केंद्रीय भूजल 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

Report on

AQUIFER MAPPING AND MANAGEMENT PLAN

ASHOKNAGAR DISTRICT, MADHYA PRADESH

उत्तर केंद्रीय क्षेत्र, भोपाल

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Department of Water Resources, River Development and Ganga Rejuvenation

Ministry of Jal Shakti

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1. INTRODUCTION

The primary objective of the Aquifer Mapping can be summed up as "Know your Aquifer, Manage your Aquifer". Demystification of Science and thereby involvement of stake holders is the essence of the entire project. The involvement and participation of the community will infuse a sense of ownership amongst the stakeholders. Greater the harmony between the two, greater will be the chances of successful implementation and achievement of the goals of the Project. As per the Report of the Working Group on Sustainable Ground Water Management, "It is imperative to design an aquifer mapping programme with a clear-cut groundwater management purpose. This will ensure that aquifer mapping does not remain an academic exercise and that it will seamlessly flow into a participatory groundwater management programme. The aquifer mapping approach can help integrate ground water availability with ground water accessibility and quality aspects.

1.1 Scope of the study:

Systematic mapping of an aquifer encompasses a host of activities such as collection and compilation of available information on aquifer systems, demarcation of their extents and their characterization, analysis of data gaps, generation of additional data for filling the identified data gaps and finally, preparation of aquifer maps at the desired scale. This manual attempt to evolve uniform protocols for these activities to facilitate their easy integration for the district as whole.

1.2 Approach and Methodology:

National Aquifer Mapping Programme basically aims at characterizing the geometry, parameters, behavior of ground water levels and status of ground water development in various aquifer systems to facilitate planning of their sustainable management. The major activities involved in this process include compilation of existing data, identification of data gaps, and generation of data for filling data gaps and preparation of aquifer maps. The overall activities of aquifer mapping are presented in the flow chart below.

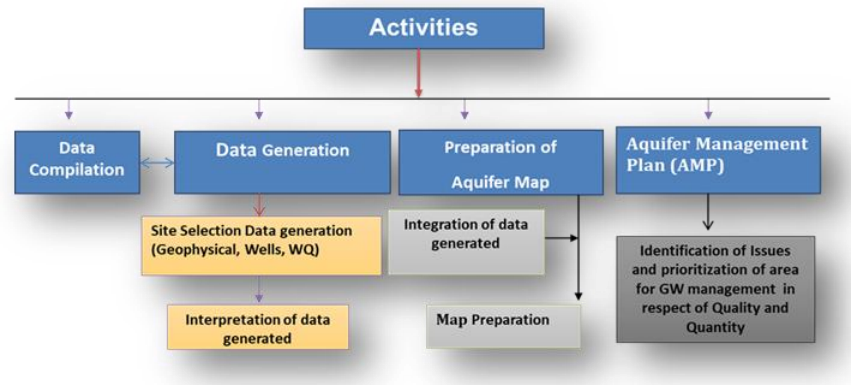


Figure 1: Steps Involved in NAQUIM

1.3 Location and Geographical Units

Ashoknagar district was previously a part of Guna district. It is situated in the northeastern part of the Madhya Pradesh and covers an area of about 4,673.94 sq km. Ashoknagar is located on the northern part of Madhya Pradesh between Sindh and the Betwa. It comes under the northern part of Malwa plateau, though main part of its district lies in the Bundelkhand Plateau.

Geographically, the district is situated between the latitude 24°18' N to 25° N and longitude 77°30' to 78°18' E and falls in Survey of India toposheet number 54 G, H & L. It is bounded in the North by Shivpuri district and east by Uttar Pradesh, in the south by the Rajgarh & in the west by the Guna district. The eastern and western boundaries of the district are well defined by the rivers (Fig. 1). The Betwa flows along the eastern boundary separating it from Sagar District and Lalitpur District of Uttar Pradesh. The elevation in the district ranges from 409 m amsl to 502 m amsl.

Ashoknagar district is divided into 5 tehsils and 4 blocks. It has 935 villages. Total population of the district is 845071 (As per census 2011) and density of the population is 147 persons per sq. km.

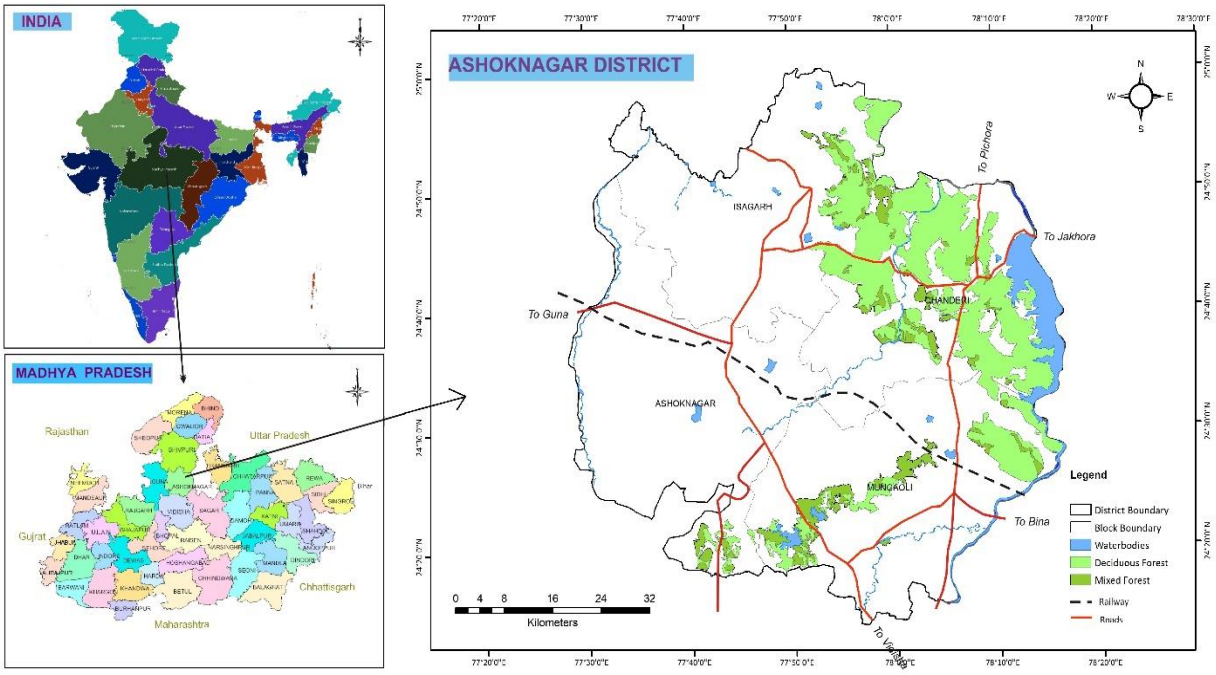


Figure 2: Base map

1.4 Demography

As per district Census 2011, the population distribution, Literacy, sex ratio and livestock has been enumerated in the table below;

Persons		**Male**	**Female**
Total Population	844979	444651	400328
Population (0-6)	136680	71424	65256
Total Literates	480957	299409	181548
Literacy Rate	67.9	80.2	54.2
Growth Rate	22.6 (2001-11)		
Sex Ratio	900		
Child Sex Ratio	914 (0-6 years)		

Table 1: Population data

(Source: District Census Handbook)

1.5 Climatic Conditions: Rainfall and Climate

The climate of Ashoknagar district is characterized by a hot summer and general dryness except during the southwestern monsoon. A year may be divided into four seasons. Cold season December to February followed by the hot season from March to about middle of June. The period from Middle of June to September is the southwestern monsoon season. October & November forms the post monsoon or transition period. The nearest observatory is Guna, hence meteorological data of Guna observatory is used except for rainfall data.

The normal rainfall of the district is 927.1 mm. District receives maximum rainfall during southwest monsoon period i.e., June to September. About 91.5% of the annual rain fall predicates during the monsoon season. Only 8.5% of the annual rain fall takes place between October to may period. Thus, surplus water for ground water recharge is available during the period from June to September.

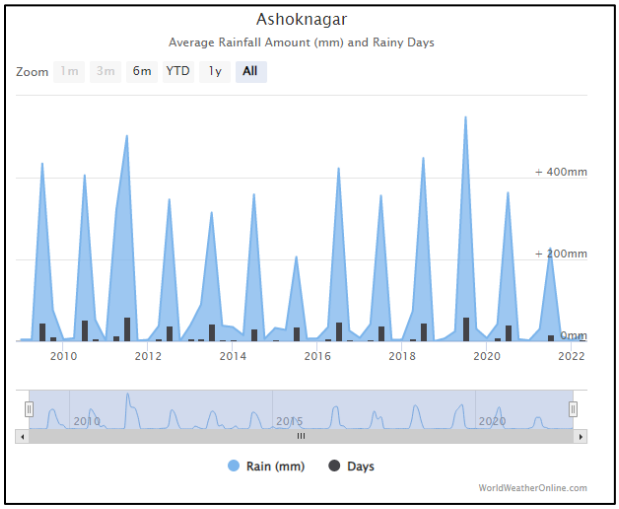


Figure 3: Decadal Rainfall Map

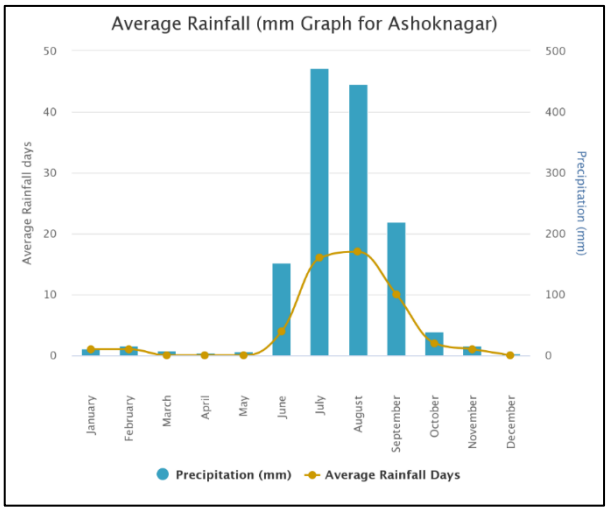


Figure 4: Yearly Rainfall

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT		NOV		DEC	
	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP
2016	11.3	56	1.8	-73	9.8	225	0.0	-100	7.3	303	83.8	18	515.8	63	324.5	3	50.0	-70	60.0	139	0.0	-100	0.0	-100
2017	1.8	-76	0.0	-100	6.3	108	0.0	-100	34.5	1817	182.0	156	194.0	-39	153.5	-51	277.3	69	0.0	-100	0.0	-100	0.0	-100
2018	0.0	-100	0.0	-100	4.0	33	7.3	936	0.0	-100	61.5	-14	285.0	-10	270.8	-14	266.0	62	0.0	-100	0.0	-100	0.0	-100
2019	0.0	-100	15.8	132	0.8	-81	10.0	1567	0.0	-100	38.5	-53	345.8	11	566.0	89	416.3	161	58.8	176	4.3	-38	0.5	-96
2020	16.8	179	4.0	-41	4.3	6	0.0	-100	29.3	1293	182.3	120	218.3	-30	484.5	62	55.0	-65	0.5	-98	4.8	-31	1.3	-89

Table 2: Rainfall and % Departures for 5yrs

Note :(1) The District Rainfall in millimeters (R/F) shown above are the arithmatic averages of Rainfall of Stations under the District.
(2) % Dep. are the Departures of rainfall from the long period averages of rainfall for the District.
(3) Blank Spaces show non-availability of Data

During the southwest monsoon season the relative humidity generally exceeds 85% (August month). In the rest of the period is dry. The driest period is summer season, when relative humidity is less than 27%. April is the driest month of the year.

