6833	24.4833	0.35	150	252	-0.245	0.092
11	Sirohi	PALRI	Dug	CGWB	72.8175	24.8644	0.83	30	349	5.128	6.83
12	Sheoganj	Palri M	Dug	Public Well	72.925	25.0153	1	48	260	-12.26	-12.6
13	Pindwara	Pindwara(Sirohi Road)	PZ	GWD	73.0462	24.7921	0	60	368	0	0
14	Sheoganj	Posaliya	PZ	CGWB	72.9667	25.0847	1.1	150	253	-26.53	-17
15	Reodar	Reodar	PZ	CGWB	72.5333	24.6333	1	150	256	1.28	0.97
16	Pindwara	SARUPGANJ	Dug	CGWB	72.9361	24.6583	1.22	25	334	-17.34	5.241
17	Sirohi	SIROHI	Dug	CGWB	72.8667	24.8833	1.39	27.26	319	3.764	10.38
18	Abu Road	SIYANA	Dug	CGWB	72.7667	24.4167	0.42	11.08	264	-0.539	0.783
19	Pindwara	VIRWARA	Dug	CGWB	72.9875	24.8414	1.15	19.55	403	0.295	2.814

Annexure-4

Lithology of the exploratory wells

Bore	Depth1	Depth2	Inferred Lithology
ABUROAD	0	9.87	Unsaturated Weathered/Fractured Schist
ABUROAD	9.87	54.8	Saturated Weathered/Fractured Schist
ABUROAD	54.8	150	Compact Schist
ADARSH DOONGRI	0	7.7	Top Soil
ADARSH DOONGRI	7.7	16	Saturated Weathered/Fractured Granite
ADARSH DOONGRI	16	38.2	Saturated Weathered/Fractured Granite
ADARSH DOONGRI	38.2	175	Compact Granite
AKRABHATTA	0	3	Top Soil
AKRABHATTA	3	11	Unsaturated Alluvium
AKRABHATTA	11	25.5	Unsaturated Alluvium
AKRABHATTA	25.5	43.7	Saturated Alluvium
AKRABHATTA	43.7	68	Compact Granite
AKRABHATTA	68	71	Compact Granite
AKRABHATTA	71	131.75	Compact Granite
AMARAPURI	0	1.55	Top Soil
AMARAPURI	1.55	4	Saturated Alluvium
AMARAPURI	4	25.3	Saturated Weathered/Fractured Granite
AMARAPURI	25.3	145	Compact Granite
ANADRA	0	42	Top Soil
ANADRA	42	135	Compact Granite
ANADRA	135	138	Saturated Weathered/Fractured Granite
ANADRA	138	162	Compact Granite
ANADRA	162	198	Saturated Weathered/Fractured Granite
BALWANTGARH	0	9	Top Soil
BALWANTGARH	9	36	Saturated Weathered/Fractured Granite
BALWANTGARH	36	48	Compact Granite
BALWANTGARH	48	51	Saturated Weathered/Fractured Granite
BALWANTGARH	51	135	Compact Granite
BALWANTGARH	135	138	Saturated Weathered/Fractured Granite
BALWANTGARH	138	198	Compact Granite
BARLOOT	0	30	Unsaturated Alluvium
BARLOOT	30	54	Saturated Weathered/Fractured Granite
BARLOOT	54	156	Compact Granite
BARLOOT	156	159	Saturated Weathered/Fractured Granite
BARLOOT	159	180	Compact Granite
BARLOOT	180	183	Saturated Weathered/Fractured Granite
CHANDRAWATI	0	3	Top Soil
CHANDRAWATI	3	6	Unsaturated Weathered/Fractured Granite
CHANDRAWATI	6	10	Unsaturated Weathered/Fractured Granite
CHANDRAWATI	10	44	Compact Granite
CHANDRAWATI	44	117.25	Compact Schist

