



JSA-CTR

Scientific Action Plan for Fatehabad



Prepared By-

Haryana Space Applications Centre (HARSAC),
Citizen Resource Information Department (CRID)

Government of Haryana

2021



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1. Introduction

1.1. History

The district derives its name from the eponymous headquarters town founded by Firoz Shah Tughlak in the 14th century. He named it after his son Fateh Khan, as Fatehabad. The Fatehabad district was carved out of Hisar district on 15 July 1997.

In November 1884, the Sirsa district was abolished and Sirsa tahsil after the distribution of villages was formed. In 1889, 15 villages forming a detached block known as Budhlada were transferred from Kaithal tahsil to Fatehabad tahsil. The Barwala tahsil containing 139 villages was abolished with effect from 1 January 1891 and its area was distributed between 3 contiguous tahsils; 13 villages going to Hansi, 24 to Hisar and 102 to Fatehabad. At the same time 13 villages were transferred from Hisar tahsil to Bhiwani tahsil and a sub-tahsil was established at Tohana in Fatehabad tahsil. In 1923, the Tohana sub-tahsil was transferred from Fatehabad to Hisar tahsil. In 1972, Tohana sub-tahsil was upgraded to tahsil. Two sub-tahsils, one at Ratia of tahsil of Fatehabad and other at Adampur of Hisar tahsil were created in 1979. By the end of 1978, the Hisar district comprised 486 villages, divided between tahsils of Fatehabad (166); Hisar (115), Hansi (119) and Tohana (86). Fatehabad came into existence as a full-fledged district with effect from 15 July 1997, now having three sub-divisions, three tahsils and three sub-tahsils.

1.2. Location

Fatehabad District is located in the south western part of Haryana. It is surrounded by Punjab in North, district Hisar in south, district Jind in East and Rajasthan and district Sirsa in the West. Fatehabad is located at $29^{\circ} 13' 24'' \text{N}$ to $29^{\circ} 49' 27'' \text{N}$ Latitudes and $75^{\circ} 11' 44'' \text{E}$ to $75^{\circ} 56' 23'' \text{E}$ longitudes. It has an average elevation of 208 meters amsl (682 amsl. feet). The Bhakra Nangal Project has caused rapid changes in water table configuration and now the Bhakra and Jamuna canals along with the seasonal Ghaggar drain Fatehabad. Fatehabad district of Haryana State has a total geographical area of 2538 sq.km River Ghaggar defines its boundary with Punjab state in northern part. The district has been subdivided into six development blocks viz Fatehabad, Tohana, Bhuna, Bhattu Kalan, Jakhhal and Ratia.

The Location Map of District Fatehabad is shown in **Figure 1**.

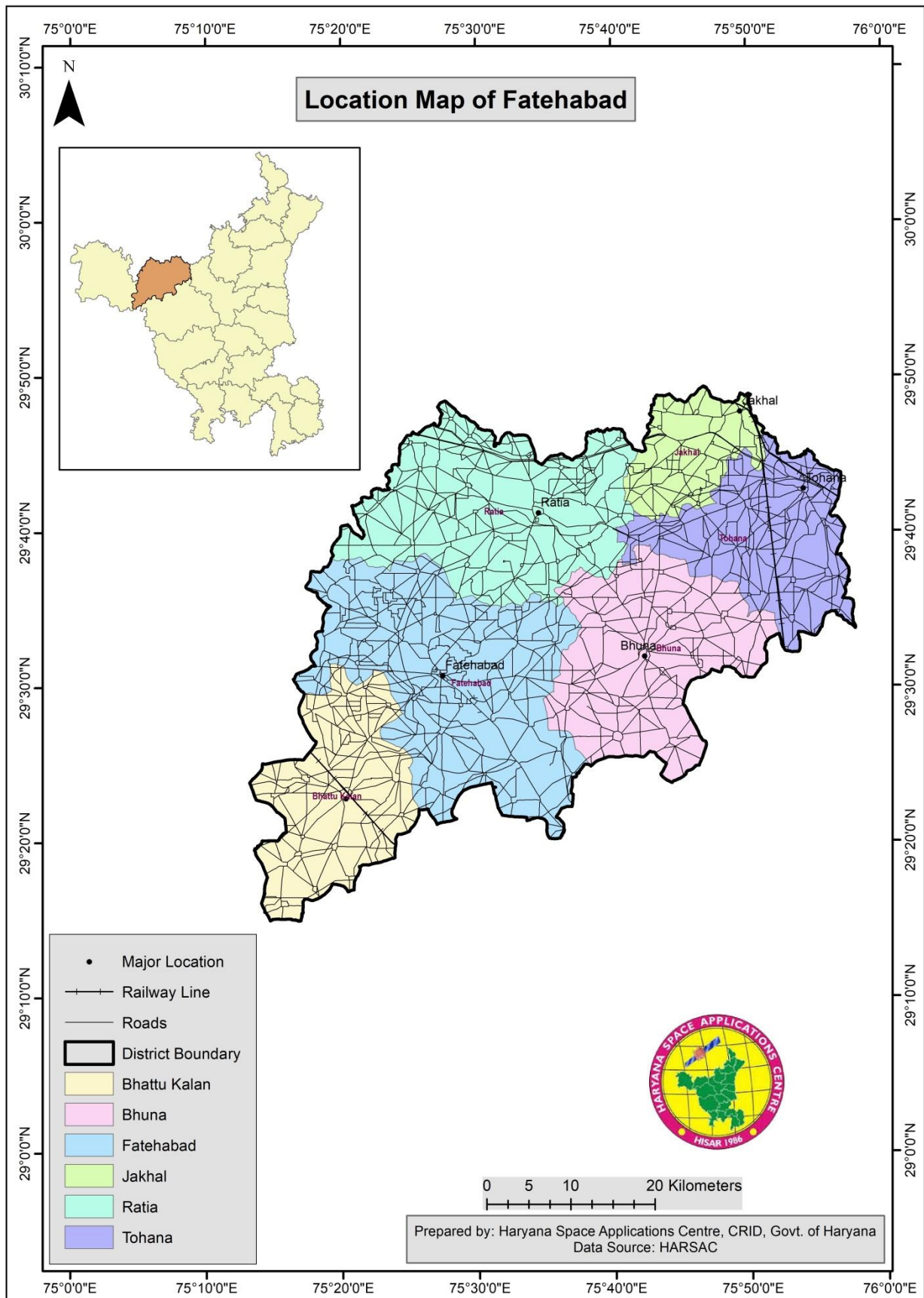


Figure 1 Location Map of Fatehabad District

1.3. Administrative setup

The administrative setup of the District of Fatehabad has been described in the following table, with specific sectoral development such as water, animal husbandry, agriculture, roadways is operated under specific departments. The detailed administrative setup is shown in **Table 1**.

Table 1 Major Administrative Jurisdictional Setup of Fatehabad District

Country	India
State	Haryana
Division	Fatehabad
Headquarters	Fatehabad
Tehsil	1. Fatehabad 2. Ratia, 3. Tohana,
Total Area	2,538 km ² (980 sq mi)
Total Population (2011)	9,42,011
Density	370/km ² (960/sq mi)
Literacy	67.92%
Website	http://Fatehabad.gov.in
Location of Fatehabad	South western region of Haryana
Coordinates	29° 31' N and 75° 27' E
Total Area	2490 sq. km
Elevation	682 ft above the sea level

Source: https://en.wikipedia.org/wiki/Fatehabad_district

Sub Divisions (3)	Fatehabad, Ratia, Tohana
Tehsils (3)	Fatehabad, Ratia, Tohana
Sub Tehsils (3)	1. Bhuna, 2. Jakhal 3. Bhattu Kalan
Blocks (6)	1. Fatehabad 2. Ratia, 3. Tohana, 4. Bhuna, 5. Jakhal 6. Bhattu Kalan
Municipal Corporation (1)	Municipal Corporation, Fatehabad
Municipal Committee (3)	Bhuna, Ratia, Jakhal
Municipal Council (2)	Tohana, Fatehabad
Population (Census 2011)	9,42,011

Source: <https://Fatehabad.gov.in/about-district/administrative-setup/>

Total Villages	243
Total Panchayats	257
Village Level	Panchayat (2997)
Block Level	Panchyat Samiti (2594)
District Level	ZilaParishad (18)

Source: <https://Fatehabad.gov.in/about-district/administrative-setup/>

1.4. Climate

Fatehabad district can be classified into tropical desert & steppe, arid and hot which is mainly dry with very hot summer and cold winter except during monsoon season when moist air of oceanic origin penetrates into the district. The hot weather season starts from mid-March to last week of the June followed by the south-west monsoon which lasts till September. The transition period from September to October forms the post-monsoon season. The winter season starts late in November and remains up to first week of March. The climate of the district is characterized by its dryness and extremes of temperature and scanty rainfall. The district has a sub-tropical continental monsoon climate where we find seasonal rhythm, intensely hot summer, cool winter, unreliable rainfall and great variation in temperature. Air is generally dry during the greater part of the year. Scorching dust laden winds which blow during hot season render the weather very tiring. Dense fog sometimes occurs during winter months. Four seasons are observed in a year. Mid-March to end of June is summer season, followed by rainy season from July to mid-September, after which a transition period of two months follows. Then the cold season comes from mid-November to mid-March. With the start of cold season, temperatures begin to decrease rapidly. January is the coldest month when mean daily maximum temperature is about 21.5°C and mean daily minimum at 5.9 °C. Cold waves affect the region in the wake of passing western disturbances and the minimum temperatures drop down to about 2.2 °C occasionally. The highest maximum temperature recorded at Hisar was 48.5 °C on May 29, 1984 and the lowest minimum temperature was -3.9°C on January 31, 1929. Records of Meteorological Observatory at Hisar, the neighboring district, may be taken as representative of the meteorological conditions prevailing in the district in general. With the onset of summer season temperatures begin to rise rapidly. May and June are the hottest months. The mean daily maximum temperatures during June are 41°C On individual days the day temperature may occasionally exceed 45.2°C. Hot westerly winds locally known as 'looh' begin to blow from the month of April. With the beginning of monsoon season, day temperatures drop appreciably whereas nights continue to be as hot as in summer. During rainy season, weather is unpleasant due to increased moisture in the air. After the monsoon season, day temperatures remain high but night temperatures go down rapidly.

1.4.1. Temperature

There is a meteorological observatory at Fatehabad and rainfall data collection at Fatehabad, Ratia and Tohana. The records of this observatory may be taken as representative of the meteorological conditions prevailing in the district in general. There is rapid increase of temperature after February. The mean daily temperature in May, which is the hottest month, is 41.60C. On individual days the maximum temperature during the summer season may rise up to about 47- or 48-degree C. The hot scorching winds, which blow in summer, add to the discomfort. Afternoon thundershower, which

occur on some days bring welcome relief, though only temporarily. During monsoons the nights are even warmer than those during the summer season. With the added moisture in the monsoon air, the nights are often uncomfortable. After the withdrawal of the monsoon in the latter half of September, the temperatures begin to decrease. The decrease in temperature is rapid after October and the drop in temperature after nightfall is particularly trying. January is generally the coldest month with the mean daily maximum at 21.7 degree C and the mean daily minimum at 5.5 °C. In the cold season, the district is affected by cold waves in the wake of passing western disturbances and the minimum temperature drops down to about 3.0 degree C occasionally. The highest maximum temperature recorded was 48.3 degree C on May 30, 1944. The lowest minimum temperature was 3.9 degree C on January 31, 1929.

1.4.2. Humidity

Relative humidity in the morning is generally high during the monsoon season and during December to February, usually being about 70 per cent or more. Humidity is comparatively less during the rest of the year, the driest part of the year being the summer season with the relative humidity being about 30 per cent in the afternoons.

1.4.3. Rainfall

The normal annual rainfall of the district is 373 mm which is unevenly distributed over the area in 22 days. The south west monsoon sets in from last week of June and withdraws in end of September, contributed about 80% of annual rainfall. July and August are the wettest months. Rest 20% rainfall is received during non-monsoon period in the wake of western disturbances and thunder storms. Generally, rainfall in the district increases from southwest to northeast. Rainfall records reveal that average annual rainfall (2005-09) in the district is 355.2 CMS. and about 72.71 percent of the normal annual rainfall in the district is received during June to September, July and September being the rainiest months. Rainfall generally increases from west to east. Rainfall in the month of June is significant mostly in the form of thundershowers. The variation in the annual rainfall from year to year is very large. On an average there are 28.2 rainy days in a year in the district at Tohana. The heaviest rainfall in 24 hours recorded in the region at Hisar was 346.7mm at Hisar on August 16, 1926. Winds are generally light in the district with some strengthening in force during late summer and monsoon seasons. Cloudiness is moderate to heavy during monsoon season, rest of the year skies are generally clear or lightly clouded. Easterly or South Easterly winds blow during monsoon season but for the rest of the year winds are westerly or Northwesterly. Air is dry for most part of the year. Relative humidity is generally high in the mornings, during monsoon season and from December to February. During summer season relative humidity is as low as 30 percent in the afternoons. Thunderstorms occur throughout the year but the highest incidence is during monsoon season.

The satellite derived average annual rainfall map (showing average annual rainfall from 2010 to 2020) of Fatehabad district is shown in **Figure 2**. Average rainfall in various blocks of district Fatehabad from 2010 to 2019 is as follows:

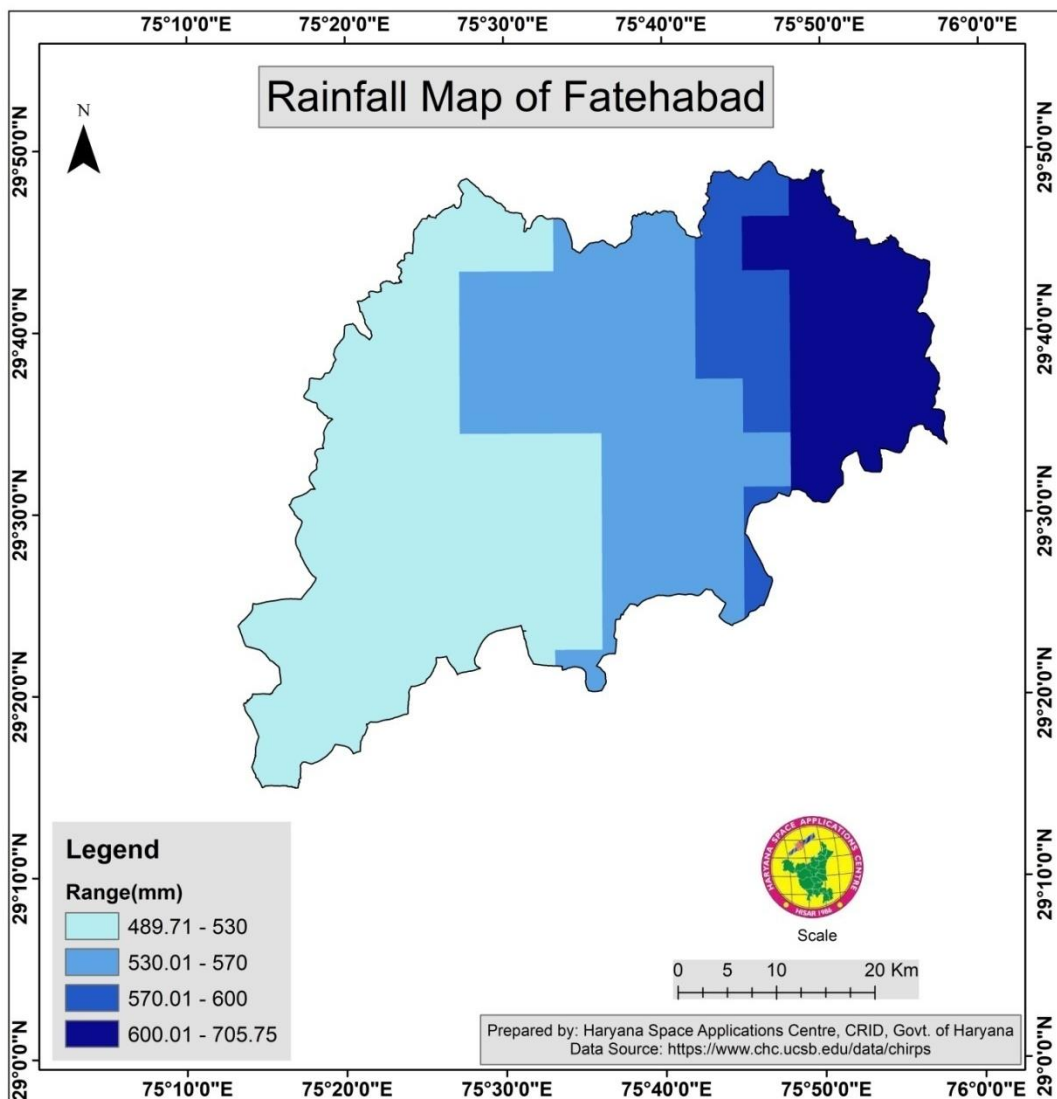


Figure 2 Rainfall Map of Fatehabad District

1.5. Elevation and Topography

The district falls under the Agro Ecological Sub Region of Rajasthan Bagar, North Gujarat plain and South Western Punjab plain, hot arid eco-sub region. The district is located in the Indo-Gangetic alluvial Plains, is by and large flat and plain flat terrain is interrupted by the randomly located sand dunes along the Ghaggar river.