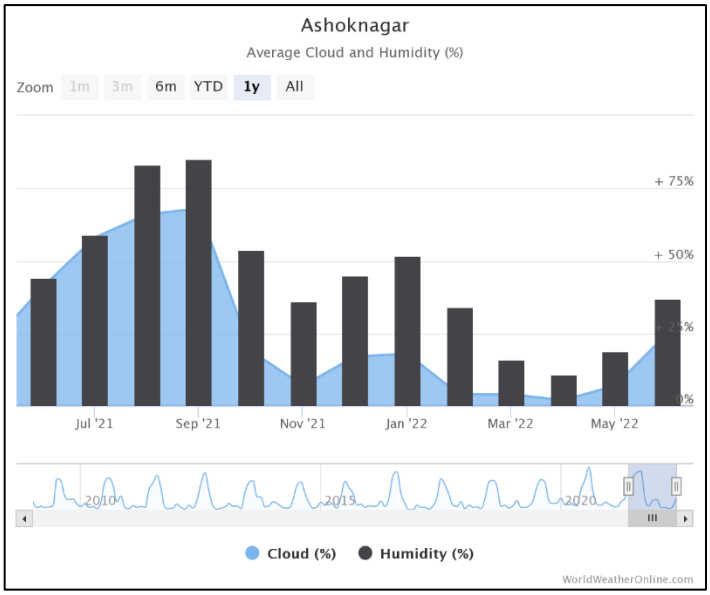


Figure 5: Humidity percentage

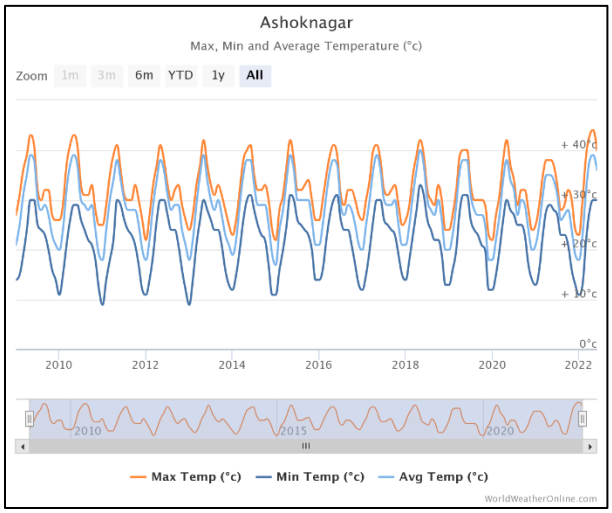


Figure 6: Decadal temerature variation

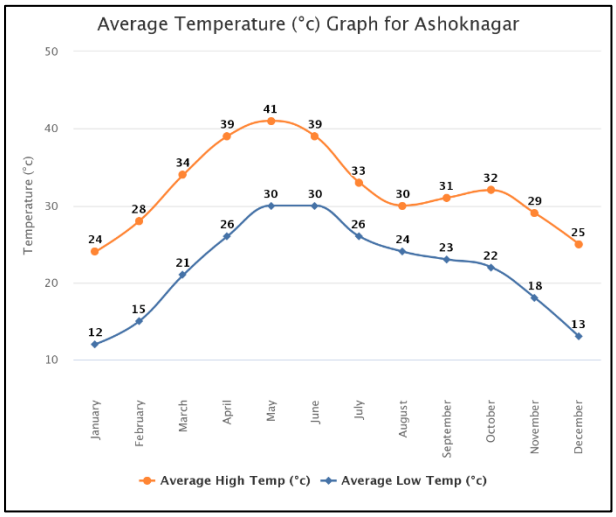


Figure 7: Yearly Temperature variation

Normal maximum temperature during the month of May is 41.3^{o}C and minimum during January month is 12^{o}C. Normal mean maximum & minimum temperature of Asoknagar is 32.5^{o}C & 17.7^{o}C respectively.

Wind velocity is higher during the pre-monsoon period as compared to the post monsoon period. The maximum wind velocity is 14.3 km/h during the month of June and minimum is 4.3 km/h during the month of November. Average normal annual wind velocity of Ashoknagar district is 8.1 km/h.

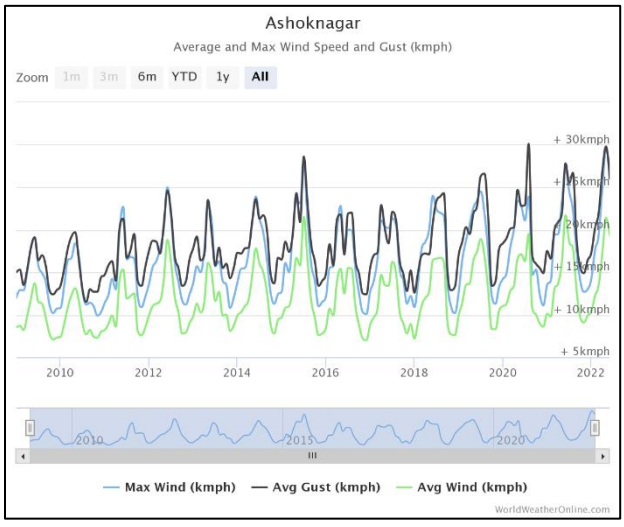


Figure 9: Decadal wind speed

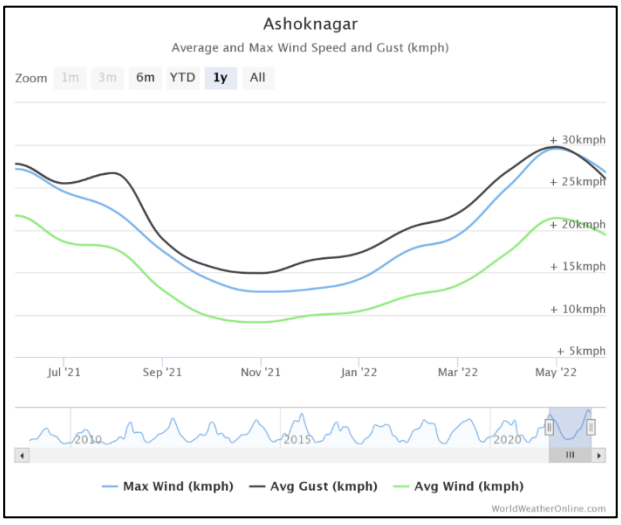


Figure 8: Yearly wind Speed

1.6 Geomorphology

District has an undulating topography inter spread mostly by low residual hills except in east & north & west, which are flat topped. The river Betwa crosses the eastern off shoot of Vindhyan hills with low scarps before entering the district. The valley portion of Betwa River in the district starts from Mungawali on Deccan trap lava flows, which is overlain by black cotton soil. Further down Betwa river passes through rugged sandstone of Vindhyan formation.

The eastern offshoot of Vindhyan range which runs south to east passes through Isagarh & Chanderi forms the second Physiographic region.

The Sindh valley and wider parts of Malwa plateau lies at general elevation of 460 m above MSL and mostly has an undulating topography. Sindh valley occupies central & western strips of the district covers Ashoknagar, Mungawali & Isagarh blocks.

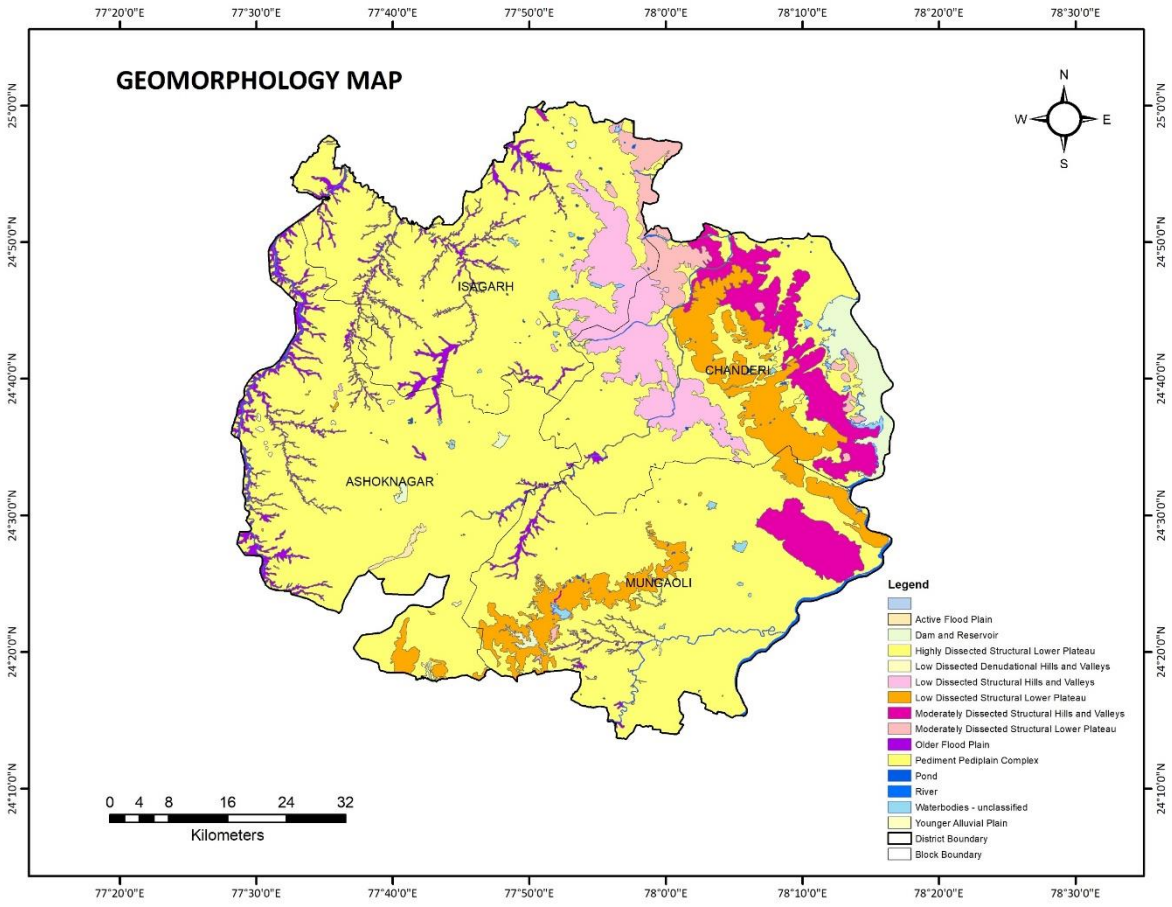


Figure 10: Geomorphology of the district

1.7 Soil Type

In this region, the main classes of soil are black, brown and bhatori (stony) soil. The volcanic, clay-like soil of the region owes its black colour to the high iron content of the basalt from which it is formed. The soil requires less irrigation because of its high capacity for moisture retention. The other two soil types are lighter and have a higher proportion of sand.