DELDAR	0	3	Top Soil
DELDAR	3	30	Saturated Alluvium
DELDAR	30	48	Saturated Weathered/Fractured Schist
DELDAR	48	198	Compact Granite
DHANARI	0	5.72	Top Soil
DHANARI	5.72	13.8	Saturated Alluvium
DHANARI	13.8	19.9	Saturated Weathered/Fractured Granite
DHANARI	19.9	26	Saturated Weathered/Fractured Granite
DHANARI	26	145	Compact Granite
FUTELA	0	9	Top Soil
FUTELA	15	21	Compact Schist
FUTELA	22	36	Compact Schist
FUTELA	39	54	Compact Schist
FUTELA	57	111	Compact Schist
FUTELA	114	150	Compact Schist
GHARAT	0	12	Top Soil
GHARAT	12	18	Saturated Alluvium
GHARAT	24	198	Compact Schist
GIRWAR	0	3.13	Top Soil
GIRWAR	3.13	21	Saturated Alluvium
GIRWAR	21	49.5	Saturated Weathered/Fractured Granite
GIRWAR	49.5	125	Compact Granite
HAMIRPURA	0	6	Top Soil
HAMIRPURA	6	12	Saturated Weathered/Fractured Granite
HAMIRPURA	12	21	Compact Granite
HAMIRPURA	21	24	Saturated Weathered/Fractured Granite
HAMIRPURA	24	69	Compact Granite
HAMIRPURA	69	72	Saturated Weathered/Fractured Granite
HAMIRPURA	72	81	Compact Granite
HAMIRPURA	81	84	Saturated Weathered/Fractured Granite
HAMIRPURA	84	198	Compact Granite
JHANKAR	0	8	Top Soil
JHANKAR	8	11	Unsaturated Weathered/Fractured Granite
JHANKAR	11	14.36	Compact Granite
JHANKAR	14.36	93.1	Compact Granite
JUBLIGANJ	0	60	Top Soil
JUBLIGANJ	60	72	Saturated Weathered/Fractured Granite
JUBLIGANJ	72	108	Compact Granite
JUBLIGANJ	108	111	Saturated Weathered/Fractured Granite
JUBLIGANJ	111	171	Compact Granite
JUBLIGANJ	171	174	Saturated Weathered/Fractured Granite
JUBLIGANJ	174	200	Compact Granite
KIWERLI	0	3.1	Top Soil
KIWERLI	3.1	6.17	Unsaturated Weathered/Fractured Granite
KIWERLI	6.17	9.2	Saturated Weathered/Fractured Granite
KIWERLI	9.2	13.3	Saturated Alluvium
KIWERLI	13.3	15.3	Saturated Weathered/Fractured Granite

KIWERLI	15.3	18.4	Saturated Weathered/Fractured Granite
KIWERLI	18.4	98	Compact Schist
KUMA	0	6	Top Soil
KUMA	6	9	Saturated Weathered/Fractured Granite
KUMA	9	200	Compact Granite
MACHGAON	0	7.6	Top Soil
MACHGAON	7.6	8.81	Unsaturated Weathered/Fractured Granite
MACHGAON	8.81	32	Saturated Weathered/Fractured Granite
MACHGAON	32	123.6	Compact Granite
MADIA	0	9	Top Soil
MADIA	9	15	Saturated Weathered/Fractured Granite
MADIA	15	144	Compact Granite
MADIA	144	147	Saturated Weathered/Fractured Granite
MADIA	147	156	Compact Granite
MADIA	156	159	Saturated Weathered/Fractured Granite
MADIA	159	198	Compact Granite
MT.ABU	0	1	Top Soil
MT.ABU	1	10.1	Unsaturated Weathered/Fractured Granite
MT.ABU	10.1	33.1	Saturated Weathered/Fractured Granite
MT.ABU	33.1	84.3	Compact Granite
MT.ABU	84.3	111	Compact Granite
MT.ABU	111	151	Compact Granite
NANDIA	0	3	Top Soil
NANDIA	3	9	Saturated Alluvium
NANDIA	9	15	Saturated Weathered/Fractured Granite
NANDIA	15	198	Compact Granite
PESHUA	0	16	Top Soil
PESHUA	10	16	Unsaturated Weathered/Fractured Granite
PESHUA	16	16.5	Saturated Weathered/Fractured Schist
PESHUA	16.5	123.4	Compact Granite
RAJPURA	0	6	Top Soil
RAJPURA	6	15	Saturated Weathered/Fractured Granite
RAJPURA	15	33	Compact Granite
RAJPURA	33	84	Saturated Weathered/Fractured Granite
RAJPURA	84	141	Compact Granite
RAJPURA	141	144	Saturated Weathered/Fractured Granite
RAJPURA	144	147	Compact Granite
RAJPURA	147	150	Saturated Weathered/Fractured Granite
SANTPUR	0	2	Top Soil
SANTPUR	2	11.2	Unsaturated Weathered/Fractured Granite
SANTPUR	11.2	12.25	Saturated Weathered/Fractured Granite
SANTPUR	12.25	101.3	Compact Granite
SAROOPGANJ	0	2	Top Soil
SAROOPGANJ	2	6.4	Unsaturated Weathered/Fractured Granite
SAROOPGANJ	6.4	8.1	Saturated Weathered/Fractured Granite
SAROOPGANJ	8.1	25.3	Saturated Weathered/Fractured Granite
SAROOPGANJ	25.3	71.1	Compact Granite