The height above mean sea level of the district as shown by Digital Elevation Model ranges from 0 to 213 m (**Figure 3**). The area is a level land having a gentle slope towards southwest as shown in **Figure 4**. The land slopes from north to south with elevation difference in eastern part of the district from North to South is about 6m (222-216 m amsl) In the rest of the district it is about 7 m (214.6-207.6m amsl) The two above said slopes result in a master slope towards south west with an average gradient of 0.27m/km. Contours of 5 meters interval showed similar topography as in digital elevation model (**Figure 5**).

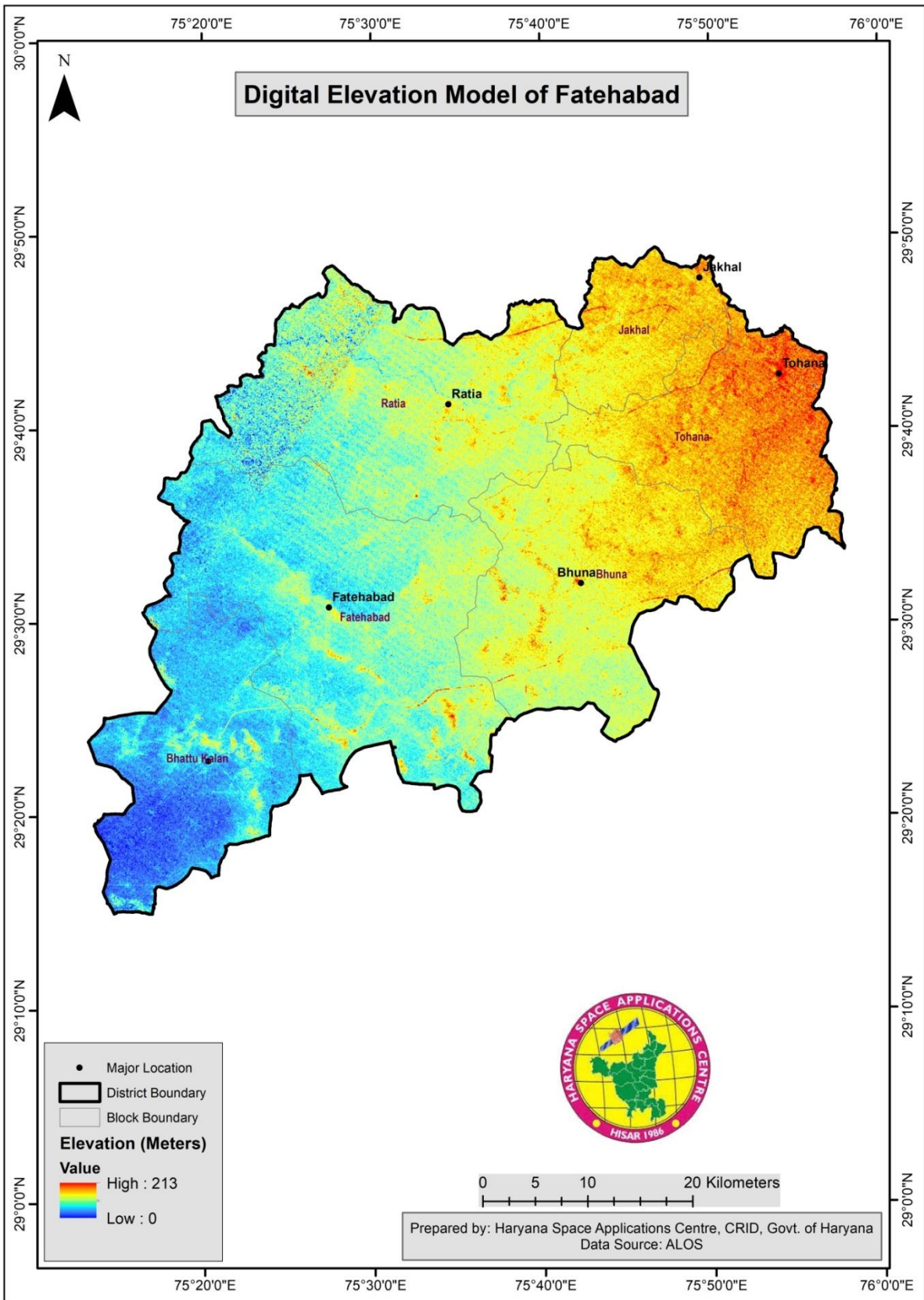


Figure 3 Digital Elevation Model of Fatehabad District

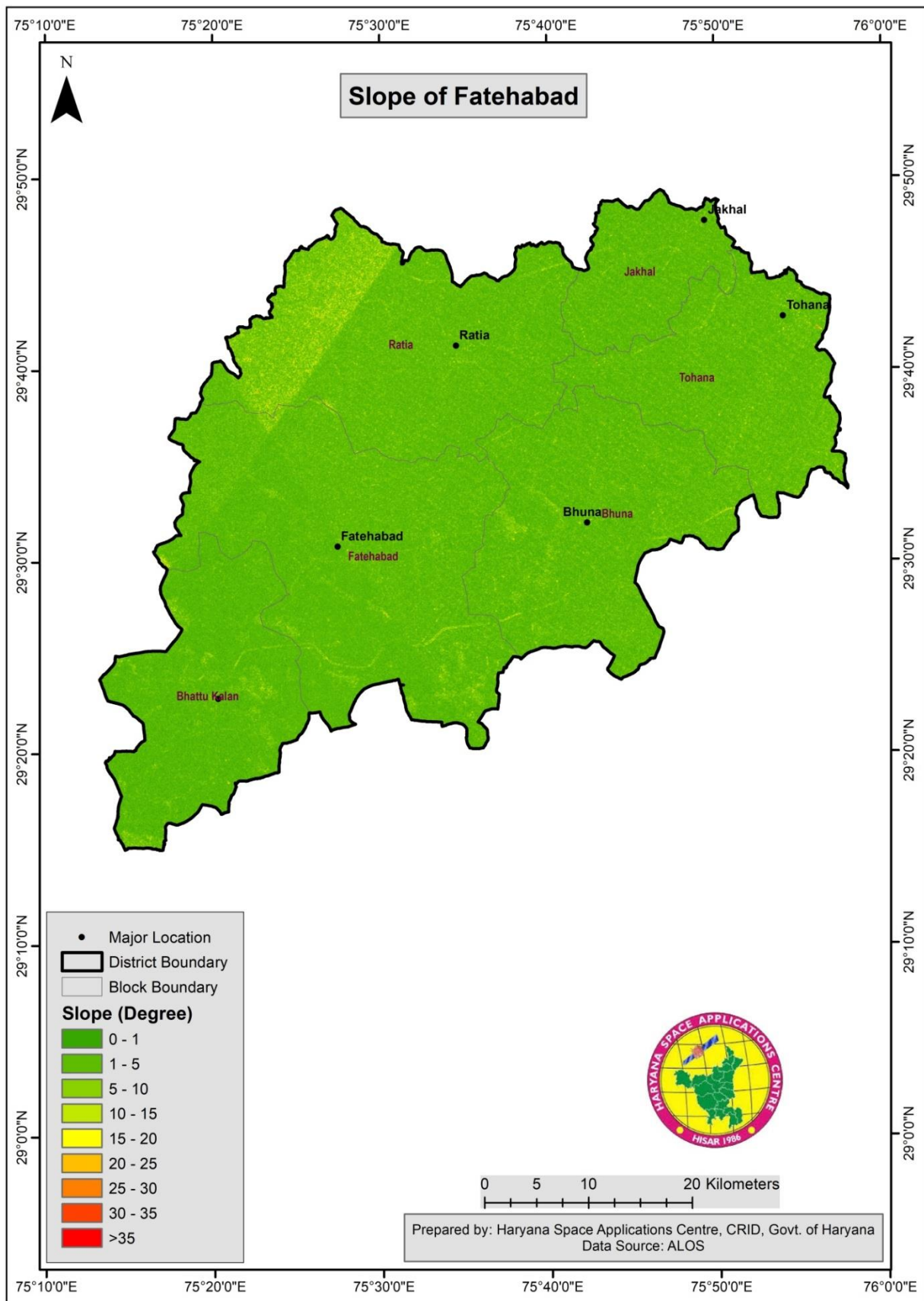


Figure 4 Slope Map of Fatehabad District

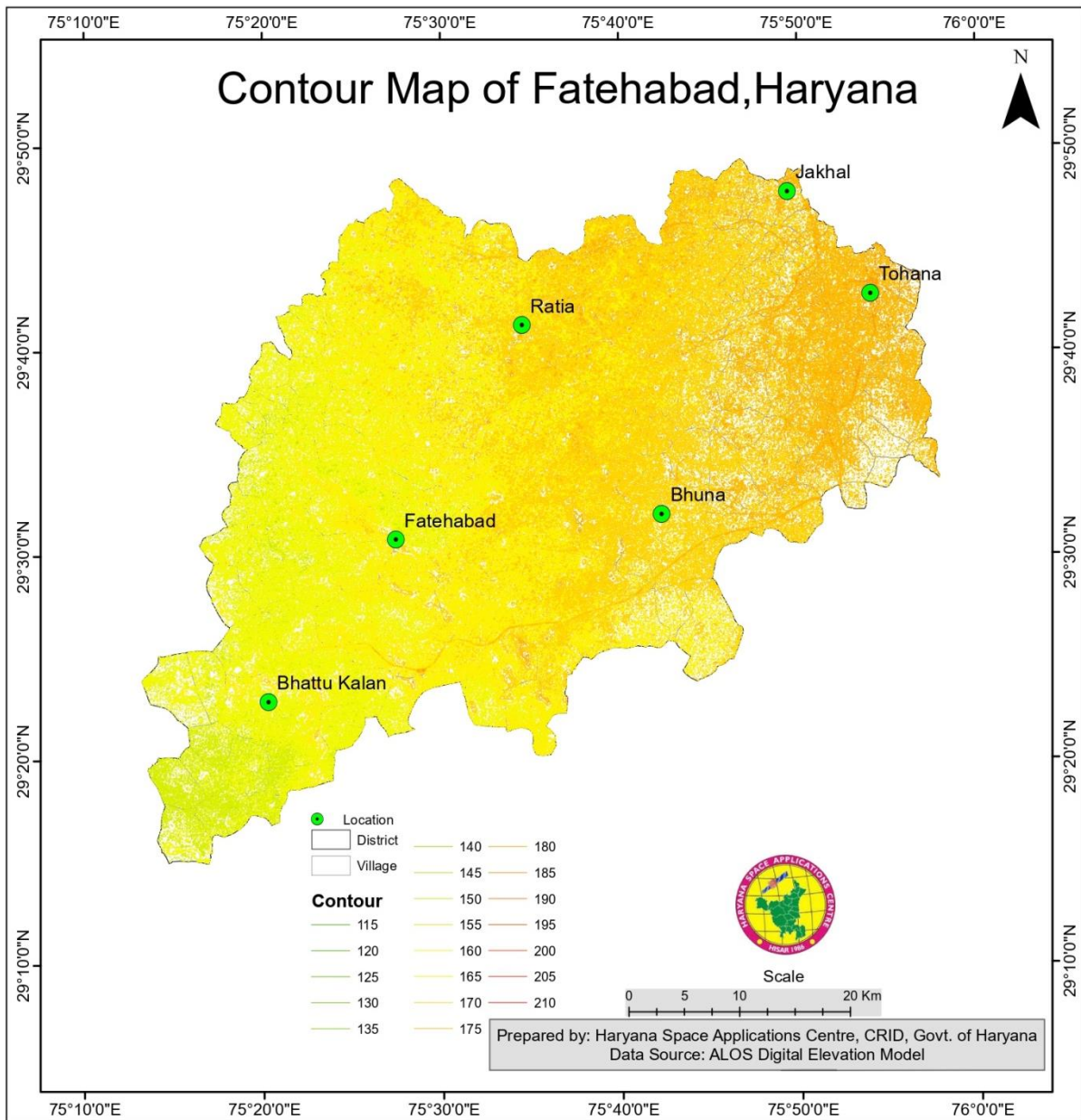


Figure 5 Contour Map of Fatehabad District

1.6. Geology and Lithology

The district is located in the Indo-Gangetic alluvial Plains, is by and large flat and plain flat terrain is interrupted by the randomly located sand dunes along the Ghaggar river (**Figure 6**). The geological formations met within the district are Indo-Gangetic alluvium consisting of newer and older alluvium with a thin blanket of aeolian deposits. The age of these formations ranges from upper-Pleistocene to Recent. Though the formations were laid down from upper-Pleistocene to Recent age, they are conformable with each other. Exploratory drilling in this area indicates that these Quaternary

unconsolidated sediments are underlain by hard rock formations of Achaean age comprising of Granites, schists and gneisses.

The older alluvium is characterized by dark brown color, rich in concretions and nodules of impure calcium carbonate known as kankar and forms slightly elevated terraces, generally above the flood level of present drainage, The older alluvium consists of inter bedded lenticular and inter fingering beds of clay, sands, gravels, silts, silty sands, silty clays with kankar mixed in various proportions poorly sorted, fine grained. The most porous and permeable zones in this formation constitute of fine to coarse grained sands, gravels. Some times kankar beds yield moderate to large quantities of water.

The unconsolidated newer alluvium occurring mainly along the flood plains of Ghaggar river in the area is light colored and poor in calcareous matter. It contains lenticular beds of sands, gravel and clays. Gravels and sands form the main aquifer zones and are normally known to yield large quantities of water.

Aeolian deposits, loess and sand dunes are found in almost in the entire district but become less frequent in the northern parts of the district. The loess is fine grained buff or grey colored windblown dust of sandy to clayey constitution. Windblown formations are deposited irrespective of altitude of lowered surface and essentially deposits of arid regions. At places sands are piled up into dunes which are constantly being shifted by winds blowing from south west. The dunes are either longitudinal or crescentic type depending on the wind action. Sands and sand dunes of Aeolian deposits may form very good aquifers but normally rest above the ground water table in the area.

A fence diagram prepared by utilizing the litho-logical logs indicates that the clay group of formations dominates the sand group. However, the sand proportion increases in the central and northern parts of the district whereas clays predominate in southern part of the district. The granular zones are more of lenticular type in the southern and north eastern part of the district but more persistent in the rest of the area. A striking feature of the formation in the area is that the clay beds are invariably thicker than permeable granular zones in the area. The bed rock which was touched in 3 boreholes in the south western part of the area is of Pre-Cambrian age and comprises of granite, mica schist and gneisses. Bed rock is shallow in south western part and thickness of alluvium increases gradually towards northeast. The maximum thickness of alluvium so far recorded in the boreholes drilled in Fatehabad district is 365.7m at Jallinia (29°31'00" and 75°34'30").