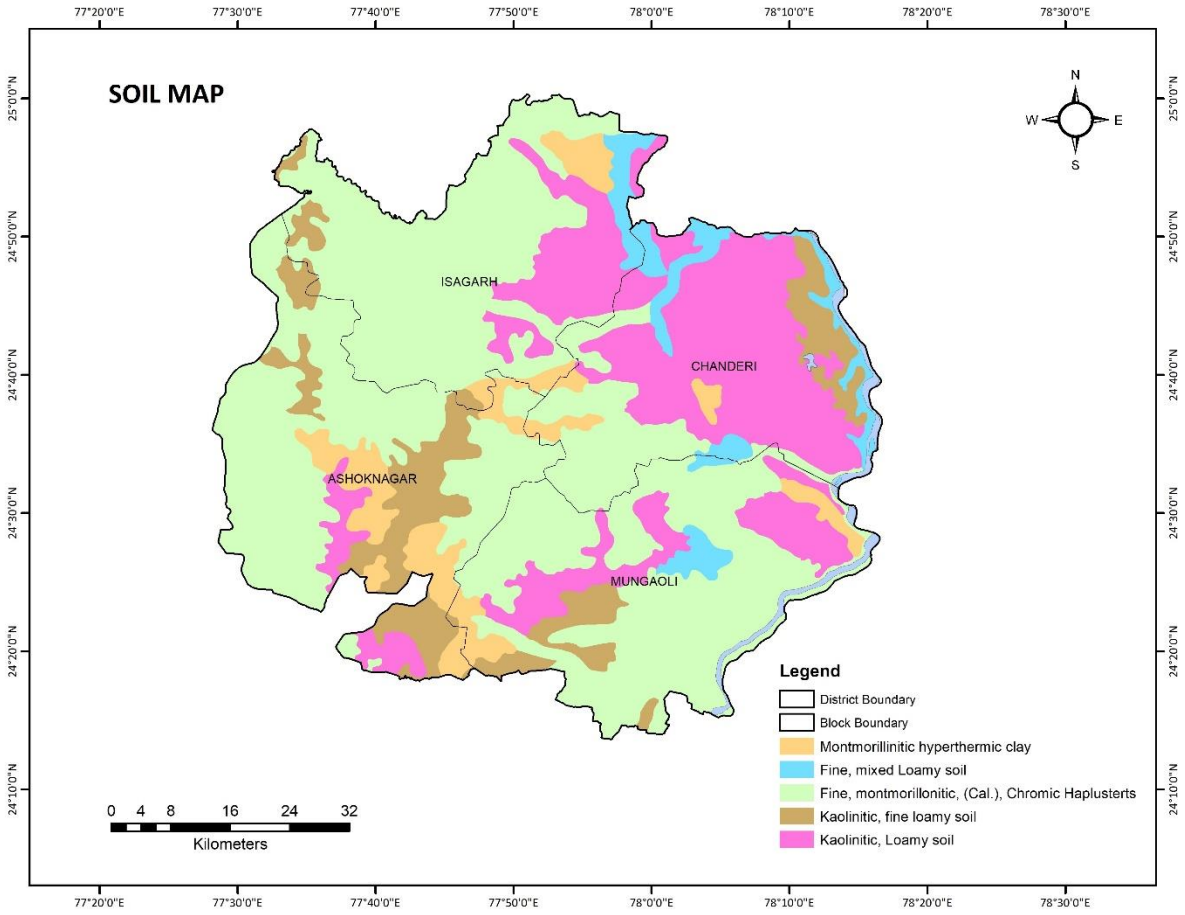


Figure 11: Soil Map of the district

1.8 Land Cover

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 controls the land use pattern of the district. Area under different land use has been provided below;

S.No.	*Land Use*	Area in hectare
1	Total geographical area	*4673.17*
2	Crop Land	*3246.18*
3	Deciduous Broadleaf Forest	*706.73*
4	Mixed Forest	*152.41*
5	Fallow land	*286.09*
6	Shrubland	*203.03*
7	Waterbodies	*147.22*
8	Built-up land	*2.7*

Table 3: Land Use Pattern of Ashoknagar District

The land cover map of the district shows that major part of the district is covered by crops which implies that the land is used for agricultural activities. Deciduous broadleaf forest & Fallow land are next major land cover of the district.

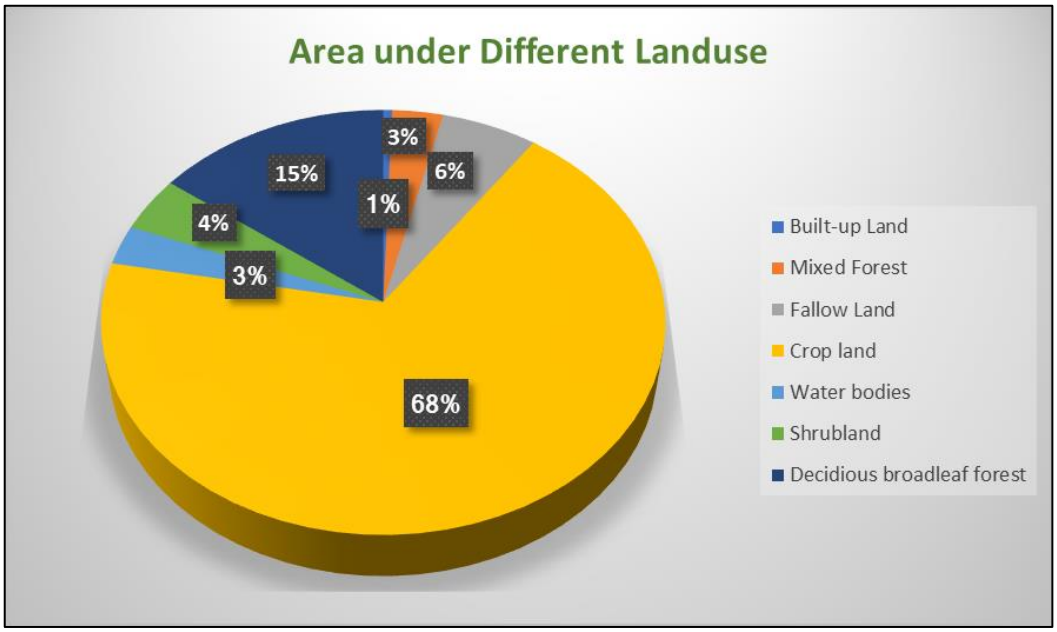


Figure 12:Pie Diagram showing % distribution of Land use

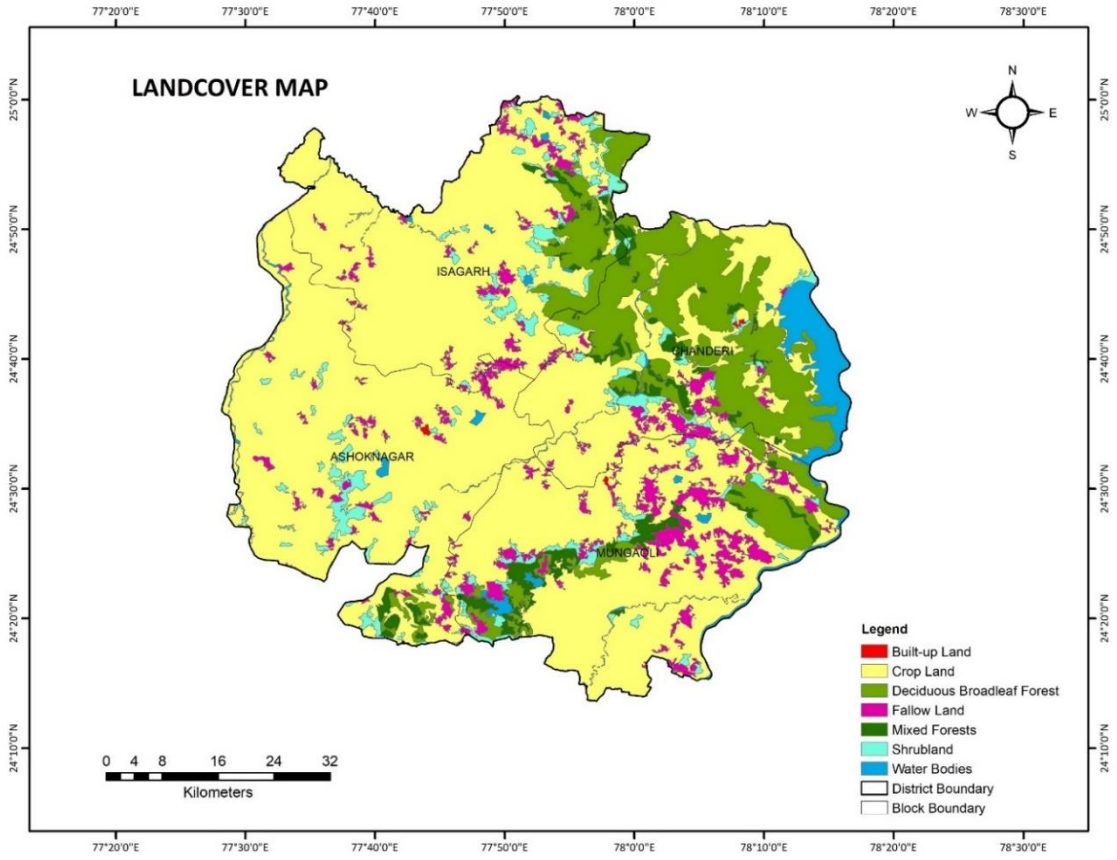


Figure 13: Land cover Map

1.9 River System and Water Resources

The district lies in the Yamuna drainage system. Sindh, Betwa, Chamba are the sub-basins in the district. Betwa forms the eastern boundary of the district. The general flow direction of all the rivers is towards north with low gradient.