SAROOPGANJ	71.1	80.2	Compact Granite
SAROOPGANJ	80.2	129	Compact Granite
SATAPURA	0	36	Saturated Alluvium
SATAPURA	36	42	Saturated Weathered/Fractured Granite
SATAPURA	42	108	Compact Granite
SATAPURA	108	111	Saturated Weathered/Fractured Granite
SIVERA	0	12	Top Soil
SIVERA	18	45	Compact Schist
SIVERA	48	111	Compact Schist
SIVERA	114	198	Compact Schist
SIYAWA	0	6	Top Soil
SIYAWA	6	32	Compact Granite
SIYAWA	32	80	Saturated Weathered/Fractured Granite
SIYAWA	80	151	Compact Granite
VERAWILPUR	0	3	Top Soil
VERAWILPUR	3	48	Saturated Alluvium
VERAWILPUR	48	57	Saturated Weathered/Fractured Granite
VERAWILPUR	57	63	Compact Granite
VERAWILPUR	63	66	Saturated Weathered/Fractured Granite
VERAWILPUR	66	120	Compact Granite
VERAWILPUR	120	123	Saturated Weathered/Fractured Granite
VERAWILPUR	123	200	Compact Granite

Annexure-5

Water Quality parameters of groundwater samples in Sirohi District

Location	**Depth in m.**	**Long.**	**Lat.**	**pH***	**EC* μS/cm at 25° C**	**CO_3**	**HCO_3**	**Cl***	**SO_4**	**NO_3***	**PO_4**	**F***	**TH***	**Ca***	**Mg***	**Na***	**K***	**TDS**	**SAR**	**Na %**	**RSC**
Sarupganj	25	72.9361	24.6583	8.23	5670	0	274	1372	840	97.0	0.04	1.32	1071	156	166	941	3	3686	12.50939	65.69515	-16.924
Ambeshwarji	25.43	72.8917	24.9556	8.05	2170	0	451	357	170	30.0	0.07	2.20	385	74	49	322	1	1411	7.140635	64.58222	-0.30378
Sirohi	27.26	72.8667	24.8833	8.4	1150	36	293	102	105	31.0	0.37	0.72	255	54	29	152	2	748	4.14204	56.66158	0.904627
Gulabganj	22	72.6750	24.6750	8.25	2050	0	427	275	202	125.0	0.39	0.65	150	27	20	327	150	1333	11.61703	85.76386	3.999963
Barlot	-	72.7167	24.9953	7.21	1450	0	317	209	152	21.0	0.11	0.44	315	82	27	191	1	943	4.68373	56.97521	-1.09786
Kalandri		72.6875	24.9250	7.85	4810	0	780	749	490	225.0	0.15	4.45	640	111	88	800	22	3127	13.75888	73.43213	-0.01027
Posaliya	60	72.9667	25.0847	8.05	580	0	85	45	135	22.0	0.08	0.99	135	26	17	72	1.00	377	2.696358	53.92007	-1.30533
Siyana	11	72.7667	24.4167	8.05	1350	0	253	184	160	51.0	0.07	0.95	270	76	19	180	12	878	4.768	60.13822	-1.24696
Mungthalla	60	72.6833	24.4833	8.45	1150	36	329	125	35	39.0	0.67	1.10	305	71	31	120	15	748	2.990224	47.90211	0.496252
Veerwara	60	72.9875	24.8414	7.88	3310	0	854	458	225	101.0	0.04	0.25	1205	167	192	211	3	2152	2.644355	27.75144	-10.0983