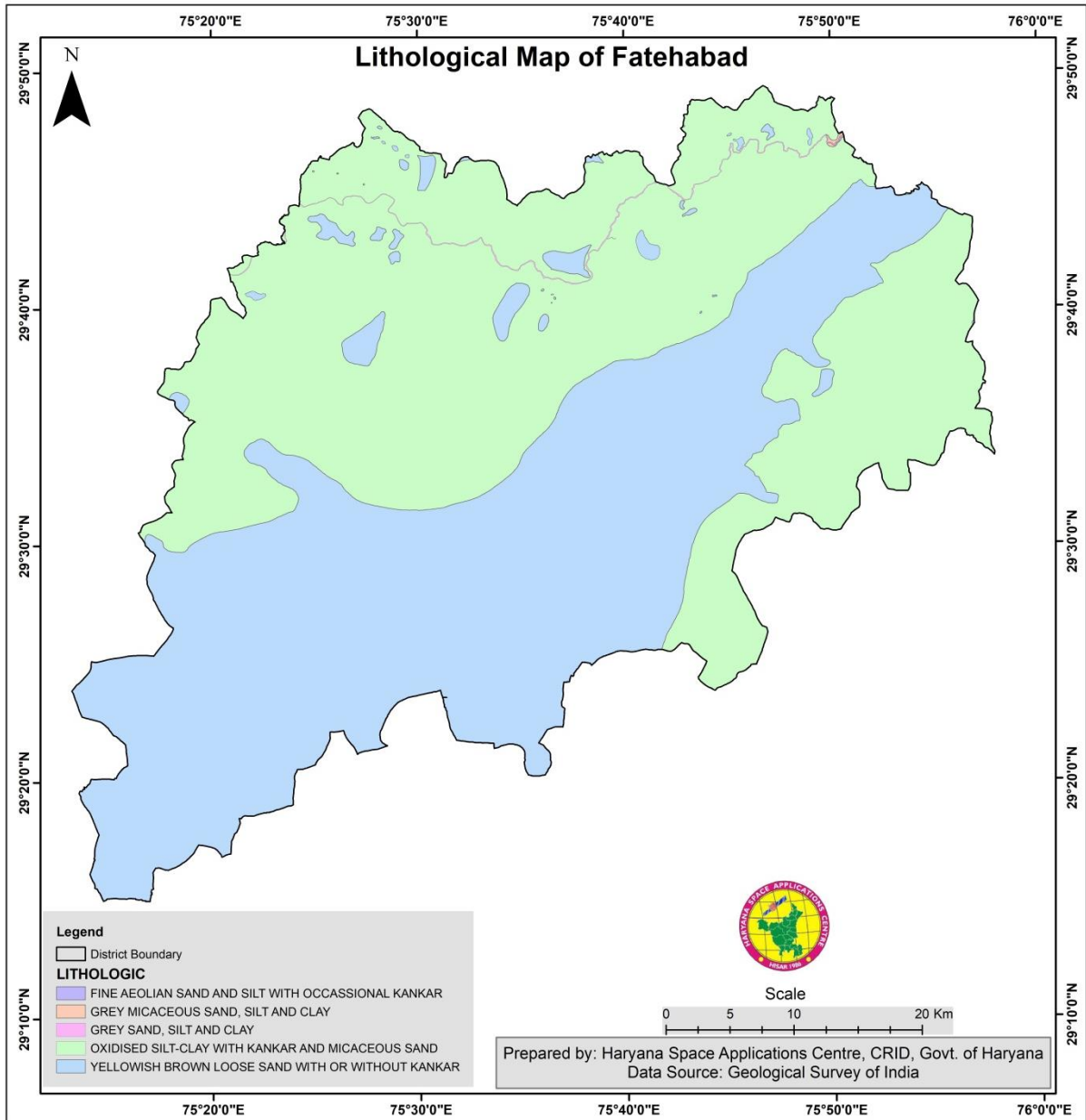


Figure 6 Lithological Map of Fatehabad District

1.7. Soil Profile

The major soil classes are silt, sandy, sandy loam, sandy clay, silty loam, sandy silt, silt clay loam and silt clay in the district (Figure 7). Majority of soil fall under the slope category of 0-3%. Only in case of Bhattu Kalan block, 16,570 hectares of soil fall under 3-8% slope category (Table 2).

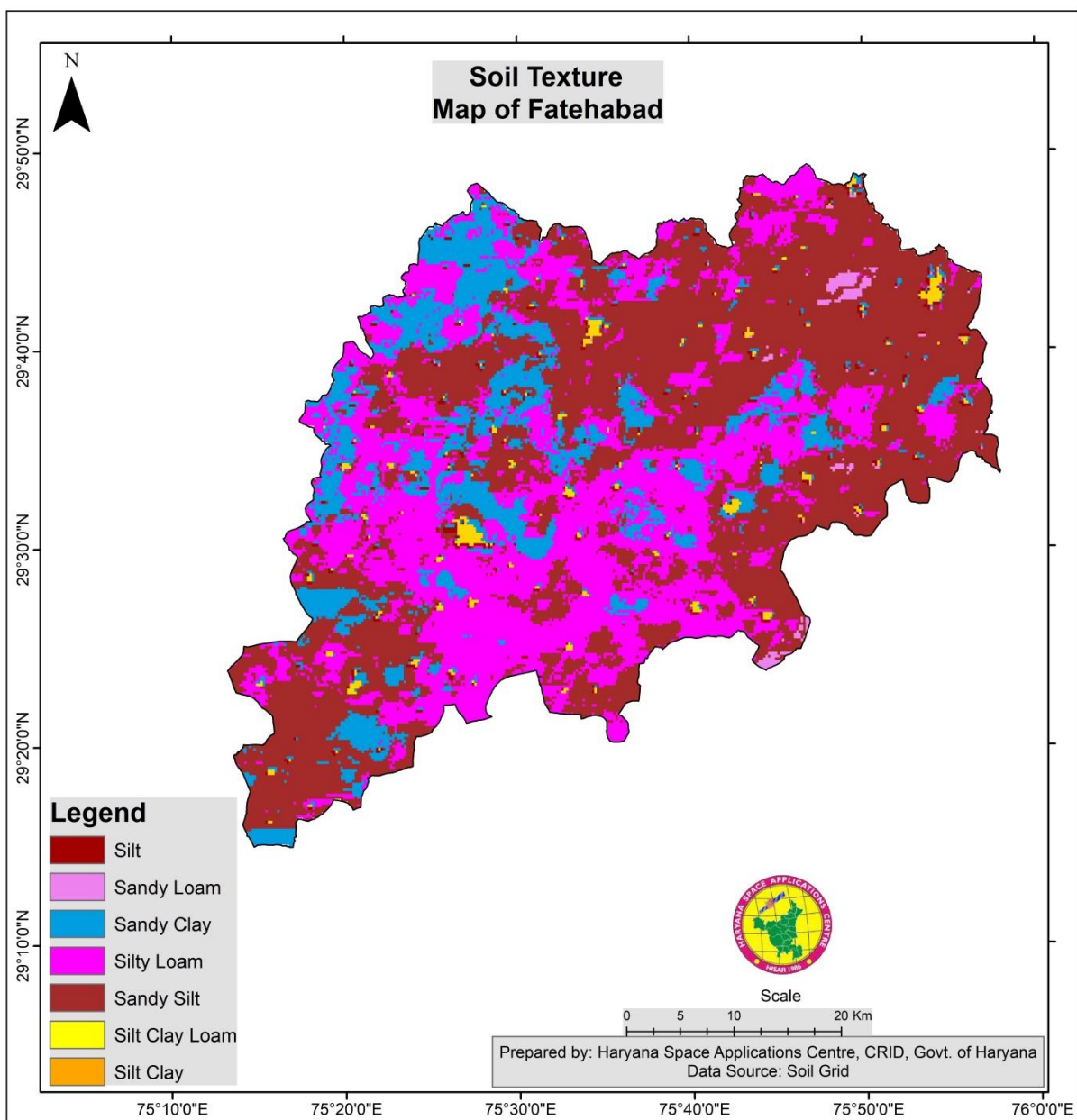


Figure 7 Soil Texture Map of Fatehabad District

Block	Soil Type	Land Slope				
		Area Ha	0-3% (ha)	3-8% (ha)	8-25% (ha)	<25% (ha)
Fatehabad	Clay, Sandy Loam	67613	67613			
Tohana	Clay	40067	40067			
Jakhal	Clay	15526	15526			
Ratia	Clay	53265	53265			
Bhuna	Clay	36468	36468			
Bhattu Kalan	Sandy, Sandy Loam	33380	16810	16570		

Table 2 Soil Classification of Fatehabad District

Source: District Agriculture Department

1.8 Landuse

As per the information provided by the District Revenue Office for the year 2015-16, total geographical area of the district is 2, 58,515 ha. The cropping intensity of the district is 101.27%. The land use land cover map of Fatehabad District is shown in **Figure 8**.

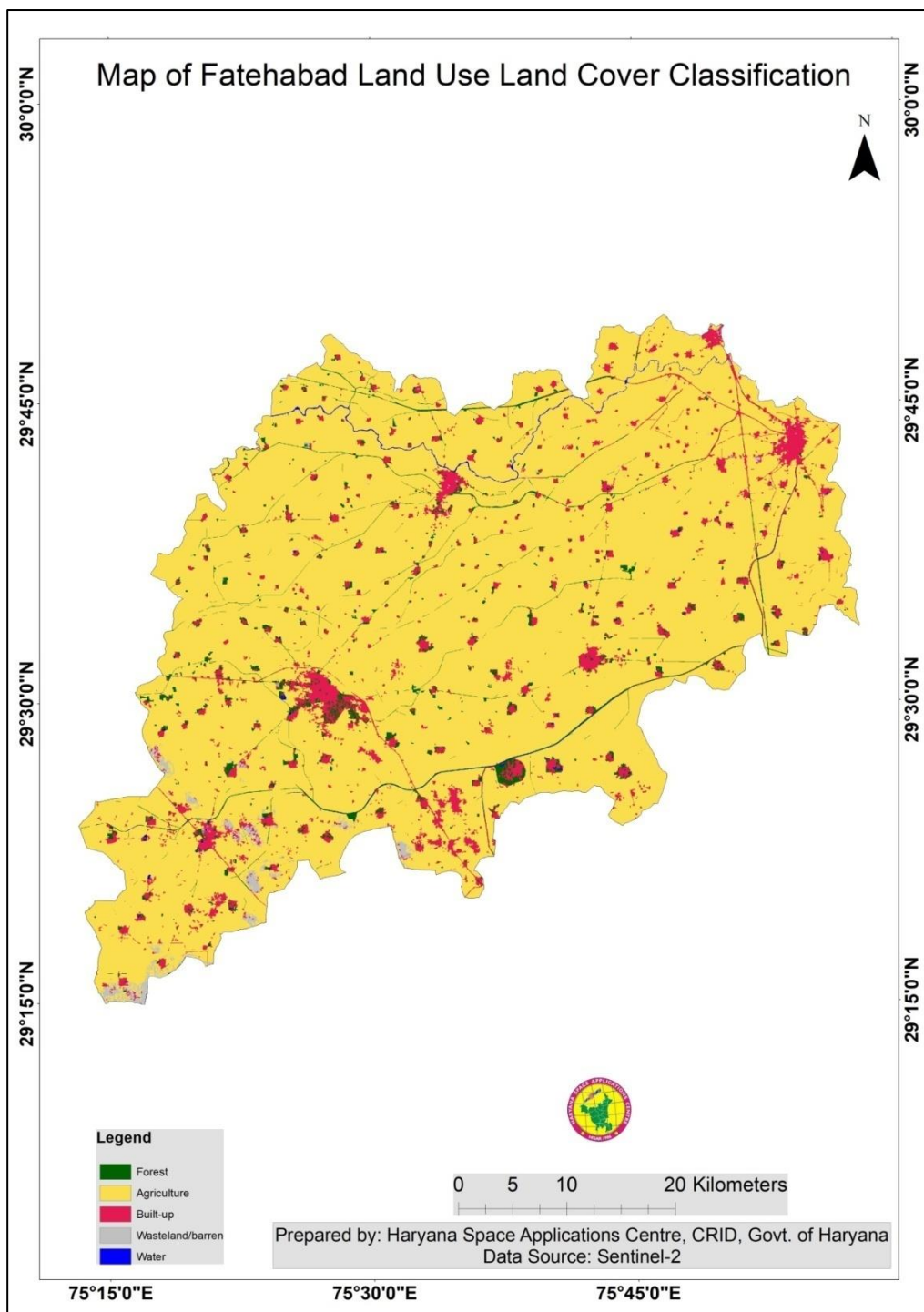


Figure 8 Landuse and Landcover of Fatehabad District

Main land use in the district is for agriculture with 84% of the land being used for agriculture. Land put to various uses in the district is given in the **Table 3** of Fatehabad district, Haryana.

Table 3 Area under Agriculture in Fatehabad District

Name of Tehsil	Total G.A (ha)	Area under Agriculture Gross cropped area	Area under Agriculture Net Sown area	Area under Agriculture Cropping Intensity	Area under Forest (ha)	Area under Wasteland (ha)	Area under Other use (ha)
Fatehabad	138075	125390	123049	101.9	14	-	12671
Tohana	61959	54158	54038	100.22	14	-	7787
Ratia	58481	53071	52622	100.85	11	-	5399
Total	258515	232619	229709	101.27	39		25857

Source: District Revenue Office, Fatehabad

2. District Water Profile

2.1. Source of Water

Drinking water supply to rural as well as urban area of the district is both tubewell and canal based and maintained by State Public Health Department and Sewerage Department along with Municipal Council of Fatehabad.

2.1.1. Canals

Therefore, the canal water constitutes the major source of water supply to the villages and towns especially western part of the district. Whereas most of water works in the district are tubewell based. At some places water works are using canal water in conjunction with tubewell water, wherever either water is not available or quality of water is fit for drinking purpose. Water supply in the district is maintained by public health department.

2.1.2. Ponds

A pond is a body of standing water, either natural or man-made, that is usually smaller than a lake. They may arise naturally in floodplains as part of a river system, or they may be somewhat isolated depressions (examples include vernal pools and prairie potholes). Usually, they contain shallow water with marsh and aquatic plants and animals. A wide variety of man-made bodies of water are classified as ponds. Some ponds are created specifically for habitat restoration, including water treatment. Others, like water gardens, water features and koi ponds are designed for aesthetic ornamentation as landscape or

architectural. In Fatehabad district total 1423 ponds/ waterbodies found on satellite data. The map of total ponds/ waterbodies that include ponds, canals are shown in **Figure 9**.

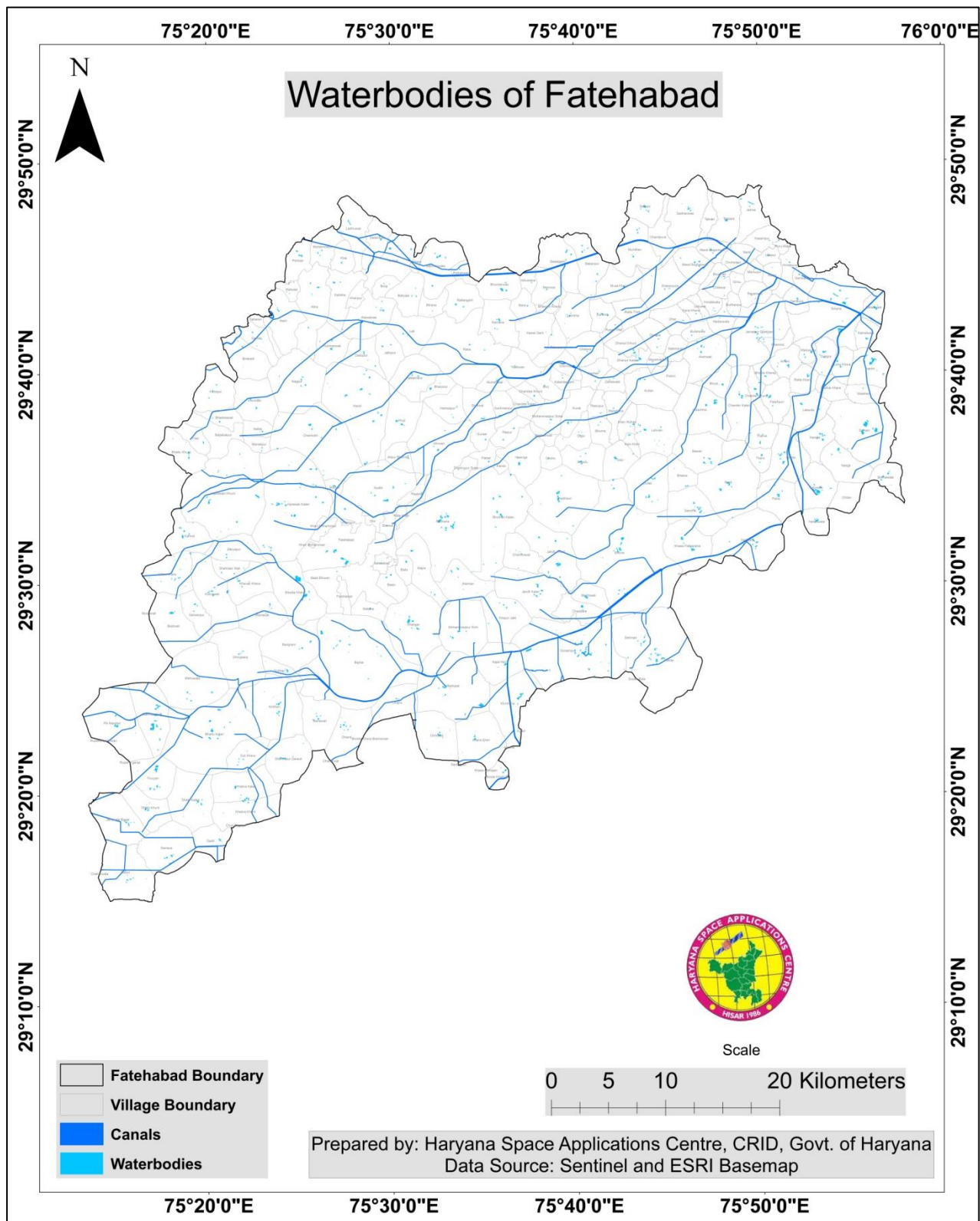


Figure 9 Waterbodies of Fatehabad District

2.1.3. Drain

Drainage means a drainage consisting of native soils such as a natural swale or topographic depression, which gathers or conveys run-off to a permanent or intermittent watercourse or waterbody. During rain or irrigation, the fields become wet. The water infiltrates into the soil and is stored in its pores. When all the pores are filled with water, the soil is said to be saturated and no more water can be absorbed; when rain or irrigation continues, pools may form on the soil surface. Surface drainage is the removal of excess water from the surface of the land. Shallow ditches, also called open drains, normally accomplish this. The shallow ditches discharge into larger and deeper collector drains. In order to facilitate the flow of excess water toward the drains DEM is very important.