Betwa River

The Betwa River is a tributary of Yamuna River. Its basin extends from longitude 770 to 810 and latitude 23°8’ to 26°N. The Betwa river originates at an elevation of 470 m in the Bhopal District in Madhya Pradesh. After traversing a distance of 590 km, the river joins the Yamuna River near Hamirpur at an elevation of 106,68 m. The total catchment area of the Betwa River is 46,580 sq km of which 31,971 sq km (68.64%) lies in M.P. and 14,609 sq km (31.36%) lies in U.P. The basin is saucer shaped with sandstone hills around the perimeter. The river has 14 principle tributaries out of which 11 are completely in Madhya Pradesh and 3 lies partly in Madhya Pradesh and partly in Uttar Pradesh. The Halali and Dhasan River are the important tributaries of the Betwa River.

Sindh River:

The Sindh originates on the Malwa Plateau in Vidisha district, and flows north-northeast through the districts of Guna, Ashoknagar, Shivpuri, Datia, Gwalior & Bhind in Madhya Pradesh to join the Yamuna River in Etawah district, Uttar Pradesh, just after the confluence of the Chambal River with the Yamuna River. It has a total length of 470 kilometres (290 mi), out of which 461 kilometres (286 mi) are in Madhya Pradesh and 9 kilometres (5.6 mi) are in Uttar Pradesh. Tributaries of the sindh river are The Pahuj, Kwari, Mahuar, and Parbati are its tributaries. The Sindh River lies to the western side of the Ashoknagar district. Ashoknagar has a well connected transport system to all major cities.

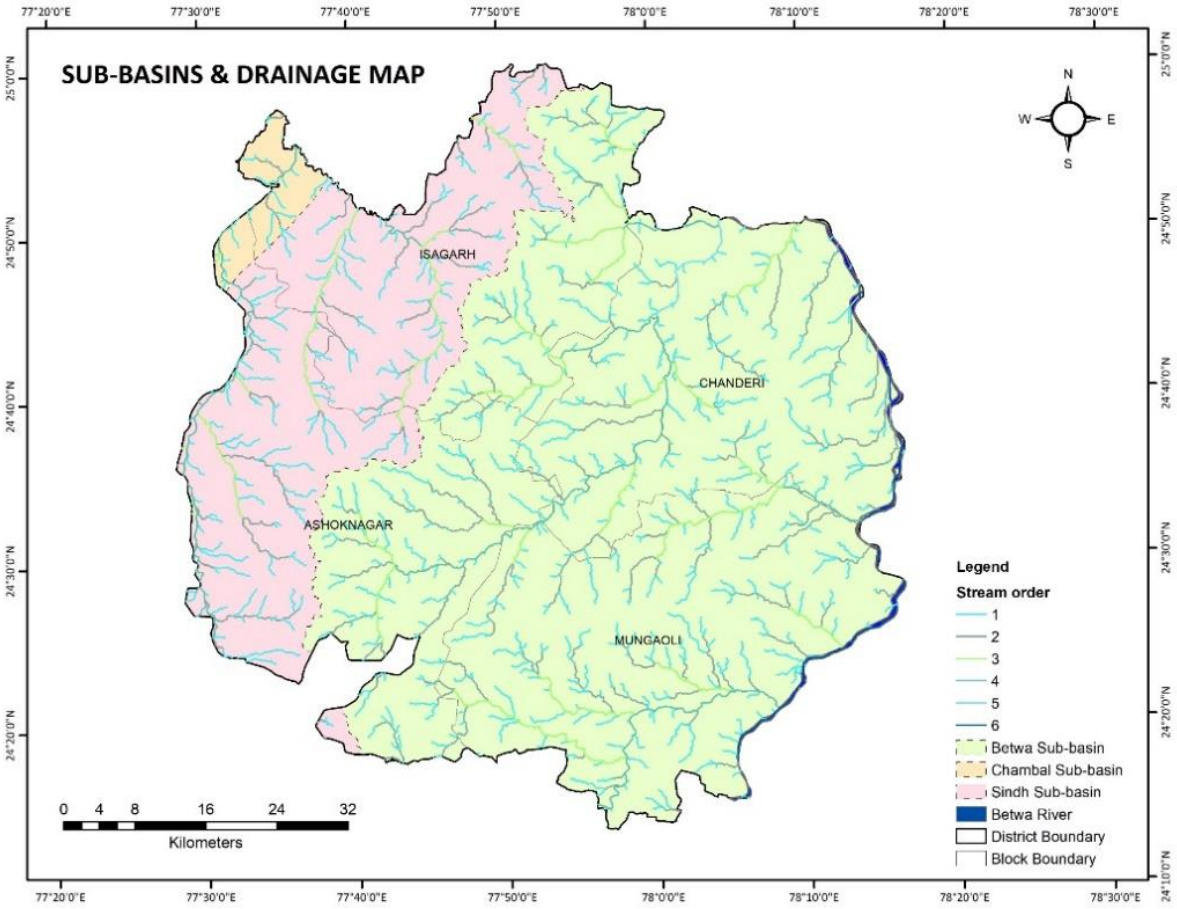


Figure 14: Drainage and Water Bodies

1.10 Agriculture & Irrigation

District is very backward in the field of agriculture. Peoples of the district prefer the cultivation in the old traditional method. The size of the fields is very small and mainly is marginal farmers. The yearly yield of the products from the fields is not enough for their home use. Hence, for the rest part of the year they

work on daily wages. The major crops grown and the source of irrigation has been enumerated in the table below;

Season	Major field crops cultivated	Area ('000 ha)				Grand total
		Kharif		*Rabi*		
		Irrigated	Rainfed	Irrigated	Rainfed	
Kharif	Soybean	-	99.14	-	-	99.14
	Urd	-	58.83	-	-	58.83
	Maize	-	9.72	-	-	9.72
	Moong	-	1.13	-	-	1.13
Rabi	Wheat	-	-	122.00	-	122.00
	Gram	-	-	126.50	-	126.50
	Lentil	-	-	35.00	-	35.00
	Mustard	-	-	7.50	-	7.50

Table 4: Area under major field crops

Different Structures	No of Structures	Area ('000Ha)
Dugwells	7245	**18365**
Tube wells/Bore wells	4679	**48175**
Tanks/Ponds	28	**2670**
Canals	22	**10641**
Other Sources	-	**29268**
Pumpsets	**14959**	-

Table 5: Area irrigated by different structures

1.11 Geology

Geologically, the area is underlain by Upper Vindhyan formation, Deccan traps and recent ferruginous laterite, different formation encountered in the district are described below;

I. STRATIGRAPHY

Upper. Rewa Sandstone

This is the oldest formation exposed in the area. It consists of cream to grey colored sandstone and is generally quarzitic. It is usually coarse grained. Frequent shale intercalations and iron staining are peculiar to this sandstone, at some places nodules of brown iron-stone and found arranged parallel to the bedding. This formation is compared of massive coarse grained sandstone strata alternating with current bedded flags. The thickness of this sandstone varies between 3.05 m. and 6-10 m. Well-developed joints were Observed in -this sandstone along which it breaks into large cubical blocks. The sedimentary structures in this sandstone include cross-bedding and ripple marks.

Ganurgarh Shale

The Ganurgarh Shale rests directly on the Upper Rewa Sandstone. It is deep red in colour for the most part of it although at places the colour changes to brown and grey. This shale is usually earthy and slightly micaceous and brittle. The thickness of it varies from 2.54 cm. to 3.8 cm. At places, this shale shows cross-joints and slaty cleavage. Sometimes it becomes more ferruginous also. Towards the top this shale is intercalated with pink coloured limestone and other calcareous materials.

Bhander Limestone

Limestone was seen along the nalla flowing west into the Kunu river and south west of Magarda to occur in beds 2.5 cm. to 15.5 cm. thick. The dominant colour of this limestone is yellowish-brown although it varies from pink to brown with distance. This limestone is associated with silica shaly materials and is therefore impure. At places this limestone is concretionary in nature. Towards the top it becomes sandy with yellow and brown argillaceous bands.

Lower Bhander Sandstone

The lower Bhander sandstone of the area forms a conspicuous horizon and has been observed in a few locality. In most places of the Bhander limestone is directly overlain by the Sirbu Shale. Where lower Bhander Sandstone occurs, the Upper portion of the Bhander Limestone becomes arenaecous and gradually passes into a bed of sandstone whose thickness never exceeds 7.5 cm. to 10 cm. The colour of this sandstone is usually reddish to dirty white. Ripple marks occur frequently in this sandstone. This sandstone is practically horizontally bedded with slight dip of 5° to the North West. This sandstone strikes NNE. Towards the top the sandstone gradually, becomes shaly and passes into the Sirboo Shale.

Sirbu Shale

This shale is exposed at the base of the Sandur hills, on the east bank of the Kunu river and also along the course of the latter for a distance of one fourth kilometre or less. Its thickness varies from a few centimetres to about 30 m. It is generally olive-green in colour although sometimes it changes to dark brown and grey. It is aluminous, earthy, slightly micaceous and brittle. When unprotected by the sandstone talus it weathers into steep precipitous faces. At places, it contains intercalations of thin bands of sandstone. At the top this shale passes into grey and pinkish purple, ripple marked sandstone blotched with brown. There are places where surface of the Sirbu Shale was been to be concealed by the debris from the overlying upper Bhander Sandstone.

Upper Bhander Sandstone

Upper Bhander Sandstone lies conformably above the Sirbu Shale. It is quite extensive and thick as compared to the other sandstones of the area. The usual colour of this sandstone is deep red with white specks or paler tints. Variation in colour from red to brown and chacolate colours is also noticeable. It is very fine grained, massive and hard. In the total thickness of this sandstone, proportion of shale intercalations increases with the depth. Its dip varies between 9° and 15° and strikes N25°E. Ripple marks occur in profusion through out the entire thickness of this sandstone. These ripples are a symmetric type consisting of long parallel ridges and troughs trending north-west with insignificant curvature. Few sets of vertical joints are usually seen. The joint directions are N30°E - S30°W and N15°W - S15$_0$E.

Deccan Trap

Two simple and horizontal flows of basalt separated by a prominent red clay and elsewhere by un-fossiliferous limestone, were worked out. Both the flows are massive and porphyritic type except that the second flow is vesicular and amygdular at places. Beyond the area of inter trappean the following are the criteria by which the individual flows of basalt were demarcated.

- Red bole horizon.
- Presence of thick weathered zones at the top of the dividual flows,
- High vesicularity indicating the top of the flows and
- The petrography of the rock types.

Laterite

Laterite occurs as small and detached capping on isolated hill tops. The thickness ofthe laterite profile varies from 1 m. to 7 m. It is highly ferruginous and cavernous. The major area of such laterite formation is the north-eastern part of the area near Dongasro, Madhopur, Bhedra and UmriVillages. At places, the laterite was seen to rest directly on the Vindhyan.sandstone and shale.