The area being a flat terrain is conspicuous by absence of any well-defined natural drainage system but the Ghaggar River drains the northern part of district. The river course falling in this area is very narrow and often causes floods when heavy rainfall occurs in the catchment area. In the rest of the area the drainage is of inland type and the excess rainwater, accumulated in natural /artificial depressions. The drainage map of Fatehabad District is shown in **Figure 10**. The statistics of length of drainages under each order are shown in **Table4**.

Table 4 Total Length of Stream Orders in Meters

Stream Order	Length in meters
1	11829
2	5794
3	3052
4	1488
5	624
6	121
7	301

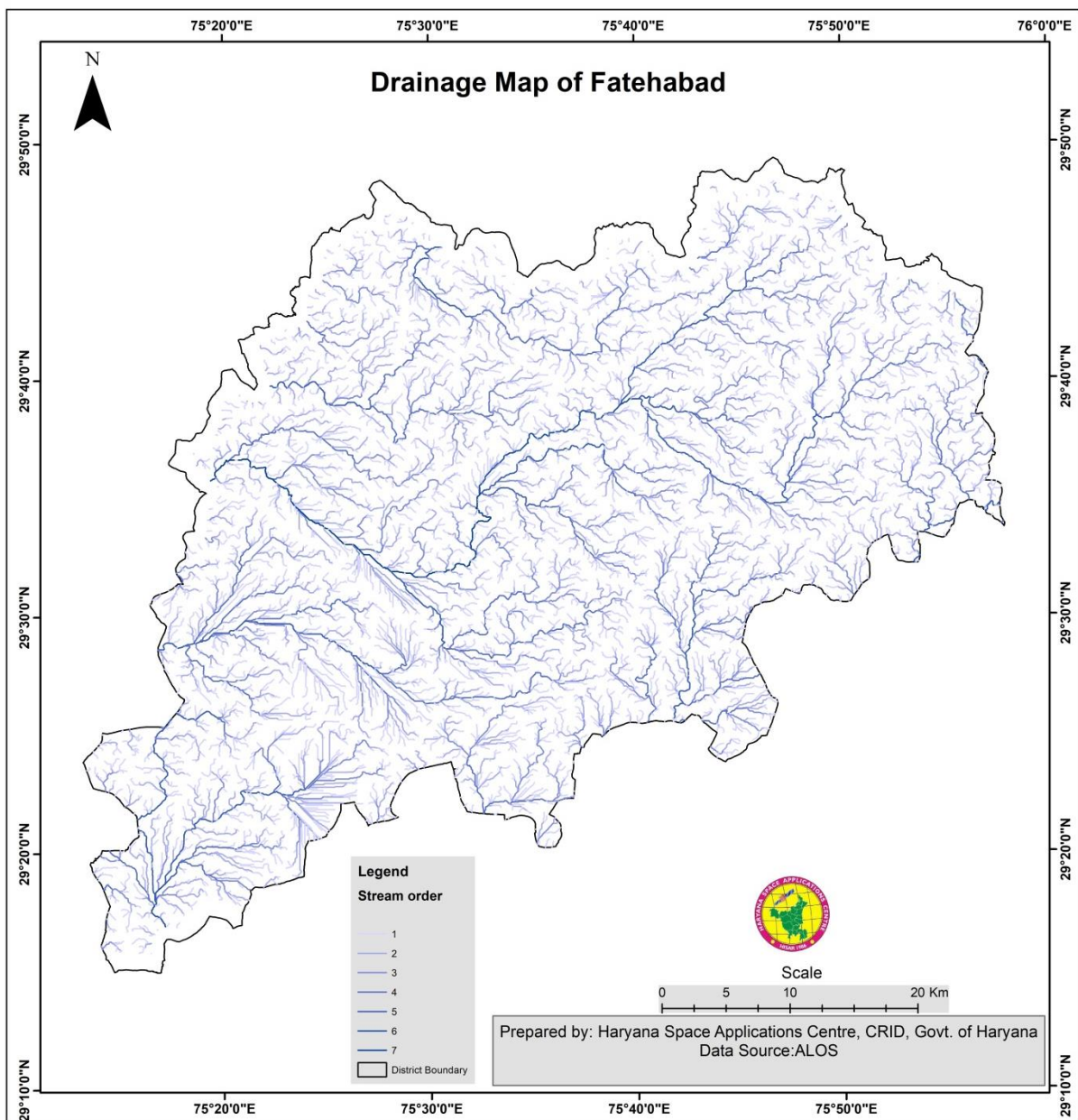


Figure 10 Drainage Map of Fatehabad District

The areas which are mainly underlain by marginal to saline water, have very low development of ground water are facing ground water logging problems. The rise of water table in certain areas less than 2m below ground level is adversely affecting the soils, crops as well as civil structures. The canals either unlined or with damaged lining increase percolation. As water table gradient in the area is very gentle and out flow of ground water is very slow. 40-sq.km area is under water-logged condition (**Figure 11**).

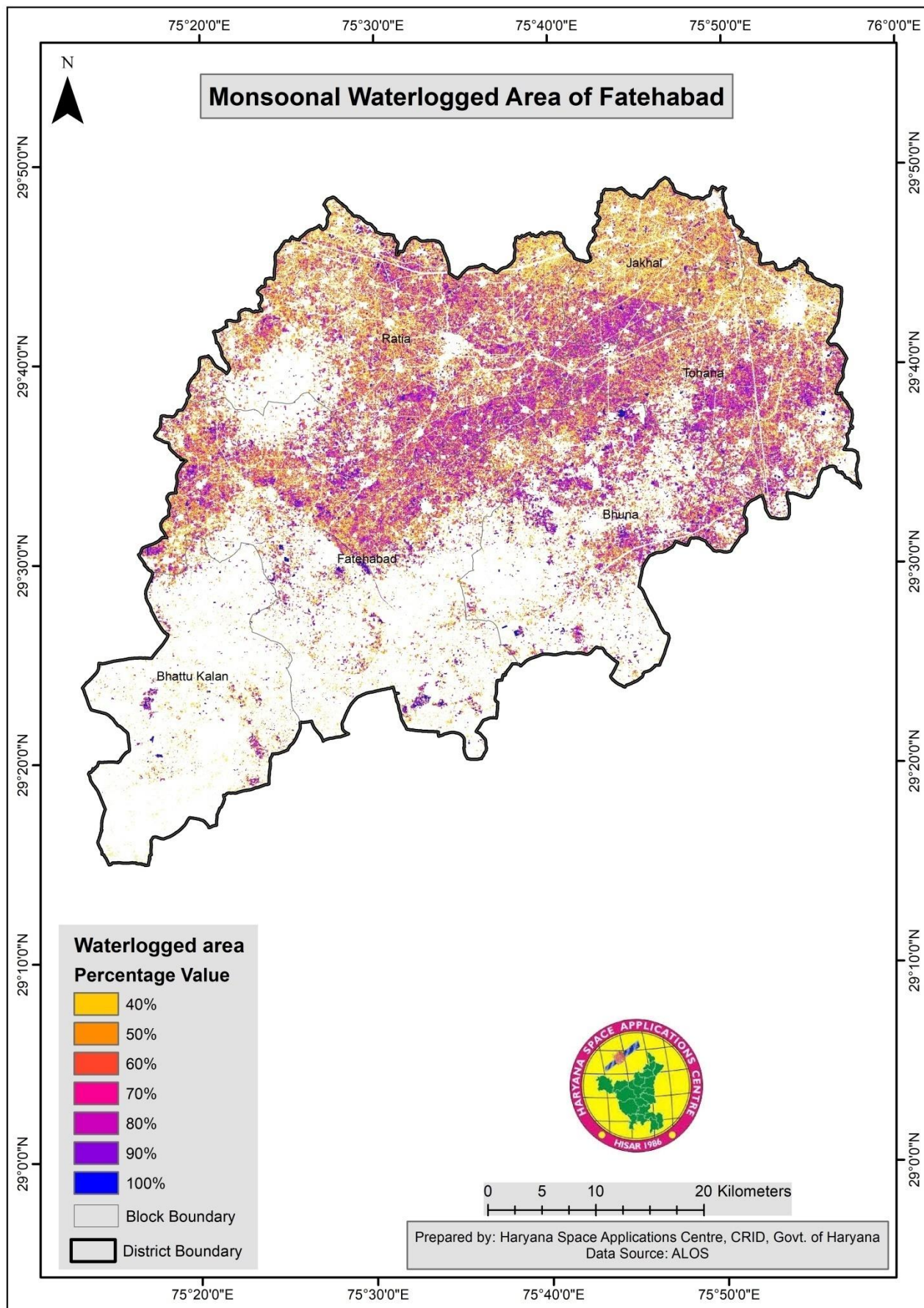


Figure 11 Monsoon Waterlogged Area Map of Fatehabad District

2.2 Water Harvesting System

A rainwater harvesting system comprises components of various stages - transporting rainwater through pipes or drains, filtration, and storage in tanks for reuse or recharge.

2.2.1 Roof Top Harvesting

There are a number of different ways to harvest rain water. But the one most essential thing that is common in all of the available water conservation techniques is to utilize natural rainwater to fulfil the daily life's water consumption. People in the city are becoming all the more conscious day by day in implementing the best possible water conservation techniques. There are major benefits of harvesting natural rainfall that the water can be harvested on a small-scale basis, such as on a bungalow or in housing societies, and it can also be done on a large-scale basis, such as at industrial level. Many commercial premises have incorporated rainwater harvesting system in their building. And slowly, a lot of housing societies are also incorporating this technique. Harvesting rainwater involves the installation of a very simple technology that can be used by both commercial as well as residential places to make a tiny difference for a good cause.

Rooftop Rain Water Harvesting is the technique through which rain water is captured from the roof catchments and stored in reservoirs. Harvested rain water can be stored in sub-surface ground water reservoir by adopting artificial recharge techniques to meet the household needs through storage in tanks. The Main Objective of rooftop rain water harvesting is to make water available for future use. Capturing and storing rain water for use is particularly important in dry land, hilly, urban and coastal areas.

2.2.2 Water Harvesting System other than Rooftop

The surface that receives rainfall directly is the catchment of rainwater harvesting system. It may be a terrace, courtyard, or paved or unpaved open ground. The terrace may be a flat RCC/stone roof or sloping roof. Therefore, the catchment is the area, which actually contributes rainwater to the harvesting system. Rainwater from the rooftop should be carried through down to take water pipes or drains to the storage/harvesting system. Water pipes should be UV resistant (ISI HDPE/PVC pipes) of the required capacity. The total no of activities achieved in Fatehabad District for rain water harvesting is shown in **Table 5** at rural and urban area. The map of water conservation activity in Fatehabad at rural and urban level is shown in **Figure12**.

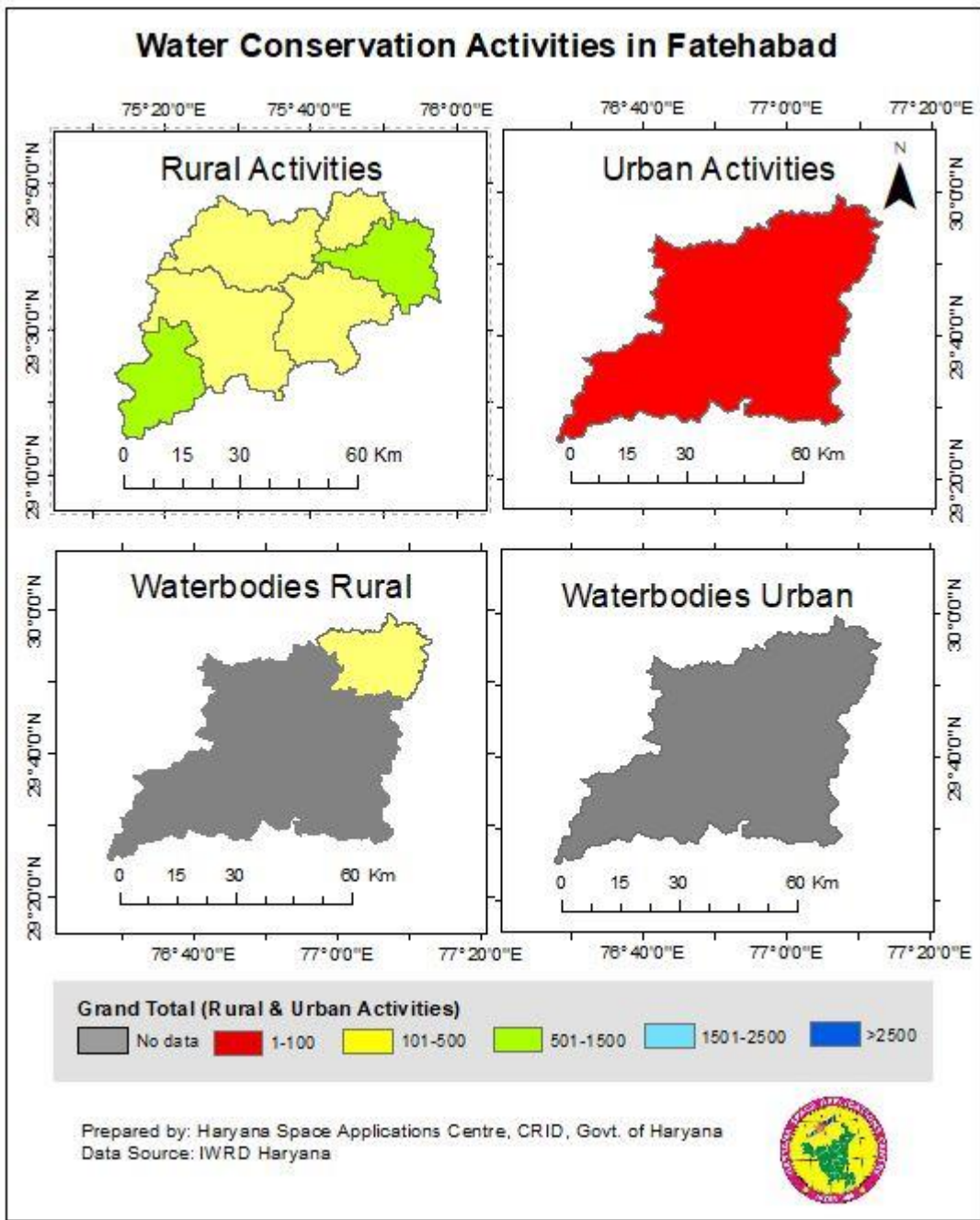


Figure 12 Water Conservation Activity in Fatehabad District

Table 5 Water Harvesting Activities in Rural and Urban Area

In Rural Area		
Sr. No	Block Name	Total No of Activity (no.)
1	Fatehabad	204
2	Bhatt Kalan	745
3	Bhuna	403
4	Ratia	427
5	Tohana	720
6	Jakhal	311
In Urban Area		
1	Fatehabad	28

2.1.4. Sewerage Treatment Plant

Sewage from every residential colony, hotel, or corporate office collected in the sewage collection system. The purpose of a sewage treatment plants (STPs) is to thoroughly treat wastewater. The sewerage treatment plant map is shown in **Figure 13**. In Fatehabad District a total of 8 treatment plant are installed having total capacity of approx. 20-30 MLD. In Fatehabad District there is one major biomedical waste management site at the border of Fatehabad and Nissing Block.