II. INTRUSIVES

The Vindhyan rocks are intruded by a number of dolerite dykes which vary in width from 10 am to 150 m. They extend in a north and north-easterly direction and are tracable for distances upto 2 to 3 km. At

places, these dykes bifurcate and branch out into smaller ones. Near their contacts with the country rock, there is little change in the sandstone and shale, except for slight baking in the latter, although chilling effect in the dyke rock, at its contact with the Vindhyan country has been observed. Xenoliths of sandstone and shale were also seen to occur in the dyke rock at some of the places near their contact.

Sills

The dykes mentioned above have given rise, to sills along the horizontal bedding planes of Vindhyan sandstone and shale. The thickness of these sills vary from 0.5 m. to 1 m.and the length ranges from 20 to 25 m. Although they show nearly parallel upper and lower margins for quite some distance, they thin out and become lenticular still further away.

Intertrappean

The inter-trappean of the area consists of calcareous chert, limestone and red-bole. The break between the eruptions of the two lava flows of the area is represented by redbole. After the eruption of the 1st flow and its solidification its surface might have been reddened due to the oxidation and the heat of the lava flowed over it.

III. STRUCTURE

Faults

The area investigated is highly disturbed. The disturbance is evidenced by the presence of normal faults with throws ranging from 0.25 km. to 0.50 km. They are more or less parallel with strikes to NNE and have broken-up the tract into faulted blocks. One of the faults is within the Vindhyan and has no effect on the Deccan Trap from which it can be said that this fault has taken place before the eruption of the lava flows, hence it is pre-trap in age. The other faults have affected the Deccan Trap formation, the evidences for which are (i)slicken sides on basalts, and (ii) silicification in them. Therefore, it can be said that the movement, has taken place only after the basalt flows came into being. The parallel strike direction of both the pre-trap fault and the post trap faults indicate that the later movements have followed the pre-trappen line of weakness

Age	*Formation*	*Lithology*
Recent **Sub Recent**		Alluvial and Black Cotton soil Ferruginous Laterite
Upper Cretaceous Early Eocene to	Decan Trap (Locally Known as Malwa Trap)	**FLOW I** Massive porphyritic Basalt
		Inter-trappeans Red clay and calcareous Chert
		FLOW II Massive and Porphyritic Basalt Dykes and Sills of Doleritic Intrusive into Vindhyan sandstone
Purana & (Pre- Cambrian)	Upper Vindhyan	Upper Bhander Sandstone
		Sirboo Shale
		Lower Bhander Sandstone
		Bhander limestone
		Gangarh Shale
		Upper Rewa Sand stone
Base is not seen		

Table 6: Geologic Succesion in the district

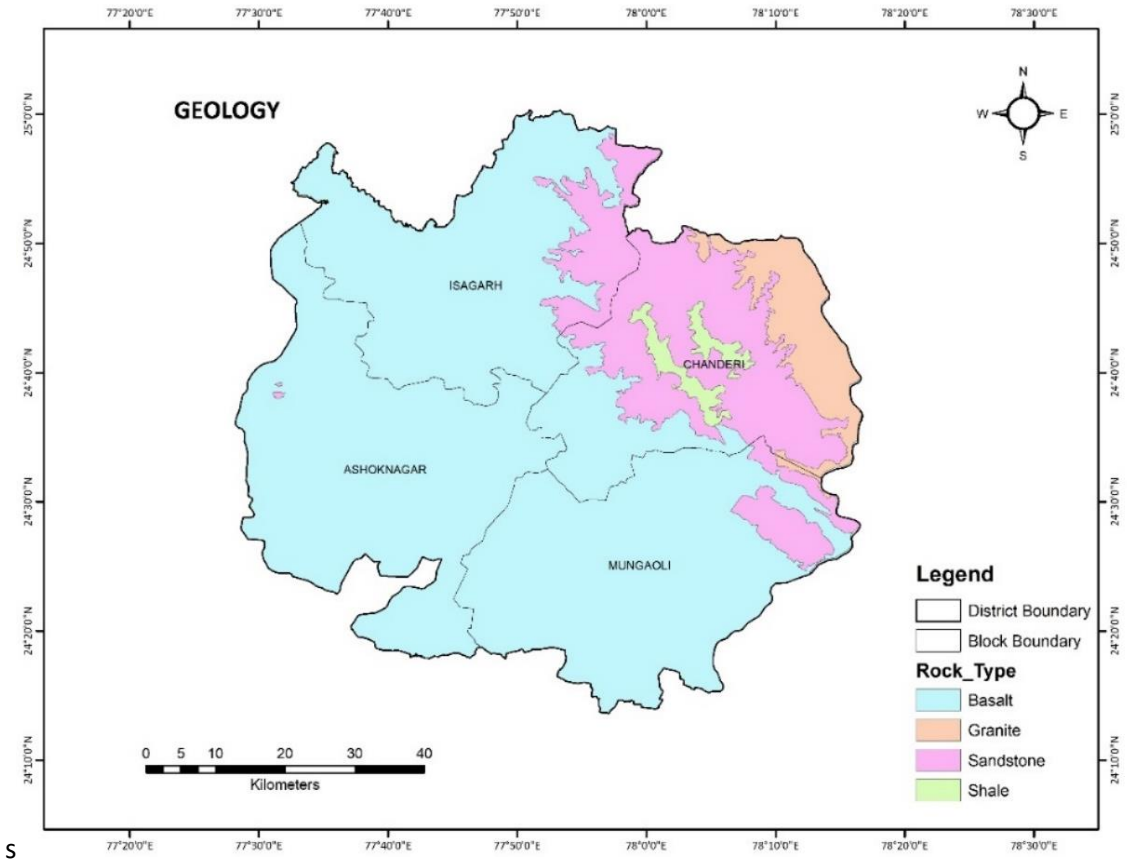


Table 7: Geology Map

2. DATA COLLECTION AND GENERATION

2.1 Data Gap Analysis

The available data of the Exploratory wells drilled by Central Ground Water Board, North Central Region, Bhopal, 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. The summarized table presenting the data requirement, data availability, and data gap analysis is presented in the following table; The compiled data were plotted on a 1:50000 scale map, and analysis of the data gap was carried out

S.No	Items	Data Requirement	Data Availability	Data Gap
1	Rainfall Data	Meteorological stations spread over the project area.	World weather website	
2	Soil	Soil map	Prepared in GIS.	
3	Land Use	Latest Land Use Pattern	Prepared in GIS.	
4	Geomorphology	Digitized Geomorphological Map	Prepared in GIS.	
5	Geophysics	Geophysical data in each Quadrant	No VES done till now	
6	Exploration Data	EW in each Quadrant with Aquifer Parameters	14 Exploratory wells along with aquifer parameters are available	
7	Aquifer Parameters	Aquifer parameters for all the quadrants		
8	Recharge Parameters	Recharge parameters for different soil and aquifer types based on field studies	Recharge parameters are given in Ground Water resource estimation	
9	Discharge Parameters / Draft Data	Discharge parameters for different GW abstraction structures	Discharge parameters are given in Ground Water Resource Estimation GEC 2020	
10	Geology	All the maps on a 1:50000 scale	Prepared in GIS.	

Table 8: Data Requirement, Data Availability, and Data Gap Analysis

2.2 Data Collection and Generation

Data on all the attributes of Aquifer Mapping has been generated based on the data availability and data gap analysis. The data generated and data collected from various state governments agencies are summarized in the following table.

S.No	Items	Data Generated	Data Collected
1	Rainfall Data		World weather website
2	Ground Water Exploration	.	GW Exploration Report
3	GW Regime Monitoring	38 Key wells established	Survey and data collection in district
4	Chemical Quality	25 Samples of Naquim in 2022 and 22 samples of NHS in 2022.	Data compilation and collection for analysis

Table 9: Data Generated and Data collected for Aquifer Mapping Area.

Exploratory Data Availability

Systematic Hydrogeological studies was carried out by CGWB & after the systematic Hydrogeological surveys the Ground Water management studies were carried out in the entire district. The ground water exploration in the district was carried out under Annual Action Plan 2002-03 & 2003-04.

Under the Groundwater Exploration Programme CGWB has constructed the 14 exploratory wells in the district.

Phreatic aquifer occurs in weathered, jointed and fracture basalt. In the areas where weathered basaltic layer is extensive, a continuous aquifer can be traced to some distance, however due to low permeability of weathered basalt the aquifer sustains limited groundwater withdrawal.

The groundwater at deeper levels occurs under semi-confined to confined condition in vesicular, jointed and fractured basalts. Data reveals that depth to WL in these borewells varies from 8.25-51.4 m bgl and discharge of wells ranges from 0.5 to 11.5 lps with variable drawdown.

The sandstone intercalated with shale beds are exposed in north eastern part of district (Isagarh and Chanderi blocks). These rocks are hard and compact but is fractured & jointed at different depths. Groundwater occurs in semi-confined to confined condition and is extracted using borewells.

The yield of these borewells is fairly good ranging from 1 to 4.9 lps.

Source of Data	No. Of tubewells as per Depth Range			Total Wells
	<100	**100-200**	**200-300**	
CGWB	5	15	5	25
TOTAL	**5**	**15**	**5**	**25**

Table 10: Data Availability of Exploration Wells

The actual data of all the wells in the area are plotted on the map (Figure 15).

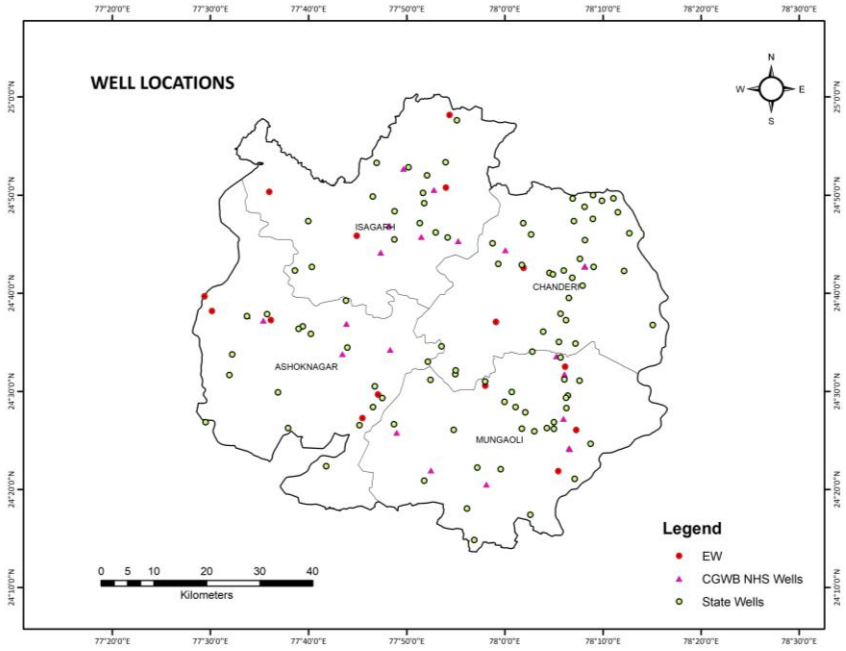


Figure 15: Locations of Exploration Data Availability

The topographic elevation values have been plotted to prepare the elevation contour map and is in Figure 16. Topographic variations on the ground surface can give the synoptic picture of gradient variations in the water levels.