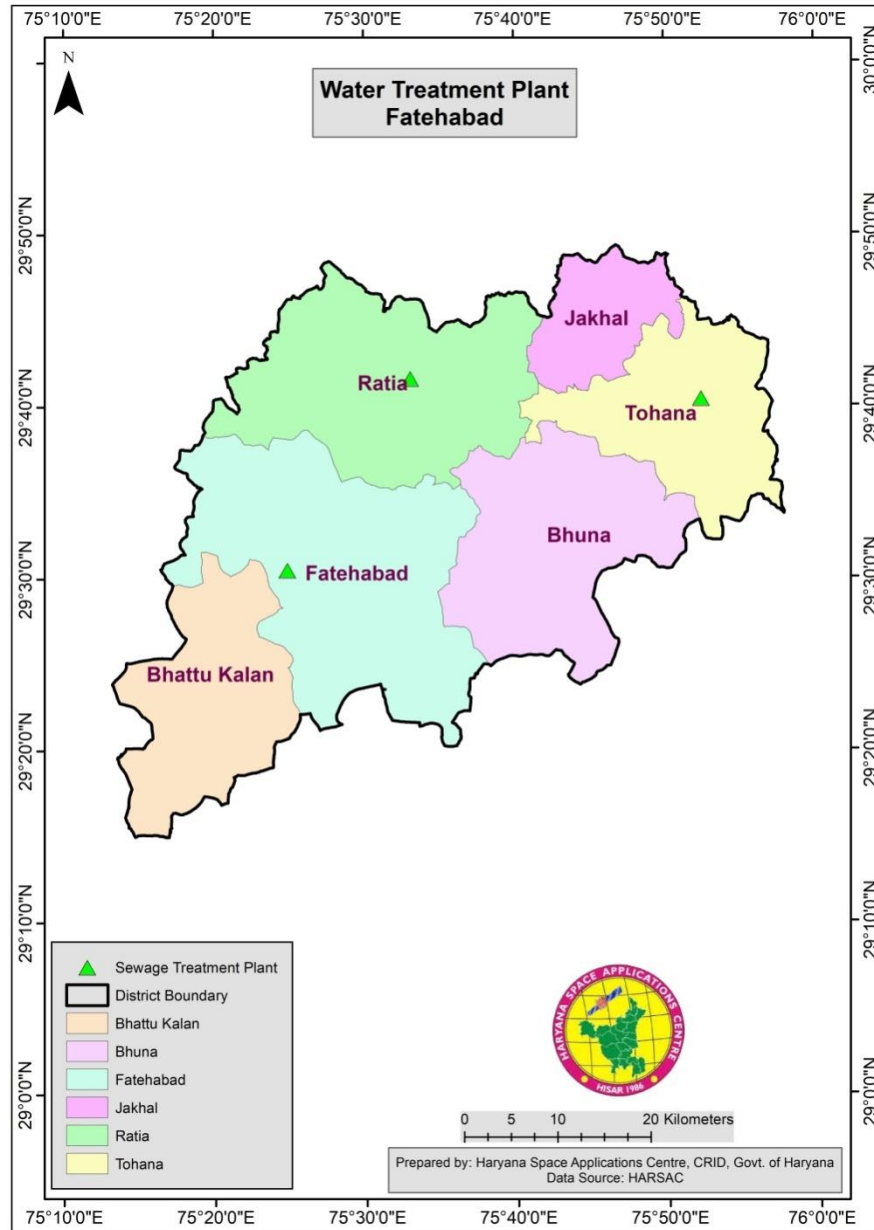


Figure 13 Water Treatment Plant of Fatehabad District

3. Irrigation Profile

Irrigation is the agricultural process of applying controlled amounts of water to land to assist in the production of crops as well as to grow landscape plants and lawns, where it may be known as watering. Agriculture that does not use irrigation but instead relies only on direct rainfall is referred to as rain-fed. Irrigation helps to grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of less than average rainfall. Irrigation also has other uses in crop production, including frost protection, suppressing weed growth in grain fields and preventing soil consolidation.

Out of gross cropped area of 4, 19,065 ha (exclusive of horticulture crops) in the district, 4, 14,104 ha (or 98.8%) is irrigated while 4,961 ha (1.2%) is Rain fed. There are only two cropping seasons namely Kharif and Rabi in the district. Kharif crops have a share of 2, 16,171ha (or 51.58%), and Rabi crops have a share of 2, 02,894 ha (or 48.42%). Paddy, Wheat and Cotton are the Major crops cultivated in kharif season. Wheat and Oil seeds including Groundnut, Til, Castor & Mustard are the Major crops cultivated in Rabi season.

Table 6 Area wise Irrigation Status of Agriculture Crops (2015-16) - District Summary

Crop									
	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total
Paddy & Wheat	110445	0	110445	180281	0	180281	290726	0	290726
Maize & Bajra	1261	288	1549	0	0	0	1261	288	1549
Moong, Gram	109	41	150	199	44	243	308	85	393
Oil Seeds	1292	8	1300	13548	398	13946	14840	406	15246
Cotton	72540	24	72564	0	0	0	72540	24	72564
Sugarcane	0	0	0	396	3	399	396	3	399
Guar & Fodder	26008	415	30163	8025	0	8025	34033	415	38188
Total	211655	4516	216171	202449	445	202894	414104	4961	419065

Out of total gross cropped area under Agriculture, Fatehabad block has a share of 27 per cent, followed by Ratia block (21.8%) and Tohana block (18.45%). Fatehabad block has the largest rainfed area of the district, i.e., 2223 ha, whereas Jakhhal block is totally irrigated. Block wise area under various crops in irrigated and rainfed situation is highlighted in **Table 6**.

Whereas, the area and block wise irrigation status of Agriculture crops (2015-2016) are given in (**Table 7**).

Table 7 Area wise Irrigation Status of Agriculture Crops (2015-16) - Block Wise Summary

1. Block: Ratia									
Crop Type	Kharif			Rabi			Total		
	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total
Paddy & Wheat	36465	0	36465	43785	0	43785	80250	0	80250
Maize & Bajra	8	1	9	0	0	0	8	1	9

Moong, Gram	0	0	0	23	0	23	23	0	23
Oil Seeds	5	0	5	99	0	99	104	0	104
Cotton	7156	0	7156	0	0	0	7156	0	7156
Sugarcane	0	0	0	11	3	14	11	3	14
Guar & Fodder	2282	98	2380	1695	0	1695	3977	98	4075
Total	45916	99	46015	45613	3	45616	91529	102	91631
2. Block: Bhuna									
Crop Type	Kharif			Rabi			Total		
	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total
Paddy & Wheat	8093	0	8093	20436	0	20436	28529	0	28529
Maize & Bajra	503	104	607	0	0	0	503	104	607
Moong, Gram	32	7	39	21	0	21	53	7	60
Oil Seeds	8	1	9	2434	116	2550	2442	117	2559
Cotton	15143	2	15145	0	0	0	15143	2	15145
Sugarcane				13	0	13	13	0	13
Guar & Fodder	3472	346	3818	1331	0	1331	4803	346	5149
Total	27251	460	27711	24235	116	24351	51486	576	52062
3. Block: Bhattu Kalan									
Crop Type	Kharif			Rabi			Total		
	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total
Paddy & Wheat	1695	0	1695	20436	0	20436	22131	0	22131
Maize & Bajra	209	54	263	0	0	0	209	54	263
Moong, Gram	48	13	61	111	10	121	159	23	182
Oil Seeds	1093	5	1098	7993	186	8179	9086	191	9277
Cotton	16361	12	16373	0	0	0	16361	12	16373
Sugarcane				27	0	27	27	0	27
Guar & Fodder	10236	1779	12015	730	0	730	10966	1779	12745
Total	29642	1863	31505	29297	196	29493	58939	2059	60998
4. Block: Fatehabad									
Crop Type	Kharif			Rabi			Total		
	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total
Paddy & Wheat	22816	0	22816	51028	0	51028	73844	0	73844
Maize & Bajra	304	129	433	0	0	0	304	129	433
Moong, Gram	29	21	50	33	34	67	62	55	117
Oil Seeds	180	2	182	2848	95	2943	3028	97	3125
Cotton	24374	10	24384	0	0	0	24374	10	24384
Sugarcane				211	0	211	211	0	211

Guar & Fodder	7366	1932	9298	2091	0	2091	9457	1932	11389
Total	55069	2094	57163	56211	129	56340	111280	2223	113503
5. Block: Tohana									
Crop Type	Kharif			Rabi			Total		
	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total
Paddy & Wheat	31749	0	31749	31799	0	31799	63548	0	63548
Maize & Bajra	234	0	234	0	0	0	234	0	234
Moong, Gram	0	0	0	9	0	9	9	0	9
Oil Seeds	6	0	6	170	1	171	176	1	177
Cotton	9218	0	9218	0	0	0	9218	0	9218
Sugarcane	0	0	0	134	0	134	134	0	134
Guar & Fodder	2306	0	2306	1697	0	1697	4003	0	4003
Total	43513	0	43513	33809	1	33810	77322	1	77323
6. Block: Jakhal									
Crop Type	Kharif			Rabi			Total		
	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total	Irrigated	Rain Fed	Total
Paddy & Wheat	9627	0	9627	12797	0	12797	22424	0	22424
Maize & Bajra	3	0	3	0	0	0	3	0	3
Moong, Gram	0	0	0	2	0	2	2	0	2
Oil Seeds	0	0	0	4	0	4	4	0	4
Cotton	288	0	288	0	0	0	288	0	288
Sugarcane				0	0	0	0	0	0
Guar & Fodder	346	0	346	481	0	481	827	0	827
Total	10264	0	10264	13284	0	13284	23548	0	23548

Source: Agriculture Department, Fatehabad

4. Water Availability

4.1. Surface Water Availability

Fatehabad district is located in the Indo-Gangetic Alluvial Plains. By and large flat and plain flat terrain is interrupted by the randomly located sand dunes. The Ghaggar River from north to north west along the northern boundary. The land slopes from north to south with elevation difference in eastern part of the district from North to South is about 6m (222-216m amsl.) In the rest of the district, it is about 7 m (214.6-207.6m amsl). The two above said slopes result in a master slope towards south west with an average gradient of 0.27 m/km. The district does not have any well-defined natural drainage system but the Ghaggar River drains the northern part of district. The river course falling in this area is very narrow and often causes floods when heavy rainfall occurs in the catchment area. In the rest of the area the drainage is of inland type and the excess rainwater, accumulated in natural /artificial depressions.

As per the data provided by Irrigation department for the year 2015-16, total annual water availability from canals was 472.78 MCM (**Table 8**). Tohana block had the maximum share, followed by Ratia block and Fatehabad block.

Table 8 Water Availability from Canals

Sr. No.	Block	Kharif (Area Ha)	Volume of water (in MCM)	Rabi (Area in Ha)	Volume of water (in MCH)	Total (Area Ha)	Volume of water (in MCM)
1	Bhuna	22523	36.38	22820	36.38	45343	72.76
2	Fatehabad	19461	41.02	20047	41.02	39508	82.04
3	Jakhal	1982	12.76	2016	12.76	3998	25.52
4	Ratia	19912	55.41	6727	55.41	26639	110.82
5	Tohana	29340	60.06	29065	60.06	58405	120.12
6	Bhattu	15112	30.76	15910	30.76	31022	61.52
	Total	108330	236.39	96585	236.39	204915	472.78

Source: Irrigation Department, Fatehabad

In addition to the above, treated water from sewage treatment plants is also used for irrigation. There are three existing sewage treatment plants of capacities 10 MLD, 6.5 MLD & 10 MLD, in the towns of Fatehabad, Ratia & Tohana. Therefore, annual water availability from sewage treatment plant is 9.6725 MCM. Considering water availability from surface sources and ground water, total annual water availability of the districts is 1088.503 MCM. Share of surface water (Canals + STP) is 482.4525 MCM (i.e., 44.32%) and Ground water is 606.05 MCM (i.e., 55.68%) (Table 9).

Table 9 Water availability of Fatehabad district

		Canals	Ground Water	STP	Total
1	Bhattu Kalan	61.52	57.52		119.04
2	Bhuna	72.76	68.68		141.44
3	Fatehabad	82.04	93.14	3.65	178.83
4	Ratia	110.82	191.44	2.3725	304.6325
5	Tohana	120.12	140.85	3.65	264.62
6	Jakhal	25.52	54.42		79.94
	Total	472.78	606.05	9.6725	1088.5

Source: Irrigation Department, PHE Department, CGWB Report, 2013

4.2. Ground Water Availability

The geological formations met within the district are Indo-Genetic alluvium consisting of newer and older alluvium with a thin blanket of Aeolian deposits. The age of these formations ranges from Upper-Pleistocene to Recent. Though the formations were laid down from Upper-Pleistocene to Recent age, they are conformable with each other. Exploratory drilling in this area indicates that these Quaternary unconsolidated sediments are underlain by hard rock formations of Achaean age comprising of Granites, schists and gneisses.

The principal source of ground water recharge is rainfall. However, major part of the rainfall is lost as run off and evapo-transpiration. A fraction of rainfall percolates down and recharges the ground water system. The other factors contributing to ground water recharge are inflow of ground water from north eastern parts, percolation from surface water bodies like ponds, seepage from canals and return flow of irrigation water. The area along the Ghaggar is underlain by recent flood plains, which is hydraulically connected with river and is getting recharge from the river during floods.

As per Central Ground Water Board report 2013 and Hydrology report of June 2021(annexure 3), the status of ground water is Over-exploited in 4 blocks namely Fatehabad, Ratia, (including new block of Nagpur), Tohana and Jakhal; Safe in 2 blocks namely Bhattu Kalan and Bhuna. None of the blocks of district falls under critical and semi-critical category, but not for from the above said situation. Block wise status of ground water and total draft and recharge details are given in following table. The following map (**Figure 14**) depicts the ground water depth in Fatehabad district.

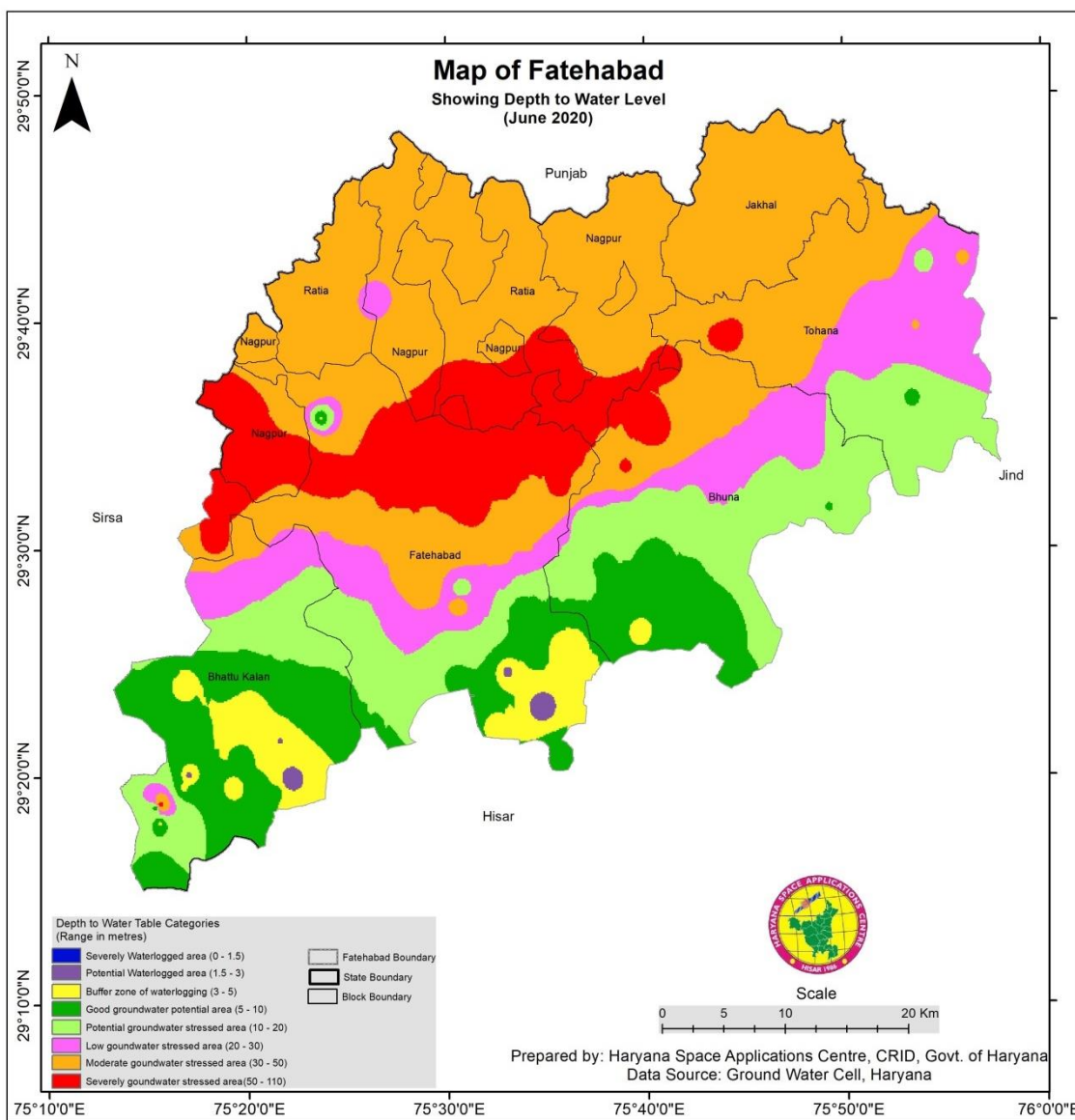


Figure 14 Ground Water Availability Map of Fatehabad District

Whereas, Status of Ground water Availability of Fatehabad district is given in **Table 10**.

Table 10 Status of Ground water Availability

Sr. No.	Block	Status of block as per CGWB notification 2013				Ground water (MCM)		
		Over-exploited	Critical	Semi-Critical	Safe	Draft	Recharge	Gap
1	Bhattu Kalan				Yes	34.95	57.52	-22.57
2	Bhuna				Yes	47.48	68.68	-21.2
3	Fatehabad	Yes				225.07	93.14	131.93
4	Ratia	Yes				359.54	191.44	168.1
5	Tohana	Yes				306.35	140.85	165.5
6	Jakhal	Yes				113.8	54.42	59.38
7	Nagpur	Yes				N. A	N. A	N. A

Source: Central Ground Water Board Report, 2013

4.3. Ground Water Quality

The results of chemical analysis of water samples from both from shallow and deep aquifers indicate that all major cations (Ca, Mg, Na, K) and anions (CO₃, HCO₃, Cl, SO₄) are within the permissible limits set by BIS, 1991, in majority of ground water samples.

An exceptionally high concentration of Sulphate is found at village Badopal (2252 mg/L). The physical parameter such as electrical conductivity shows a wide variation between 800µS/cm in southern & northern area and 5610µS/cm in the central part of the district. Nitrate concentration (104 mg/L) above the prescribed permissible limit is recorded at village Badopal and high concentration of fluoride of 6.3 mg/L, 1.65 mg/L and 2.59 mg/L are reported at villages Loha Khera, Sadalpur and Dhaula, respectively. 58.5% of the groundwater samples show sodium as the dominant cation whereas none of the anions is particularly dominant. Ground water generally depicts a mixed type of chemical character. Iron, an essential plant and animal nutrient, is found to be above permissible limits at Bhattu (1.44) Bhattu Kalan (5.75) and Fatehabad (1.60) whereas in rest of district iron is found to be below the permissible limit. Arsenic is found above the prescribed limit at Samain (0.0570 mg/L) in Tohana Block.

The blockwise average water quality index value and concentration of various constituents of ground water of Fatehabad District are given in **Table 11**. Whereas, **Figure 15** shows the Water quality Index of Fatehabad District.

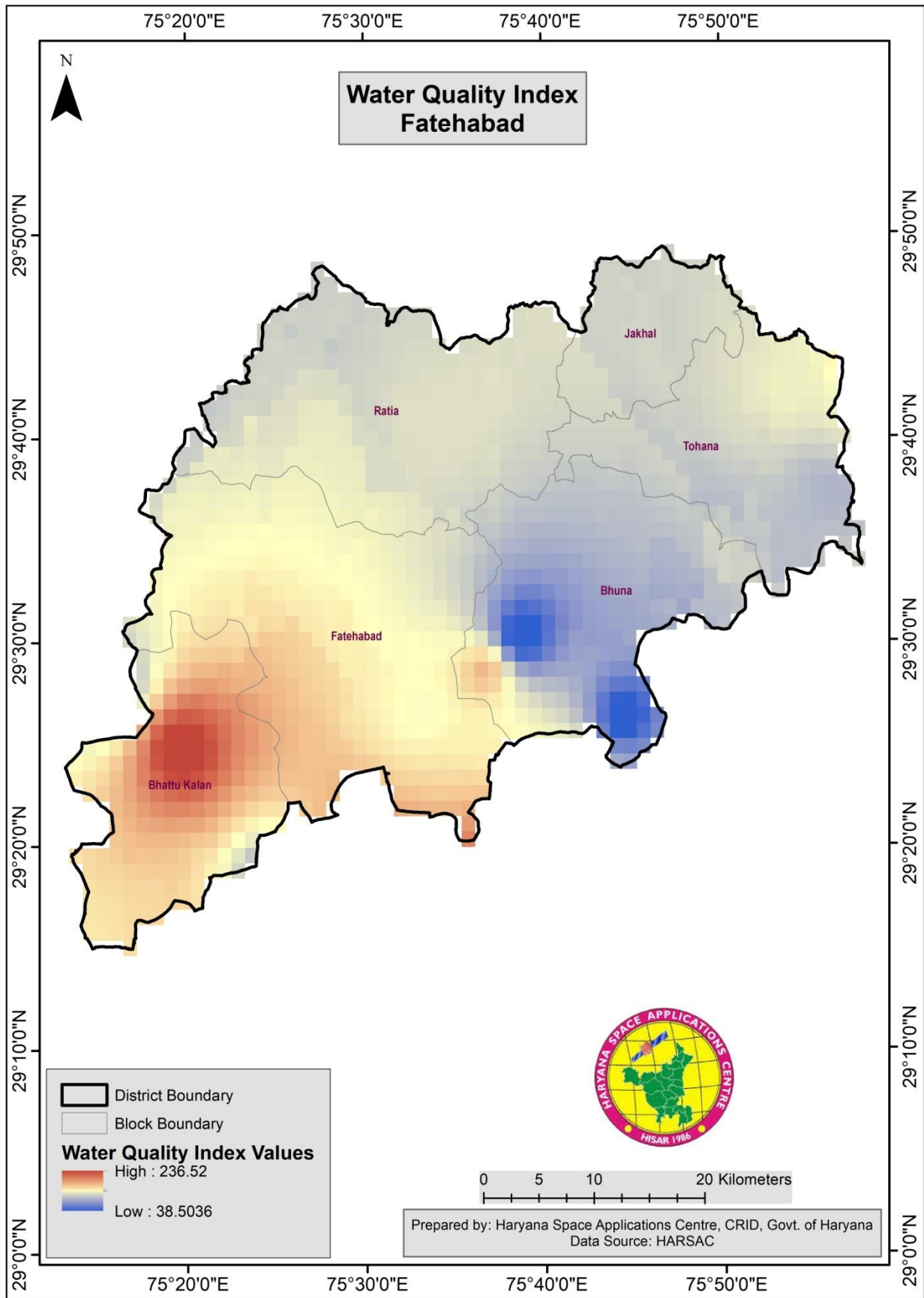


Figure 15 Water quality Index of Fatehabad District

Table 11 Concentration of various constituents in Ground Water

Constituents	Minimum Concentration	Maximum Concentration
pH	7.78	8.95
EC Micromhos /cm at 25 °C	800	5610
CO₃ (mg/l)	0	98
HCO₃ (mg/l)	100	672
Cl (mg/l)	28	764
SO₄ (mg/l)	0	2252
NO₃ (mg/l)	3	104
F (mg/l)	0.61	6.30
Ca (mg/l)	12	248
Mg (mg/l)	10	199
Na (mg/l)	56	980
K (mg/l)	5	155
TH (Total Hardness as CaCO₃)	90	1381

5. Aquifer System

The geometry and nature of aquifer provide the basic parameters for determining occurrence and movement of ground water and are significant for resource evaluation. The alluvial complex in the area constitutes a vast regional aquifer. Aquifer geometry is chiefly irregularly shaped tabular bodies of highly permeable sand interspersed with lenticular layer of semi pervious to impervious silty clay or clay layers. The area has both unconfined/ semi unconfined and confined/ leaky confined aquifers. The alluvium forms the principal ground water reservoir and the principal aquifer material comprises fine to medium sand and often mixed with kankar. This aquifer is either in the form of isolated lenses of sand embedded in clay beds or well-connected granular zones that have a pinching and swelling disposition and are quite extensive in nature. The occurrence of clay beds is rather irregular and on a regional scale their extensions are limited. Thus, while locally the presence of such beds can give rise to leaky confined or confined conditions. Granular zones which occur inter-bedded with clay in unconsolidated formations from the principal ground water reservoirs. Thickness of upper zone extending down to a maximum depth of 50 mbgl varies from place to place and water occurs under water table conditions. The ground water occurring under unconfined conditions are tapped by shallow tubewells but the deeper aquifers are tapped through medium to deep tubewells. The ground water from unconfined condition is abstracted through hand pumps and through shallow tubewells maximum up to the depth of 50 meters. However medium depth tubewells for the purpose of irrigation and drinking area are being drilled up to the depth of 175 m. Aquifer up to the depth of 175 m is semi confined leaky aquifer. Water from aquifer below the depth of 200 m is saline to highly saline in the southern part of district. This aquifer is confined aquifer. However,

no information is available for quality of water for deeper aquifer. As we move towards the southern part of the district argillaceous sediments increases in percentage. Northern part of the district has especially more arenaceous sediments in comparison to southern part of the district due to presence of Ghaggar flood plains and presence of some paleo-channel passing through this area.

Aquifer Parameters:

Ground water being a dynamic flow system the various fundamental parameters of the aquifers in the area were required to give it a mathematical treatment and quantify the same. Aquifer parameters viz transmissivity (T), storativity (S), hydraulic conductivity (K) and yield (discharge) of the test well have been determined on the basis of Aquifer Performance Test (APT) conducted on exploratory wells constructed in the district. To assess the aquifer parameters, aquifer performance tests were conducted on 12 wells. The transmissivity value in the area varies between 177 and 2900 m²/day. The storativity values vary from 2.3 x 10⁻³ to 5.4 x 10⁻².

6. Water Requirement/ Demand

The demand has been worked out on the basis of data collected from different departments which has already been presented in previous chapters. The unit for volume of water has been chosen as million cubic meters (MCM) instead of Billion cubic meters as suggested in the guidelines.

Domestic Water Demand:

To assess present population (2016) and future population (2022), an annual growth rate of 1.685% is assumed, based on the decadal growth in population from census 2001 to census 2011. To assess water demand, requirement of 100 lpcd for rural and 140 lpcd for urban are assumed. The Domestic Water Demand in the year 2016 and 2021-2022 are given in the **Table 12** and **Table 13** respectively.

Table 12 Domestic Water Demand (2016)

Block Wise Domestic Water Demand of Fatehabad District (2016)						
Blocks	Present Population (2016)			Present Gross Water Demand in (MCM)		
	Rural	Urban	Total	Rural	Urban	Total
Ratia	160944	38171	199115	5.87	1.95	7.82
Jakhal	55722	14777	70499	2.03	0.76	2.79
Tohana	120452	67141	187593	4.4	3.43	7.83
Bhuna	139383	0	139383	5.09	0	5.09
Bhattu Kalan	130962	0	130962	4.78	0	4.78
Fatehabad	219195	74629	293824	8	3.81	11.81
Total	8,26,658	1,94,718	10,21,376	30	10	40

It can be observed that total present domestic water demand is 40 MCM. The share of water demand from rural areas is 30 MCM (i.e., 75%), and from urban areas is 10 MCM (i.e., 25%).

Table 13 Domestic Water Demand (2021-2022)

Block Wise Present Domestic Water Demand of Fatehabad District (2021-22)						
	Rural	Urban	Total	Rural	Urban	Total
Ratia	175951	41730	217681	6.42	2.13	8.55
Jakhal	60918	16155	77073	2.22	0.83	3.05
Tohana	131683	73402	205085	4.81	3.75	8.56
Bhuna	152379	0	152379	5.56	0	5.56
Bhattu Kalan	143174	0	143174	5.23	0	5.23
Fatehabad	239634	81588	321222	8.75	4.17	12.92
Total	903739	212875	1116614	32.99	10.88	43.87

Crop Water Demand:

It has been assumed that water potential required is equal to the total crop water demand of cultivated area, while the existing water potential is equal to crop water requirement of irrigated area. It can be observed that water potential to be created is to the tune of 14.72 MCM for Fatehabad district. The Crop wise water demand for Fatehabad district is given in **Table 14**.

Table 14 Crop wise Water Demand

Agriculture and Horticulture water Requirement of Fatehabad District			
Name	Water Requirement	Name	Water Requirement
	(MCM/Ha)		(M C M / Ha)
Paddy	0.0075	Ground nut	0.0015
Wheat	0.0036	Rape seed	0.0015
Barley	0.00075	Mustard seed	0.0015
Bajra	0.0045	Cotton	0.003
Jowar	0.003	Sugar cane	0.0045
Maize	0.003	Gram	0.003
Pulses	0.003	GUAR	0.003
Potato	0.007	Cucumber	0.00625
Onion	0.0055	Muck Melon	0.0025
	0.008	Water	0.00375

Tomato		Melon	
Radish	0.0025	Pumpkin	0.0075
Carrot	0.005	Long Melon (Tar Kakri)	0.00375
Bottle gourd	0.0025	Bitter gourd	0.0025
Ridge gourd	0.0025	Summer Squash	0.0025
Tinda	0.0025	Other (Specify)	0.0025

Livestock Water Requirement:

As mentioned in section 1.3, based on livestock census 2007, 2012 and 2019 the annual growth in the population of small animals can be considered as: 0.198% (in case of poultry), 23.042% (in case of pigs), -3.92% (in case of goats) and -9.27% (in case of sheep). In case of large animals, annual growth in the population can be considered as: 4.67% (in case of cattle), 1.44% (in case of buffalo) and 12.76% (in case of draft animals). Accordingly, the present livestock population (2016) and future livestock population (2022) is assessed. The **Table 15** represents the animal wise water requirement as well as total water requirement of the district for animals.

Table 15 Livestock Water Demand

Fatehabad District Livestock Water Consumption & Demand				
Total Number of livestock	Present water Demand (MCM)	Water demand in 2022(MCM)	Existing Water Potential (MCM)	Water potential to be created (MCM)
772943	15.12	16.59	15.12	1.47

It has been assumed that the existing water potential is equal to present water demand of livestock. Thus, the water potential to be created implies the quantum of water availability to be created to meet livestock water demand in 2022. It can be observed that water potential to be created is to the tune of 1.47 MCM for Fatehabad district.

Industrial Water Requirement:

As per information provided by District Industries Centre, there are 1190 industrial units registered in Fatehabad district. However, all the industrial units consume water from their own resources and therefore industrial water requirement is considered as NIL from irrigation department.

Water Demand for Power Generation:

As per information provided by Department of Power, the demand of water for power generation has been calculated as 1.095 MCM, considering the requirement of 3000 kilo Lts per Day. The future water demand in 2022 is calculated as 175.339 MCM, considering the requirement of 480380.3 kilo Lts per Day. The water requirement for power generation is given in the **Table 16**.

Table 16 Water Requirement for Power Generation

Water Requirement for Power Generation- Fatehabad				
Power Requirement	Present Water Demand (MCM)	Water Demand 2022 (MCM)	Existing Water Potential	Water Potential to be created (MCM)
1200 MW	1.095	175.339	1.095	174.244

Total Water Demand of the Various Sectors for the District:

This section presents the total water demand of the district and has been calculated by summing up all major sectors consuming water. The total water requirement is given in the **Table 17**.

Table 17 Total Water Requirement for Fatehabad District

Present and Future Total water Demand of District Fatehabad						
	Domestic	Crop	Livestock	Industrial	Power	Total MCM
Year (2016)	40	2030.46	15.12	0	1.095	2086.675
Present (2021-22)	43.87	2030.46	16.59	0	1.095	2092.015
Future (2025)	53.87	2030.46	16.59	0	175.339	2276.259

6.1. Water Budget

A total of 482.4525 MCM surface water and 606.05 MCM ground water is available in Fatehabad district. It can be observed that based on present and projected water demand (2022), and present water availability (surface & ground), the present water gap is to the tune of 998.177 MCM, and projected water gap (2022) is to the tune of 1177.76 MCM.

Table 18 depicts the block wise water budget in Fatehabad district.

Table 18 Water Budget Blockwise

Existing water availability (MCM)		Total (MCM)	Water demand (MCM)		Water gap (MCM)	
Surface water	Ground water		Present	Projected (2022)	Present	Projected (2022)
482.4525	606.05	1088.503	2086.68	2266.26	998.177	1177.76

Whereas **Table 19** depicts the present and future water requirement for drinking and household consumption of Fatehabad District.

Table 19 the present and future water requirement for drinking and household consumption of Fatehabad District

Sr. No	Block Name		Present for Year (2021-22)			Projected for Year (2025)		
			Liters per capita day (LPCD)	Monthly in Cubic Meter	Yearly in Cubic Meter	Liters per capita day (LPCD)	Monthly in Cubic Meter	Yearly in Cubic Meter
1	BHATTU KALAN		9212912	276387	3362712	9664345	289930	3527486
2	BHUNA		15341400	460242	5599611	16096197	482886	5875112
3	FATEHABAD		13966082	418982	5097620	14653213	439596	5348423
4	JAKHAL		5223827	156715	1906697	5585759	167573	2038802
5	NAGPUR		6808229	204247	2485004	23694536	710836	8648506
6	RATIA		8968438	269053	3273480	9407892	282237	3433881
7	TOHANA		10782689	323481	3935681	11313198	339396	4129317
A	Ratia (MC)		6118934	183568	2233411	6419986	192600	2343295
B	Tohana (MCI)		10519554	315587	3839637	11037116	331113	4028547
C	Jakhal Mandi (CT)		1282684	38481	468180	1345792	40374	491214
D	Fatehabad (MCI)		11656972	349709	4254795	12230495	366915	4464131
	TOTAL	Fatehabad District	99881721	2996451	36456827	121448528	3643456	44328713

Data: As per Public Health and Engineering Department Aug, 2021

7. Strategies for Water Conservation

7.1. Artificial Sensitive Urban Design

As more and more portions of the district become urbanized, it is crucial to integrate water sensitive urban design into planning of the major upcoming clusters of towns and cities that are in the satellite of the main city of Fatehabad. Water Sensitive Urban Design (WSUD) is a familiar concept for engineers and architects practicing and designing in the face of overwhelming environmental changes brought in by climate change. A major part of WSUD also allows us as a society to grow more resilient towards more intensive changes in rainfall patterns, as they grow more intensive, however scarcer in terms of frequency.

The methods of water table recharge strategies in urban area are shown in **Table 20**.