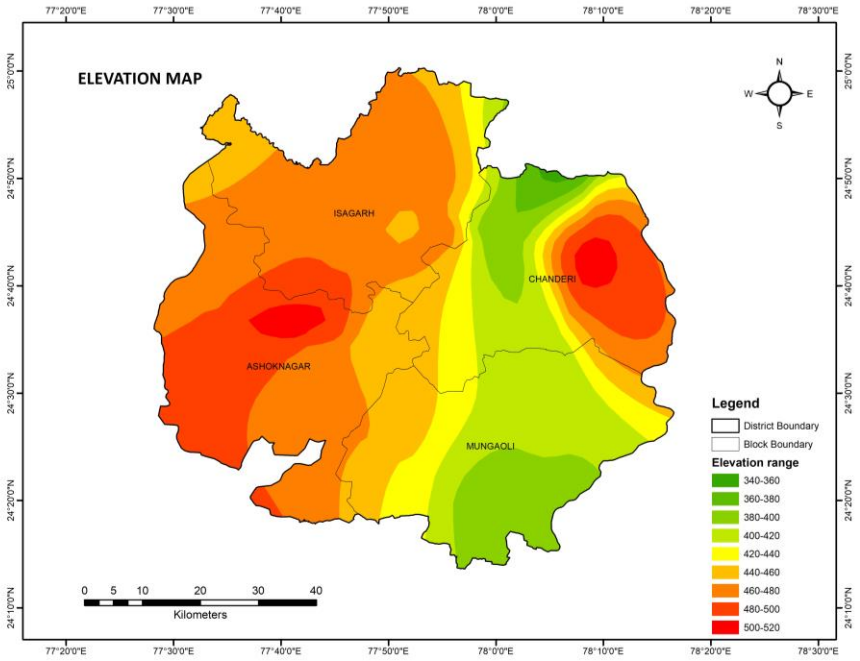


Figure 16: Elevation Contour Map

Key Well Establishment:

During Premonsoon'2022, key wells have been established to fill the data gaps and to enlarge the hydrogeological knowledge of the area. 10 by 10 km grids were prepared and 38 locations were identified to generated water level data. Groundwater samples from all these locations were collected for basic chemical data analysis and 12 GW samples for heavy metal analysis were collected. The key well location map is shown below;

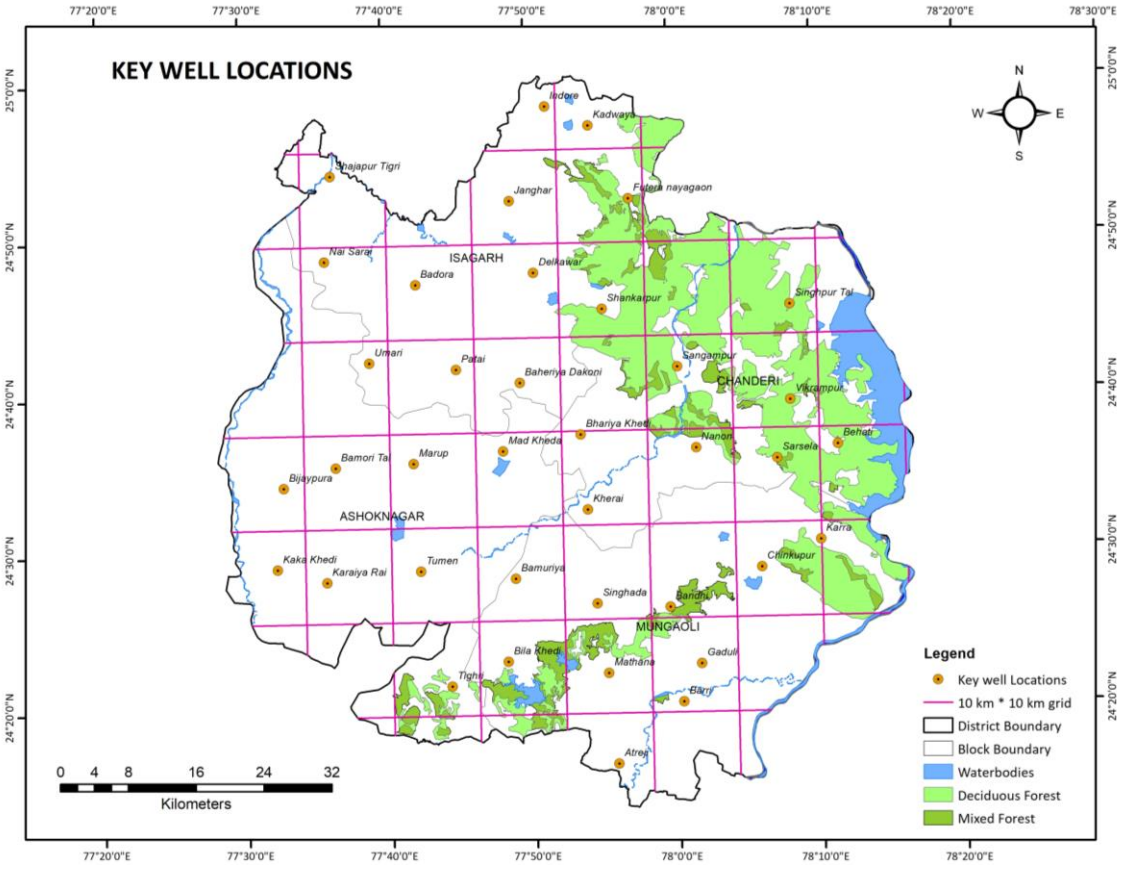


Figure 17: Key well locations, Ashoknagar District

2.3 Hydrogeology

Systematic Hydrogeological studies was carried out by CGWB under Annual Action Plan of 1990 – 91 & after the systematic Hydrogeological surveys the Ground Water management studies were carried out in the entire district under AAP 2000 - 2001.The ground water exploration in the district was carried out under Annual Action Plan 2002-03 & 2003-04.

2.3.1. Major Aquifers

District is characterized by variety of geological formations representing vast period of geological time. The distribution of the Geological formation is shown in Fig

Alluvium

Alluvium of Quaternary age occurs as a narrow belt along the major rivers like Sindh, Betwa, Kethan & Orr. It comprises pebble beds, gravel, silt & sand.

In the area occupied by alluvium, the ground water occurs under water table condition. The granular portion of this formation such as sand & gravel forms good aquifers, but the thickness is shallow. The yield of the wells in this formation ranges from 2 to 7 lps.

Deccan Trap

Deccan trap basalts of Malwa Group of Cretaceous to Paleozoic age occupy major part of the district. Intertrappean of lacustrine or fluviatile origin occur in the top part of each lava flow. Deccan trap consists of number of basaltic lava flows.

Water bearing capacities in Deccan trap formation differ from flow to flow. weathered basaltic layer is extensive, a continues aquifer can be traced to some distance, however due to low permeability of the weathered basalt the aquifer sustain limited ground water withdrawal. The groundwater at deeper levels occurs under semi confined to confined conditions in vesicular, jointed & fractured basalts. Unit draft of the wells varies from 0.001 to 0.008 m cm/year for dug wells & 0.005 – 0.017 m cm/yr.

Vindhyan Formations

The Sandstone intercalated with Shale beds are exposed in the north-eastern parts of the district (Isagarh & Chanderi blocks). The rocks are hard & compact, but at places and at different depth it is fractured & jointed and forming potential aquifer at deeper levels. The ground water occurs under semi confined to confined conditions and are being exploited through bore wells. The yield of these bore wells is fairly good ranging between 1.0 to 4.9 lps. The depth to water level during pre-monsoon period ranges from 3.70 to 22.10 m.bgl. with seasonal fluctuation of 0.07 to 9.98 m

Archeans

The Archeans rocks are represented by the Bundelkhand Granites in the district and occurring in northeastern portion of the Chanderi block. The intensity of the weathering is varying from place to place. The intensity of the weathering is high and formation of the deep residum or mantle overlying the hard granite in the low lying, intermountain & depressions. The weathered mantle of the granite forms sometimes-good aquifers at a shallow depth, where ground water occurs under water table condition. The yield of this formation ranges from less than one to 3 lps.

Under the Ground water Exploration Programme CGWB has constructed the exploratory wells & observation wells of 96 to 201.30 m deep. The depth to water levels in these wells varies from 8.25 to 51.40 m bgl and discharge of the wells ranges from 0.5 to 11.5 lps with a draw down of 28.00m.

2.3.2. Depth to Water Level

To monitor the change in ground water levels in the district, Central ground Water board is regularly monitoring 17 dug wells & 5 borewells four times in a year. However, the depth to water level discussed

below is generated after identifying the data gap and establishing key wells uniformly throughout the district to provide holistic water level scenario.

Pre - Monsoon Depth to Water Levels

The pre-monsoon depth to water levels (DTW) data collected during key well establishment shows that the water level ranges from 1.53 m bgl to 12.7 m bgl. The shallowest water level has been reported at Vikrampur while the deepest at Bhariya khedi. The water level map represents the unconfined aquifer.