Table 20 Methods of water table recharge strategies in urban area

Sr. No.	Method	Image
1	Flow Through Planters	
2	Pervious Strips	
3	Pervious Pavement	
4	Stormwater Tree	

7.2. Plantation (wasteland map)

A major portion of WSUD that is popular within the Government Departments is plantation of various species of plants, both in public and private spaces, to encourage community participation and increase green cover. While increasing the aesthetic value of a location, plants are heavily influential to change microclimates and in fact playing a factor to rainfall patterns. Along with benefits of carbon sequestration, they contribute to increasing the local biodiversity of the region by attracting several types of fauna as well. Currently a multi-departmental approach within Fatehabad is being undertaken both within and outside of government with the engagement of several active citizen stakeholders and non-governmental organizations. Geo-tagging of these plantations and survival monitoring would be undertaken actively by engagement of the mentioned stakeholders.

The wasteland that could be used for plantation for conservation of water in Fatehabad district is shown in **Figure 16** and **Table 21** shows the proposed no of plantation targets in Fatehabad District.

Table 21 The proposed targets for plantation in Fatehabad District

Block Name	Wasteland Area (acre)	Plantation at 5 feet spacing
Bhatt Kalan	212.80	1853912
Bhuna	356.32	3104319
Fatehabad	709.35	6179877
Tohana	323.73	2820385
Jakhal	21.74	189414
Ratia	531.74	4632457
Total	2155.68	18780364

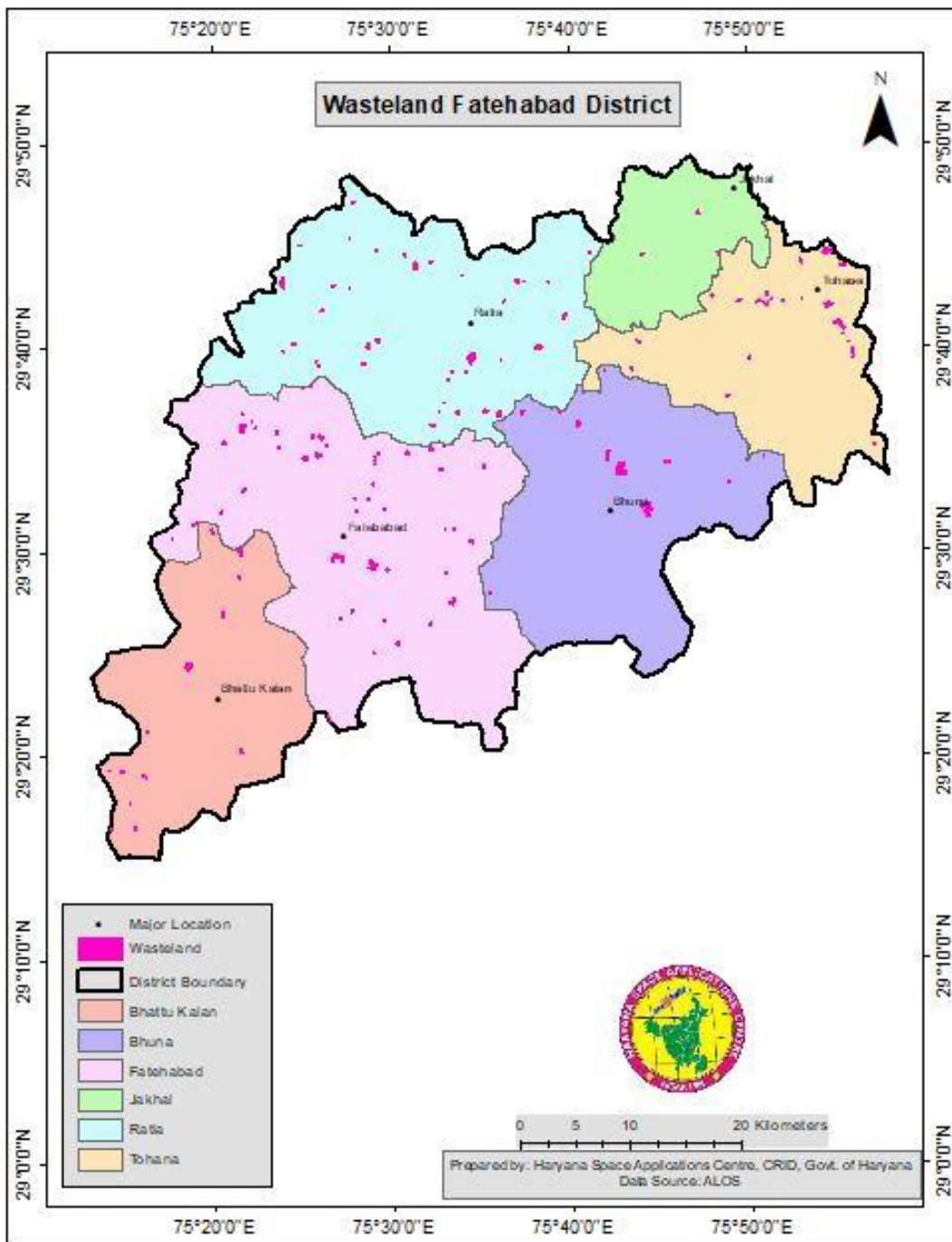


Figure 16 Blockwise Wasteland of Fatehabad District

7.3. Surface water management

7.3.1 Pond restoration and rejuvenation

As earlier mentioned, the number of surface water bodies such as ponds and lakes are continuously disappearing from the landscape. However, their preservation, restoration and rejuvenation would be essential to not only survival of biodiversity, but also to maintain microclimates, and ultimately essential to preserve human civilization.

Research also shows that that storage of water within a single pond structure contributed to a range of 26,000 to 62,000 m³ to groundwater recharge over a year, that was equivalent to 1.3 to 3.6% of the total water recharge volumes in the study carried out in Ramganga Basin, India, which would serve to irrigate lands of 8 to 18 hectares of land cropped in the rabi season. As such ponds demonstratively serve as an essential structure for water security. Although it serves to only hold a relatively small volume of water, the stored water becomes vital for food security and economic stability within a small community.

Ponds are also essential structures that provide water security in areas where groundwater has grown extremely saline and cannot be used for irrigation purposes. Irrigation channels have been built in such areas during the Green Revolution in these areas in order to meet irrigation demands in this region. However, in order to supply to the increasing demands of high yield production, a lot of pressure has been put on the agriculture industry, as a result of which freshwater demand has increased. The original channels are therefore not sufficient to meet the current water demands. Without accesses to enough water, structures such as ponds become of essential service to allow for agriculture to be sustained in areas of water scarcity.

Thesetraditionalwaterbodiesarewhatsaveddroughtthitvillagesfromthebrinkofextinctionand starvation in the great spell of droughts that the nation faced in the 970's. The led pioneers such as Anna Hazare and P R Mishra who revolutionized and reinstated the importance of having waterstorageandwiseutilizationforincreasingcopyieldhaveservedasmodelsforrevivingthese traditional lifelines within the rural eco-system, while setting important benchmarks for its urban counterparts. Culturally, duetoitslife-sustainingproperties,pondshavealsoenthecentersor natural hubs for monthly or annual fairs to be held, and have been biodiversity hotspots that encourage the link between human and wildlife.

In order for pond restoration and rejuvenation to be done in a scientific and methodical manner, following 11 step procedures that is accommodative of each individual pond site requirements are given below

1. Pond Identification and Pond profiling

2. Project Feasibility Assessment
3. Administrative Approvals (Demarcation, GIS mapping, and Panchayat Resolution)
4. Detailed Project Report
5. Financial Approval
6. Community Mobilization
7. Cleaning and Levelling
8. Civil Work, Micro-STP Installation and Waste Management
9. Landscaping and Beautification
10. Sustainability Plan (O &M)
11. Monitoring and Evaluation

7.3.2 Decentralize Treatment Plan

It is recognized that in the absence of 100% sewerage network connectivity just managing the gray water component would be an incomplete solution. In the rapidly urbanizing cities of developing countries, decentralized wastewater treatment systems are an attractive solution for addressing the problems of water pollution and scarcity.

Decentralized wastewater treatment consists of a variety of approaches for collection, treatment, and dispersal/reuse of wastewater for individual dwellings, industrial or institutional facilities, clusters of homes or businesses, and entire communities. An evaluation of site-specific conditions is performed to determine the appropriate type of treatment system for each location. These systems are a part of permanent infrastructure and can be managed as stand-alone facilities or be integrated with centralized sewage treatment systems. They provide a range of treatment options from simple, passive treatment with soil dispersal, commonly referred to as septic or onsite systems, to more complex and mechanized

approaches such as advanced treatment units that collect and treat waste from multiple buildings and discharge to either surface waters or the soil.

Decentralized wastewater treatment systems could be a feasible alternative for areas which are not connected to sewer networks as well as ones which are newly developed, so that the construction of their infrastructure is inadequate, not ready or would be executed in the future. Therefore, for local communities in the peripheries of urban development that exists outside the city center and rural areas where open drainage systems still exist. Over the past three decades, the city limits of Fatehabad city have been continuously growing as evidenced by the satellite images of increasing urban infrastructure.

However, planning for sewage infrastructure and pipelines are a long-term investment, with the advent of exponential population increase also has been a challenge. Instead, decentralized wastewater management approach can be considered as a sustainable and cost-effective alternative as it treats discharges or reuses the effluent in the relative vicinity of its source of generation. Therefore, decentralization of wastewater treatment facilities is a feasible solution that may allow for localized treatment which may eventually be reused for secondary purposes. Like other systems, decentralized systems must be properly designed, maintained, and operated to provide optimum benefits.

The following table (**Table 22**) shows a list of generic conditions that are most often found in Fatehabad according to the type of treatment considerations and other main constraints such as land availability and population, given that finances are a constant.

Table 22 Indicators and factors to decide the type of decentralized treatment required

Type of Effluent Received	Land Availability	Number of people	Type of Treatment Required
Grey and Black Water Effluent	Yes	<5000 people	Natural Based Technology
Grey + Black Water Effluent	Yes	>5000 people	Hybrid Technology
Grey and Black Water Effluent	No	>5000 people	Mechanized
Black Water	Yes	<5000 people	Hybrid
Black Water	No	>5000 people	Mechanized FSTP for a cluster

7.3.3 Information Education and Communication

Through open exchange of information, education and communication established between the community and the implementing agency, ownership of the projects and interventions is reinstated; from inception to implementation and beyond. Selected committee members that form groups such as self-help groups, youth groups are in fact chosen to carry out regular capacity building of the community at large, with special attention paid to children, women and those belonging most vulnerable groups are carried out. Knowledge exchange and capacity building are at the core of IEC activities. **Figure 17** shows the various stakeholders involved in IEC Activities.

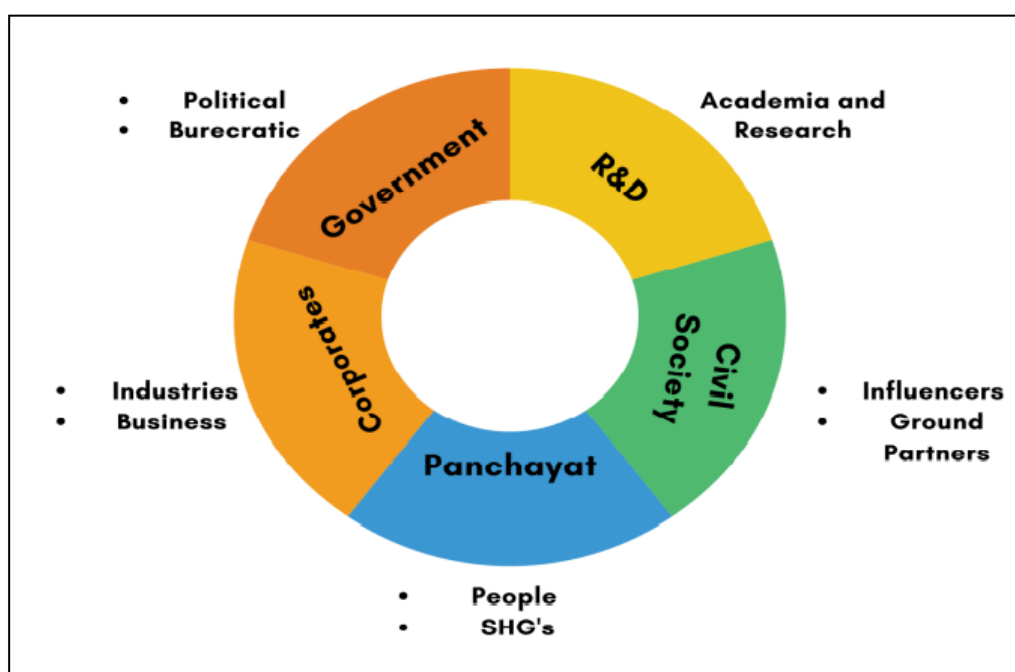


Figure 17 The Various Stakeholders of IEC Activities

Whereas, the various activities and interventions that can be carried out for IEC are given in the **Table 23**.

Table 23 The numerous activities and interventions that can be carried out for IEC

S. No.	IEC	Intervention / Topic	Target Group	Objective	Collaterals	Outcome/ Result
1	Webinars	- Role of RWA, Schools and Citizen in Rain water harvesting - How to Harness and Harvest Rain	- RWA(through MCG) - Schools (3rd party) - Corporates(3rd Party)	- To Engage Local People in Rain water Harvesting - To make them aware of the facts and rules of RWH	Letter from which dept. Letter to Mayor and Commissioner for inviting for webinar	- Knowledge about Rain water harvesting - Respective roles and duties towards RWH
2	Capacity Building Sessions	- Technical Training sessions - Awareness Training Sessions - Workshops	- MCG Workers - MCM Workers	- Training of ground worker of MCG - Implementation Work	Presentation Retrofitting Checking list Repair and Cleaning List	1. The workers will clean and repair the RWH post training - Training on Real time Problems - Generate Employment Opportunities
3	Competitions in RWA's (Same type of Settlements)	- Water Management and Conservation	- RWA	-To save water - To bring the best practices through RWA	- Competition brief with parameters	- To recognise and reward the best RWA - Lead by Example
4	Formation of Clubs	-how do we know about good vendor? - how do we identify places for RWH - How do we build RWH?	RWA	To make water representative from every RWA	Check list of water auditing for the water representative	1. do the meetings with respective water representative from every RWA. -Team building for the Society
5	Guidelines	- Guidelines for All the drops of the Society	- RWA - govt institutions - Schools - Corporates	Information Flow	- guidelines and poster	- Information and Awareness on Water

		regarding Rain water harvesting and its maintenance	- Rural Public buildings			conservation and Rules
6	Information Boards	- Water awareness (Ponds, RWH, Plantation)	- Schools - Public Institutes Open Spaces Roads -	- To change the perspective of people	Location, Capacity, Design OF RWH, information board	Awareness , mobilise citizens - Information about the RWH in Their vicinity
7	Rain Centre	- Any Problems related to water	- All the Citizens	To Resolve the issue related to RWH	FAQ (Technical)	Acts as Point of Contact for all the queries in Water Management
8	Social Media	- All the updates of the Events and posts	- All the Citizens	- Digital marketing - Awareness	FAQ TYPES Best Practices Video clips of Officers and celebrities	Awareness , mobilise citizens
9	Recognitions/Awards	- Rain water Harvesting - Best Practises - Best RWA in Water management	- RWA - In Panchayats - NGO - Schools - Corporates - Active Citizens	to recognise best practices	-Parameters list for best practices	To encourage more practices and people - Increase interest and motivation for the end users
10	Video Clips and Interviews	- Individual water Conservation steps - Best Water Management Practices	- RWA - In Panchayats - NGO - Schools - Corporates - Celebs	Digital marketing - Awareness - virtual presence	- letters for the celebs, script.	To recognise people, encourage more
11	Working Models	- Rain water Harvesting Models - GuruJal Pond Sites	- Schools	To aquire more prototypes for District Administration	- Proper Guidelines	Showcasing Children work in Administration

12	Plantation Drives	- Awareness on Plantation drives	<ul style="list-style-type: none"> - Urban (RWA, MCG, MC) - Rural (Pond Sites) - Schools -NGO's - NYK - District Youth Affairs and Sports -Kalagram -NGO's -Durga Shakthi -Civil Defence -Lion Club 	<ul style="list-style-type: none"> -To increase the green Cover To increase the water holding Capacity 	<ul style="list-style-type: none"> - Plant List Nursery Database - Distribution Chain Management Posters 	<ul style="list-style-type: none"> Better environment for Future Generations
13	Collaborations	- For IEC		<ul style="list-style-type: none"> To involve stakeholders to facilitate sessions 	<ul style="list-style-type: none"> - Letter of Collaboration -Google form 	<ul style="list-style-type: none"> - No Overlapping of the work or activities - More effectiveness in Catch the rain Campaign

8. Proposed Activity

8.1. Rainwater harvesting

Rain water harvesting primarily consists of the collection and storage of rainwater for subsequent use as source of water. The harvested water can be used for both potable and non-potable applications. There are many examples of rainwater harvesting systems which provide water for domestic, commercial, institutional and industrial purposes as well as agriculture, livestock, groundwater recharge, flood control, process water and as an emergency supply for firefighting. There are different criteria and techniques to select suitable sites for harvesting rainwater. In recent years, the analytical hierarchy process (AHP) and multi-influencing factors (MIF) are most widely used model for identification of rainwater harvesting sites. The AHP technique determines the weights of thematic layers and their rank to process identify the zones of rainwater harvesting sites. MIF analysis is an effective tool for water management because it is comparatively simple and reliable.

There are some factors that affect the rainfall water harvesting which needs to be focused for the development of suitable sites of water harvesting. These factors include rainfall, slope, soil texture, drainage, topography and land use / land cover and integration of these factors using weighted overlay analysis that results in suitable sites for rainwater harvesting. These sites are then classified into various suitability levels, namely, not suitable, less, medium, good and very good. The most suitable sites for rainfall water harvesting are shown in map (**Figure 18**). The block wise area proposed for rainwater harvesting under most suitable sites is shown in **Table 24**. For the process of calculating suitable site a fixed weightage is needed to be applies on the above-mentioned criteria (**Table 25**).

Table 24 Block wise area under very good suitable site proposed for rain water harvesting

Block Name	Area (Very Good suitability area in Sq meter)
Bhatt Kalan	172296131
Fatehabad	513468444
Bhuna	297177567
Tohana	327205968
Jakhal	145385109
Ratia	145385109

Table 25 Assigned Weight for Criteria Parameters

Parameters	Weightage
Rainfall	35
Slope	25
Drainage Density	5
Soil Texture	20
LULC	15

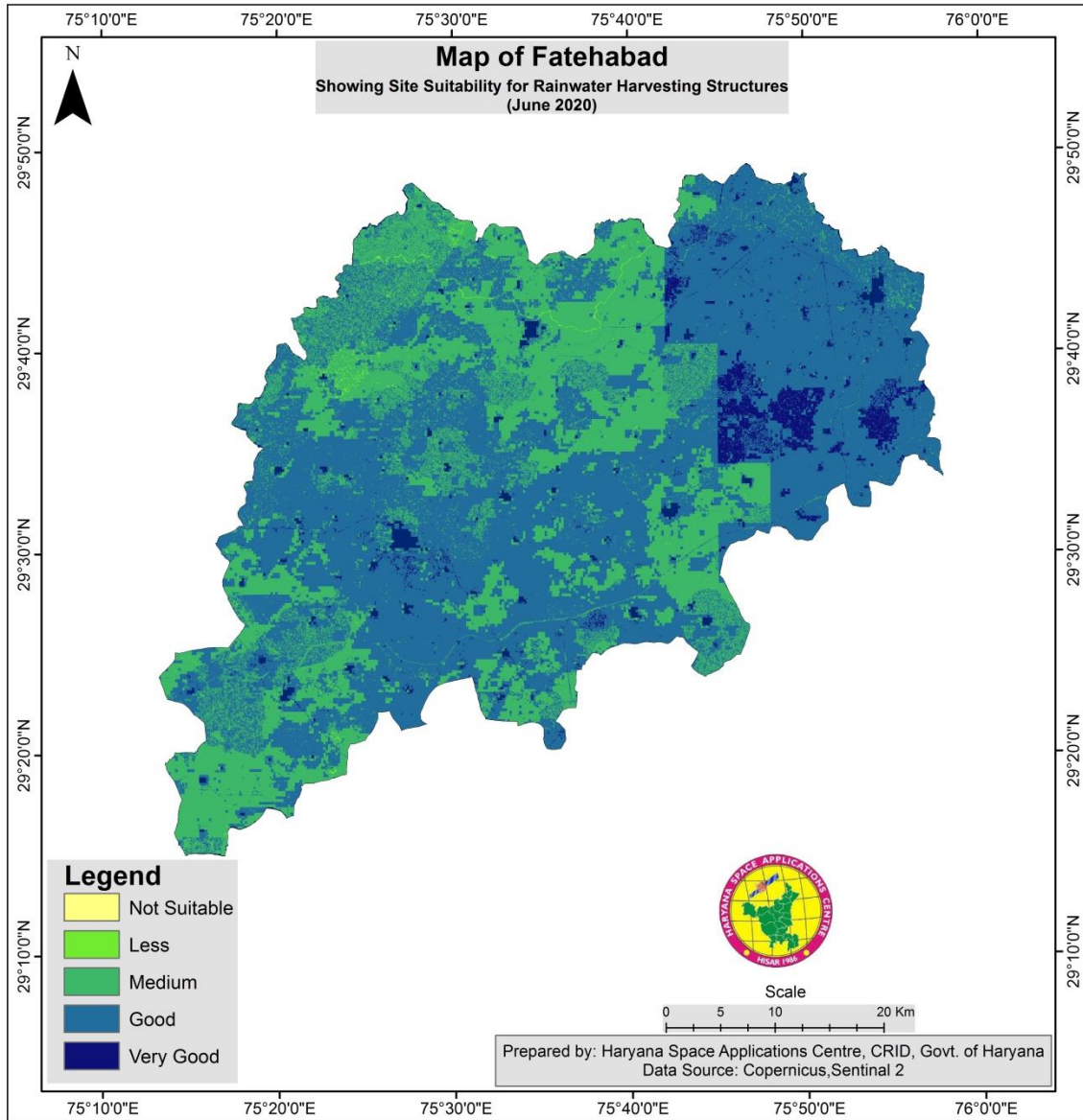


Figure 18 Site Suitability Map of Rainfall Harvesting Structure in the Year 2020

8.2. Multicriteria

In this section some water harvesting structures are proposed with the suitable sites. These structures are calculated based on different criteria. These criteria are Natural drainage and water occurrence datasets that should exclude the settlement and water bodies on the same place. Stream order system is a simple method of classifying stream segments based on the number of tributaries upstream. Following are the outcomes that show the type of structure on the streams. **Figure 19** shows the proposed suitable site based on multi criteria. Block wise proposed suitable sites based on multi- criteria is shown in **Table26**.

Following are the harvesting structures proposed based on criteria mentioned as above.

1. 31 Mini percolation Tanks
2. 16 Percolation Tank
3. 15 Pakka check Dams
4. 6 Annicut
5. 2 Micro Irrigation tanks

Table 26 Block wise proposed suitable sites based on multi-criteria

Sr. No.	Block Name	Mini percolation Tank	Percolation Tank	Pakka Check Dam	Annicut	Micro Irrigation Tank
1	Tohana	1	1	1	0	0
2	Ratia	1	2	4	3	0
3	Fatehabad	16	3	0	1	1
4	Jakhal	8	6	6	1	1
5	Bhuna	0	0	1	0	0
6	Bhatt Kalan	5	4	3	1	0

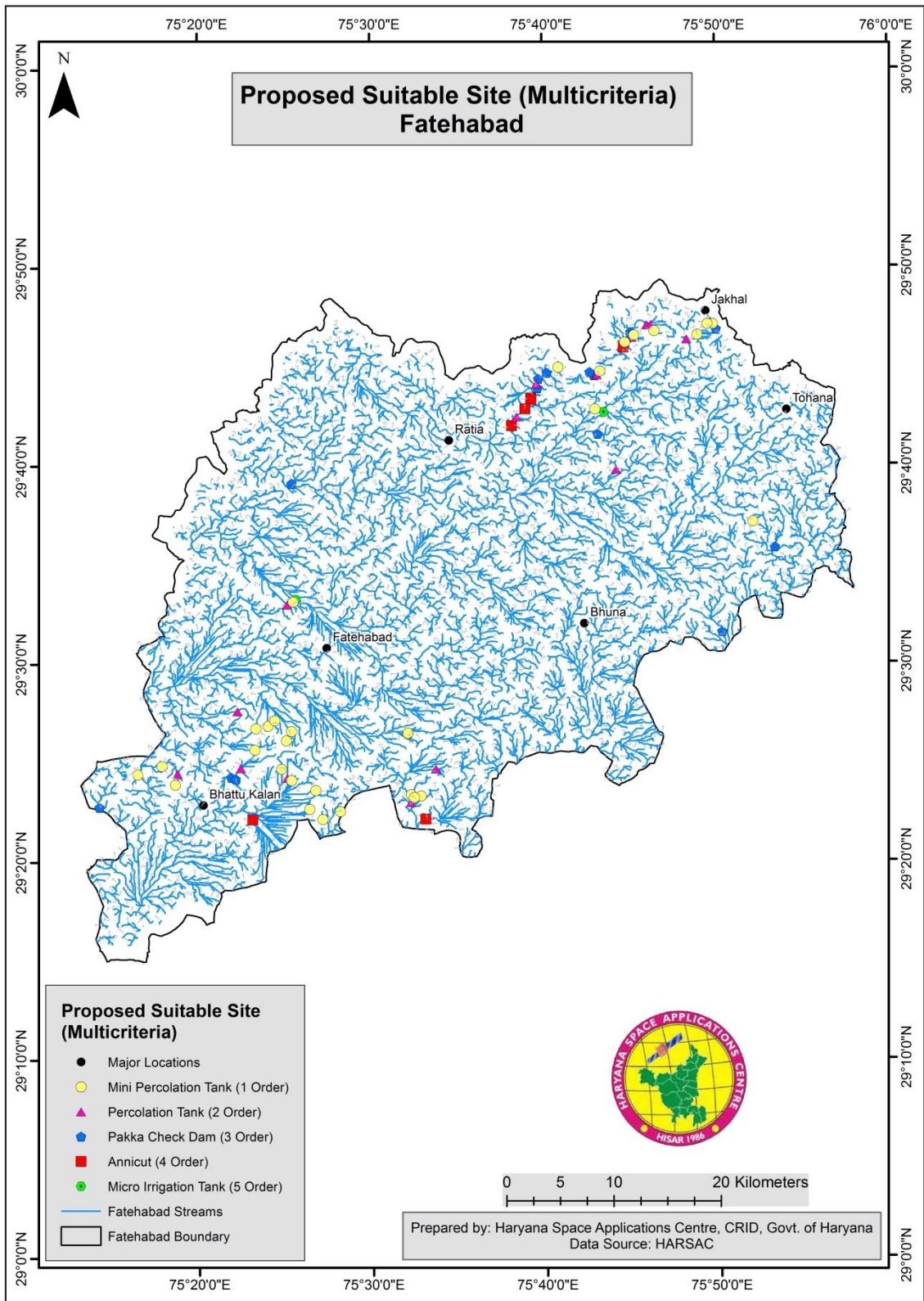


Figure 19 Proposed Suitable Sites based on Multicriteria in Fatehabad District

8.3. Based on Drainage

The drainages that are created from satellite imagery can be used as base for the water harvesting structure.

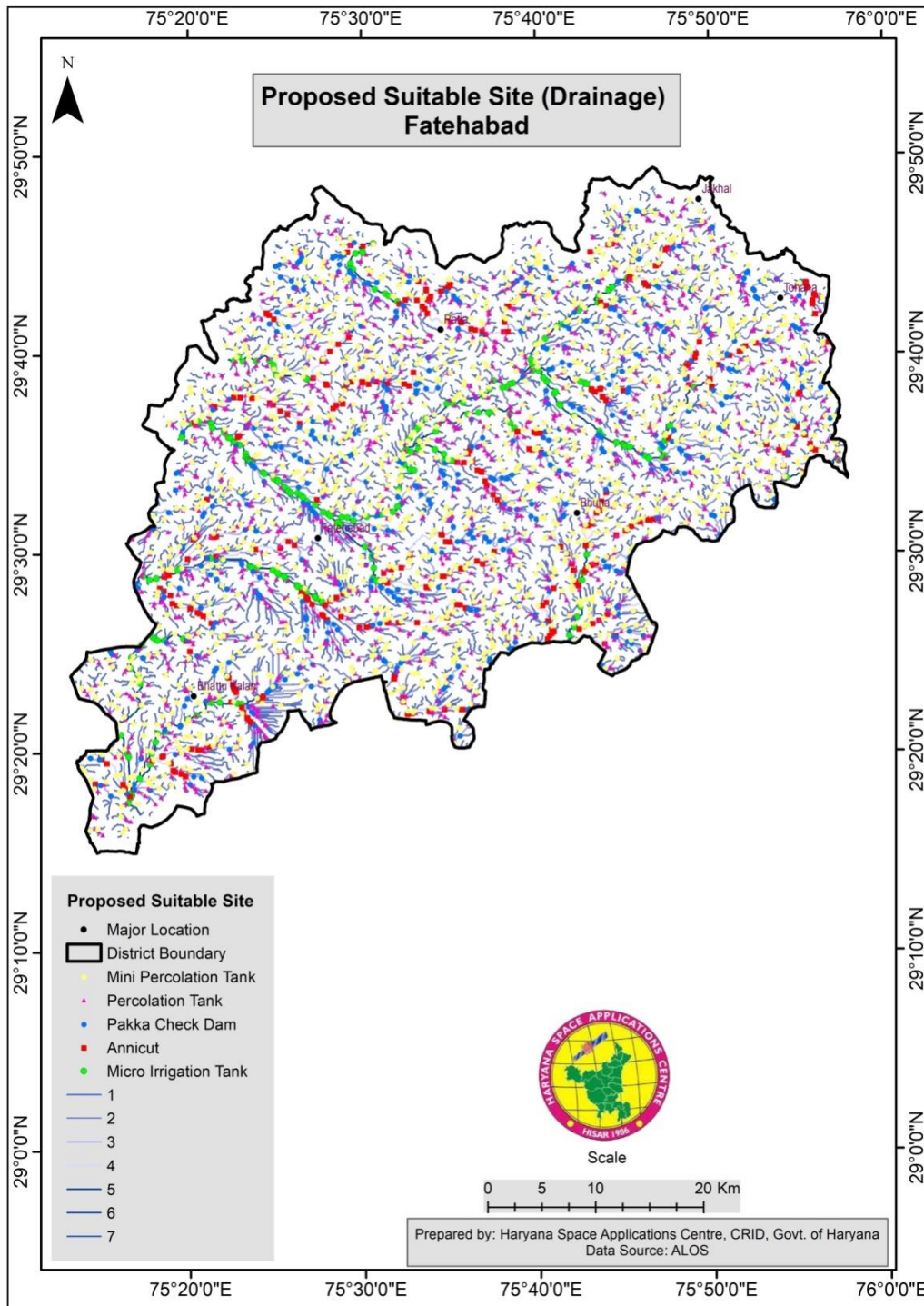


Figure 20 Proposed suitable sites based on drainage in Fatehabad District

Stream order system is a simple method of classifying stream segments based on the number of tributaries upstream. So, based on the order of streams we can propose the suitable sites for water harvesting structures. A general idea says that Mini percolation Tanks on 1st order Stream, percolation Tanks on 2nd Order Stream, pakka check Dams 3rd Order Stream, Anicut on 4th order, Micro Irrigation tanks 5th Order can be built. **Figure 20** shows the proposed suitable sites based on drainage structure in Fatehabad district. The proposed harvesting structures in Fatehabad based on drainage are given in **Table 27**.

Table 27 Proposed harvesting structures in Fatehabad based on drainage

Sl. No.	Block Name	Mini percolation Tank	Percolation Tank	Pakka Check Dam	Annicut	Micro Irrigation Tank
1	Bhatt Kalan	166	207	96	61	47
2	Fatehabad	308	364	196	84	34
3	Bhuna	250	267	133	80	37
4	Tohana	205	207	109	46	5
5	Jakhal	86	92	48	18	11
6	Ratia	249	288	137	72	33
	Total	1264	1425	719	361	167

9. Conclusion

Due to rapid urbanization, the Fatehabad district has seen problems related to water resources. There is water scarcity in lean season and waterlogging in monsoon season. Water logging over roads due to insufficient/unmanaged drains is the major problem. Current scientific report includes required information for the water harvesting where it is excess especially during monsoon/rainy season. The current water infrastructure information related to ponds/waterbodies, canals, natural drains, and drains based on slope is helpful in taking decisions on the construction of new structures for water harvesting. Block-wise estimates are given in the report.

Environmental concerns are not situated in one side of the world. Water is a broad source extending to different countries along with different advanced technologies. Irrigation has become widespread to improve farming and food production as well. Risks are taken into account because there may be cases in which misuse of conservation technology can affect our health and other resources other than water. Menses illustrates this situation well in his research regarding wastewater in the dairy industry. Through extended research, it is found that these happenings don't just occur once and in one place. The solution to prevent these occurrences exists in such initiatives of the government such as the JAL SHAKTI ABHIYAN. This is where collaboration is important among states and regions. To better and preserve our natural resources, actions and attitudes towards sustainability must stay at a high level throughout nation who is willing to work together towards the same goal.

..... END

“Jal Shakti Abhiyan: Catch The Rain”



**WATER CONSERVATION
AND RAIN WATER HARVESTING**

**RENOVATION OF
TRADITIONAL WATER BODIES**

**REUSE AND RECHARGE
STRUCTURES**

WATERSHED DEVELOPMENT

INTENSIVE AFFORESTATION

**ENUMERATION OF WATER
BODIES**

**TRAINING / AWARENESS
PROGRAMS BY KVK**

Catch The Rain
Where it falls, When it falls