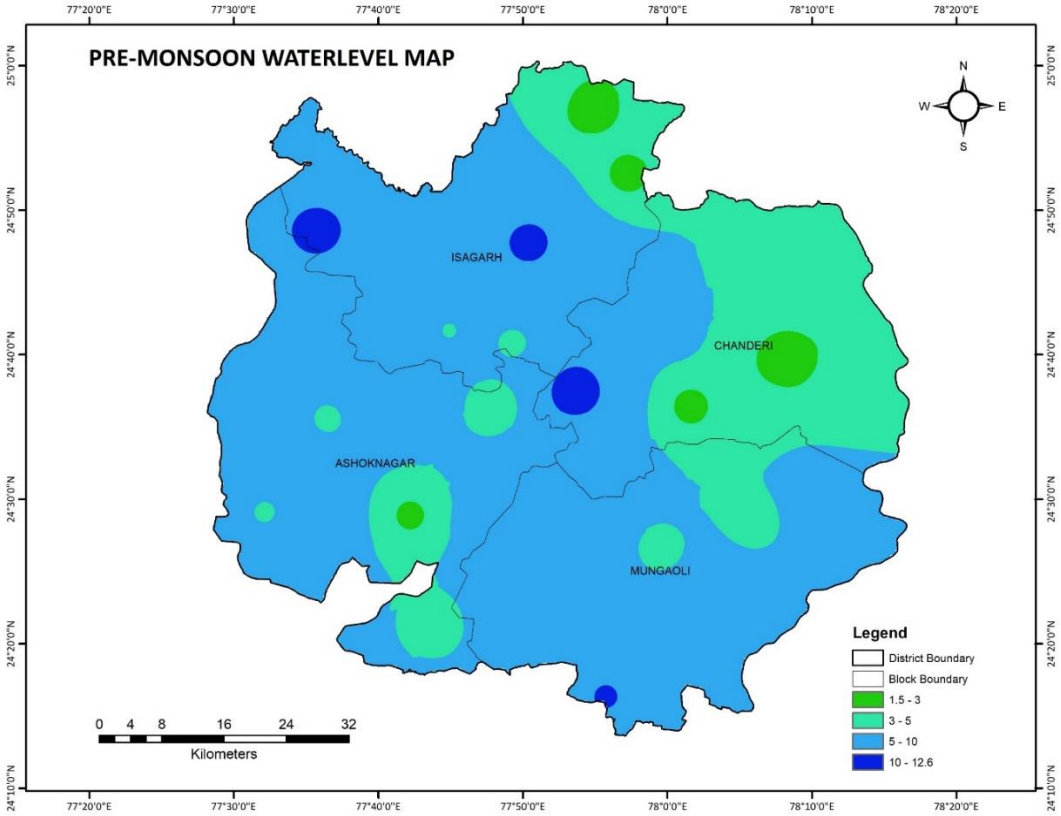


Figure 18: Depth to Pre Monsoon Water level May, 2022

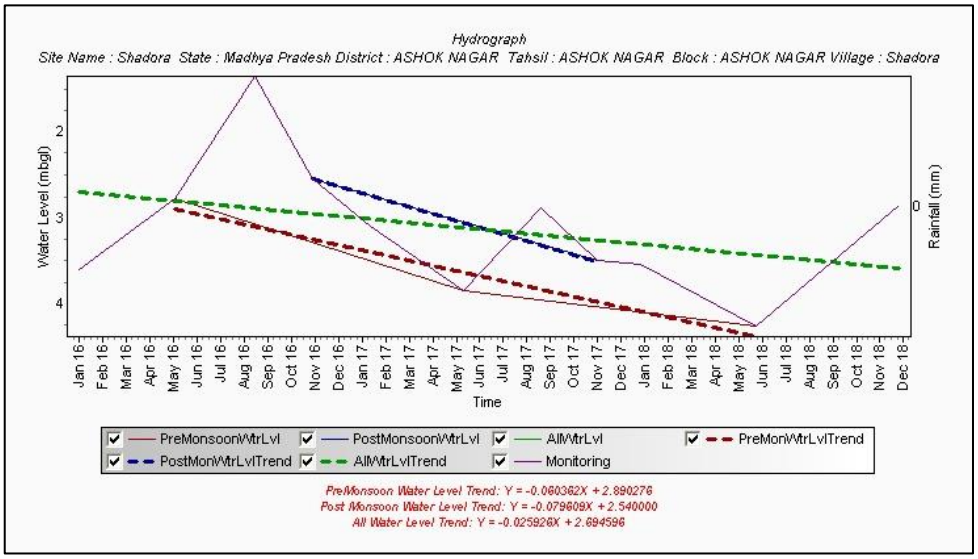
S.no.	Sample-ID	Name	Lat	Long	MP	WL (mbmp)	WL (mbgl)
1	ASK-1	Barri	24.338	78.00568	0	9.85	9.85
2	ASK-2	Patai	24.6948	77.7482	0.6	5.5	4.9
3	ASK-3	Umari	24.7034	77.6476	0	9.15	9.15
4	ASK-4	Nai Sarai	24.8118	77.597	0.69	10.93	10.93
5	ASK-5	Shajapur Tigri	24.9023	77.6055	0	5.44	5.44
6	ASK-6	Badora	24.7858	77.7028	0.2	9.45	9.25
7	ASK-7	Janghar	24.8732	77.8138	0.3	5.85	5.55

8	ASK-8	Baheriya Dakoni	24.6798	77.8222	0	4.57	4.57
9	ASK-9	Mad Kheda	24.6074	77.8013	0	3.65	3.65
10	ASK-10	Marup	24.5957	77.697	0	5.8	5.8
11	ASK-11	Bamori Tal	24.5926	77.6062	0	4.62	4.62
12	ASK-12	Bijaypura	24.5718	77.5453	0	9.1	9.1
13	ASK-13	Kaka Khedi	24.4855	77.5368	0.63	5.45	4.82
14	ASK-14	Karaiya Rai	24.4709	77.594	0	7.75	7.75
15	ASK-15	Tumen	24.4814	77.7034	0.75	3.3	2.55
16	ASK-16	Bamuriya	24.472	77.8134	0	7.34	7.34
17	ASK-17	Bila Khedi	24.3839	77.8029	0	6.9	6.9
18	ASK-18	Tighri	24.3588	77.7372	0	4	4
19	ASK-19	Atreji	24.2733	77.9288	0	10.2	10.2
20	ASK-20	Mathana	24.3699	77.9193	0	7.66	7.66
21	ASK-21	Gaduli	24.3783	78.0273	0.13	9.35	9.35
22	ASK-22	Chinkupur	24.4798	78.0996	0	3.83	3.83
23	ASK-23	Karra	24.5078	78.1688	0	8.28	8.28
24	ASK-24	Delkawar	24.7965	77.8405	0	11.37	11.37
25	ASK-25	Kadwaya	24.9517	77.9073	0.55	2.37	1.82
26	ASK-26	Indore	24.973	77.8572	0.2	5.1	4.9
27	ASK-27	Futera nayagaon	24.8737	77.9527	0	2.5	2.5
28	ASK-28	Shankarpur	24.7568	77.9194	0	6.74	6.74
29	ASK-29	Sangampur	24.694	78.0057	0	5.8	5.8
30	ASK-30	Bhariya Khedi	24.6237	77.892	0	12.7	12.7
31	ASK-31	Kherai	24.5439	77.8984	0	6.82	6.82
32	ASK-32	Nanon	24.6075	78.026	0.38	2.78	2.4
33	ASK-33	Sarsela	24.595	78.12	0.8	5.1	4.3
34	ASK-34	Vikrampur	24.6569	78.1365	0	1.53	1.53
35	ASK-35	Behati	24.6089	78.191	0	3.74	3.74
36	ASK-36	Singhpur Tal	24.7584	78.1383	0	4.3	4.3
37	ASK-37	Singhada	24.444	77.9075	0	5.53	5.53
38	ASK-38	Bandhi	24.439	77.9922	0.1	3.78	3.68

Table 11: Pre-monsoon water level

2.3.3. Hydrograph Analysis

The variation in short term and long-term water level trends may be due to variation in natural recharge due to rainfall and withdrawal of groundwater for various agricultural activities, domestic requirements, and industrial needs.



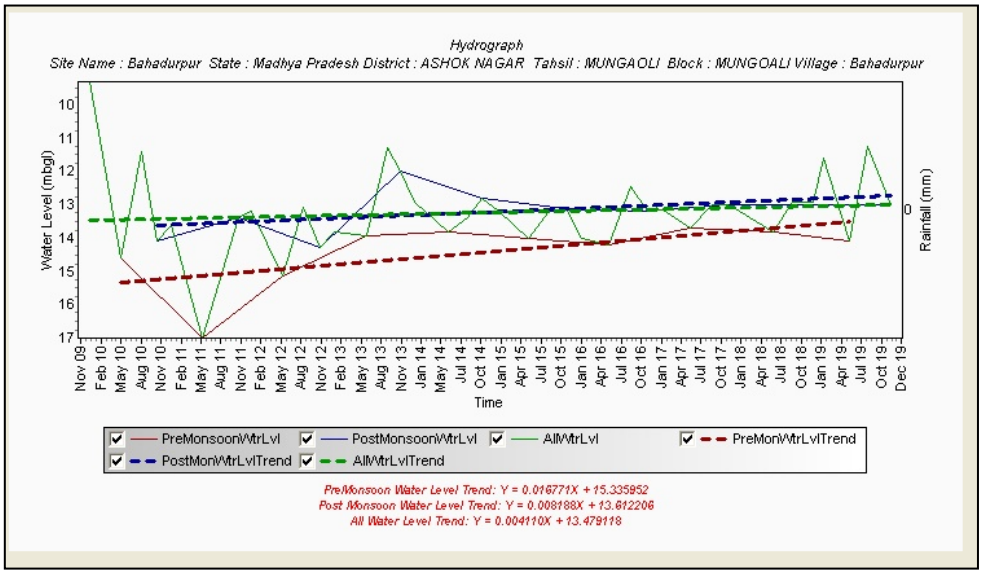


Figure 19: Hydrographs of NHS locations in district

3. GROUND WATER RESOURCES

The dynamic ground water resources of the Madhya Pradesh State assessed jointly by the CGWB and State Ground Water Departments under the supervision of the State level Committees.

The dynamic ground water resources are also known as Annual Replenishable Ground Water Resources since it gets replenished/ recharged every year.

Ashoknagar district is underlain by Deccan trap basalts, Vindhyan sandstone and Archaean granite-gneisses. Dynamic Ground water resources of the district have been estimated for base year - 2019-20, on block- wise basis. Out of 4,67,394 ha of geographical area, 4, 62,244 (98%) ha is ground

water recharge worthy area and 5,150 (2%) is hilly area. There are four numbers of assessment units (block) in the district having command area (4.46 %) and non-command area (95.54%). Out of 4 blocks of the district, 3 blocks are categorized as safe and Ishagarh block fall under semi-critical category (Safe in 2016-17). Highest stage of ground water extraction, is computed as 77.74% (67.06% in 2016-17) in Ishagarh block. The annual extractable resource in the district is 35701.85 ham and gross ground water extraction for all uses is 22428.24 ham, making stage of ground water extraction 62.82% (54.91 % in 2016-17) as a whole for district. After making allocation for future domestic supply for year 2025, balance available ground water for future use would be 13092.45 ham.

Assessment Unit	Type of rock formation	Recharge worthy area of formation (in hectares)	Areal extent (in hectares)			
			Total Geographical Area	**Hilly Area**	**Ground Water Recharge Worthy Area**	
					Command area	**Non- command area**
Ashoknagar	Deccan trap basalt	124803	124803	0	3506	121297
Chanderi	Deccan trap basalt, Archaen granite, Vindhyan sandstone	108870	113070	4200	4799	104071
Ishagarh	Deccan trap basalt	107115	107115	0	3435	103680
Mungawali	Deccan trap basalt	121456	122406	950	8910	112546
District Total		**462244**	**467394**	**5150**	**20650**	**441594**

Table 12: Recharge worthy area

Assessment Unit Name	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	AnnualGW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availabilityfor future use (Ham)	Stage of Ground Water Extraction (%)	Categorization
CHANDERI	4878.08	318.00	5196.08	353.54	2370.17	68.35	**safe**
MUNGAWALI	4660.87	493.26	5154.14	542.86	5724	47.17	**safe**
ASHOKNAGAR	5833.17	527.00	6360.17	584.87	3399.11	64.79	**safe**
ISHAGARH	5309.42	408.43	5717.85	446.58	1599.17	77.74	**semi_critical**
DISTRICT TOTAL	**20681.54**	**1746.69**	**22428.24**	**1927.85**	**13092.45**	**62.82**	

Table 13: Dynamic Ground Water Resource & Development Potential (31.03.2020)

4. GROUND WATER RELATED ISSUES

4.1 Ground Water Depletion

It has been observed that water level has been declining over the years, The dug wells that have been the source of availabilty of groundwater resource in the area is drying up or the water level has gone deeper. The issue has been mainly observed in western part of the district. The people have started opting for the borewells for sustenance. However, being a hard rock terrain, the drilled wells do not yield water always.

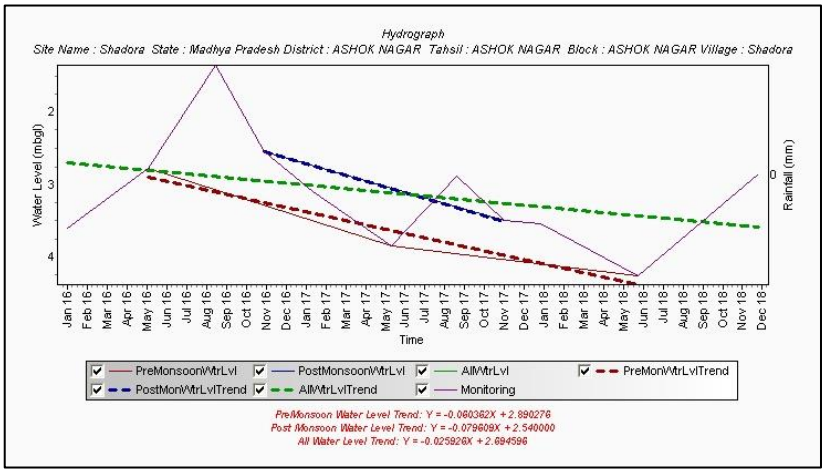


Figure 20: Hydrograph showing declining water level

Figure 21: Dugwell at village Nai Sarai showing deep WL

4.2 Rising Water table

In eastern parts of the district the water table is rising due to limited/non-extraction of ground water. In addition, being topographically lower area, it becomes prone to groundwater influx if the stratigraphic formation be uniform. There is an urgent need to arrest the rising water trend in this part of the district.

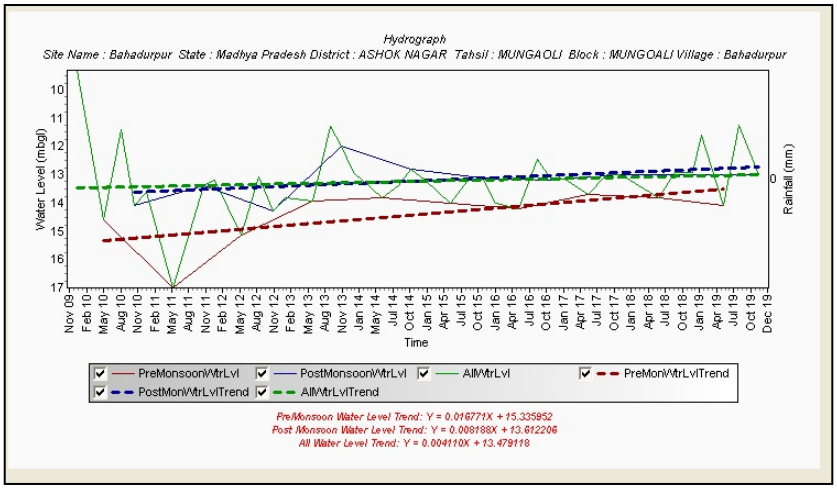


Figure 22: Hydrograph showing rising water level

Figure 23: Dugwell at village Vikrampur showing shallow WL

4.3 Ground Water Quality

The ground water of the study area is alkaline in nature. Ground water in the area is fresh. However, Nitrate concentration has been found to be above acceptable limit at few places due to localized waste disposal. Bahadurpur has reported nitrate concentration of 125 mg/L while Chanderi has reported 80 mg/L.

4.4 Ground Water Irrigation Scenario

As per MI Census data 16.8% of irrigation in the district is still carried out by dug wells. The gradual drying up of dug wells through years has affected the productivity of the fields depending on dug well for irrigation demands.

5. MANAGEMENT STRATEGIES AND AQUIFER MANAGEMENT PLAN

Aquifer mapping is leads to groundwater management plans to be implemented by including demand side-management and Ground Water Use Efficiency.

5.1 Scope of Implementation

This plan is focusing on the technical aspects of the ground water recharge through various means so that various implementing agencies may get the appropriate technical guidelines. The existing/ongoing schemes of the central or state govt. like MANERGA, IWSP, PMKSY (Prime Minister Krishi Sinchai Yojna), NABARD funded schemes, Urban Development schemes, departmentally funded projects etc. may be benefitted from the recharge plan by incorporating the input in the operational guidelines/ design and for locating the specific sites.

Agriculture University, engineering Collages, Academic and Research Institution, NGO may also take up the pilot or demonstrative projects in the blocks suitable to them to plan at local level as per local conditions.

5.2 Rejuvenation of Traditional water bodies and structures

Rejuvenation of traditional waterbodies such as Baoli & ponds existing in the district. Baolis on trade routes were often frequented as resting places. The beautiful stepwells typically have beautiful arches, carved motifs and sometimes, rooms on their sides.

Storage tanks existing on higher elevation such as at Chanderi fort plays important role in rainwater harvesting. These structures were mainly used for utilitarian purposes and social gatherings.

Rejuvenation of these baolis & storage tanks will be a positive move towards conservation of water resources.

Figure 24: Baoli at village Indore

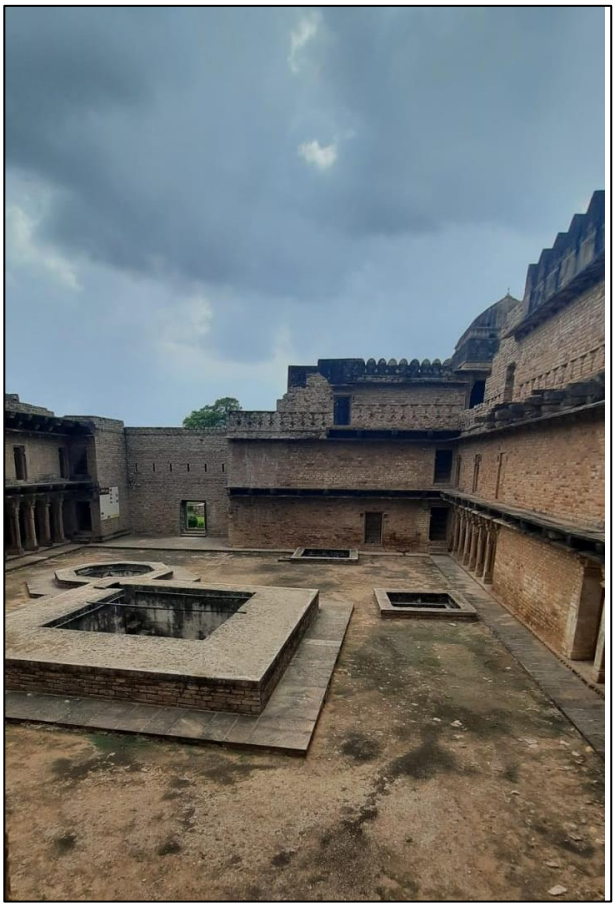


Figure 25: Storage tanks at Chanderi Fort

5.3 Artificial Recharge

During the field survey it has been observed that many of the dug wells have dried. Using these dug wells & construction of artificial recharge structure such as recharge shaft, percolation tank will help in augmentation of groundwater resource. In addition, nala bunds, check dams and gully plugs along the river will accelerate the surface water recharging the groundwater.

5.4 Increase in Irrigation Potential

As per the Groundwater Resource Estimation'2020, 3 out of 4 blocks of the district fall under safe category which implies that the groundwater extraction in the district is lower than the recharge. Furthermore, the water quality in the district is fresh and suitable for irrigation purpose. Therefore, it is suggested for sustainable utilisation of GW resource for increasing the agricultural productivity of the district which would further lead to improved socio-economic condition of the population.

5.5 Mass Awareness and Community mobilisation:

Keeping in view the prevailing water situation in country and the wasteful water use practices, educating water users that the water resources are not an inexhaustible entity and have a value becomes a significant task. Domestic, agricultural and industrial sectors must be addressed to understand that conserving the resource would lead to sustainability and bring about economic and social stability. Awareness about conserving groundwater level and proper utilization of rainwater for storage among different stakeholders would create a positive impact. Furthermore, it would help the government in improving the groundwater scenario of India.

6. CONCLUSION

The highly diversified occurrence and considerable variations in the availability and utilization of groundwater makes its management a challenging task. Scientific development and management strategy for groundwater has become imperative to avert the looming water crisis. In this context, various issues such as, prioritization of areas for development of groundwater resources vis-a-visits availability, augmentation of groundwater through rainwater harvesting and artificial recharge, pricing and sectoral allocation of resources and participation of the stakeholders must be considered. In view of the above, the present study area a systematic, economically sound and politically feasible framework for groundwater management is required.

A thorough study was carried out based on data gap analysis, data generated in-house 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 Ashoknagar district.

Geographically, Ashoknagar district covers an area of 4673.94 sq. km, out of this 51 sq. km area is occupied by forest. Geologically, the area is occupied by Deccan basalt, Vindhyan formations & Archaen granites. As per Ground water assessment year 2020 the average stage of ground water development is 62.82 %.

As per Ground water assessment 2020 the stage of ground water development are categorized as safe. The area has declining water level, low yield potential of aquifers are the major issues in the district.

Recommendations

• It is suggested to develop ground water extraction through DW with emphasis on improving the sustainability of groundwater resources.

• Land based interventions like construction of lined farm ponds, rehabilitation of existing farm ponds along with horticulture plantation as may be feasible to take on to increase the availability of irrigation water during both kharif (July to October) as well as rabi (October to March) season.

• Sustainable management of the area is required to be taken off to improve the quality and quantity of the groundwater and regular monitoring is therefore recommended.

• The interventions above need to be supported by regulation on extraction from deeper aquifer. So, the deeper ground water resources are protected for future generation and also serve as ground water sanctuary in times of distress/drought.

• 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.

- Farmers should be trained for adopting more efficient irrigation techniques and water conservation practices and boosting recharge.

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- *District Brochure, Ashoknagar, Central Ground Water Board, North Central Region, Bhopal, 2018.*