जल शक्ति अभियान

संचय जल, बेहतर कल

Report No.-07

JSA-CTR

Scientific Action Plan for Hisar

हर बूंद संचय, हर खेत पानी

सिंचाई एवं जल संसाधन विभाग हरियाणा

Prepared By-

Haryana Space Applications Centre (HARSAC),

Citizen Resource Information Department (CRID)

Government of Haryana

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1 Introduction

1.1 History

The city of Hisar was founded by a Muslim ruler, Firoz shah Tughlaq in 1354 A.D. 'Hisar' is an Arabic word which means 'Fort'. The city, which we know today as 'Hisar', was originally called 'Hisar Firoza (also Hisar-e-Firoza) or in other words the 'Fort of Firoz'. But as the days rolled by, the very word 'Firoza' was dropped from its original name.

It was in these lands that the very first evidence of the presence of man was discovered with the excavation of Agroha, Banawali and Kunal. All of these were the pre-Harappan settlements, bringing for us the very first images of pre-Historic times. The presence of the pillar in Hisar fort belonging to the time of Emperor Ashoka (234 A.D.) originally from Agroha, the discovery of coins of the Kushan Kings tells tales of ancient India. The nobles and Amirs were also directed by the Sultan to get the residences built here. The buildings were constructed with lime and burnt bricks. The fort-city had four gates which were subsequently named as the Delhi Gate and Mori Gate to the east, the Nagori Gate to the south and Talaqi Gate to the west.

While constructing the palace, popularly known as 'Gujari Mahal' for his beloved, Firoz shah also built a new city around it. The Gujari Mahal still stands in its austere majesty. This palace is a complex of different buildings, including the royal residence of the sultan Firoz shah, Shahi Darwaza, Diwan-e-Aam, Baradari with three tehkhanas, a Hamam, a Mosque and a Pillar. The style of architecture of the Gujari Mahal is dignified. The palace has beautifully carved stone pillars. During Akbar's reign (1556-1605) Hisar became once more a place of considerable importance. It was made the headquarters of the revenue Division known as sirkar. As some of Mughal Princes who were attached with Hisar, subsequently became the emperors. The city Hisar then known in the history of India as the Duke of Wellington of Mughal Era.

1.2 Location

Hisar is located at 28o56'00''to 29º38'30''North latitudes and 75º21'12‖to 76º18'12‖ East longitudes. It has range of elevation of 212-215 meters above MSL. This city is situated on National Highway No. 10 connecting the National Capital Delhi via Rohtak to Sirsa. Also, it is connected through National Highway No. 65 Connecting State Capital Chandigarh to Churu (Rajasthan). It is connected by Railways to Ludhiana, Jaipur, Churu, Bathinda and Delhi. The nearest Airports are Chandigarh and Delhi. Hisar is situated in South-Western parts of Haryana. The Hisar district is bordered by district Fatehabad in the North, Rohtak and Jind districts in the East and Bhiwani district in the South and Bhadra tehsil of Hanumangarh district (Rajasthan) in the West. The Location Map of Hisar district is shown in **Figure 1**.

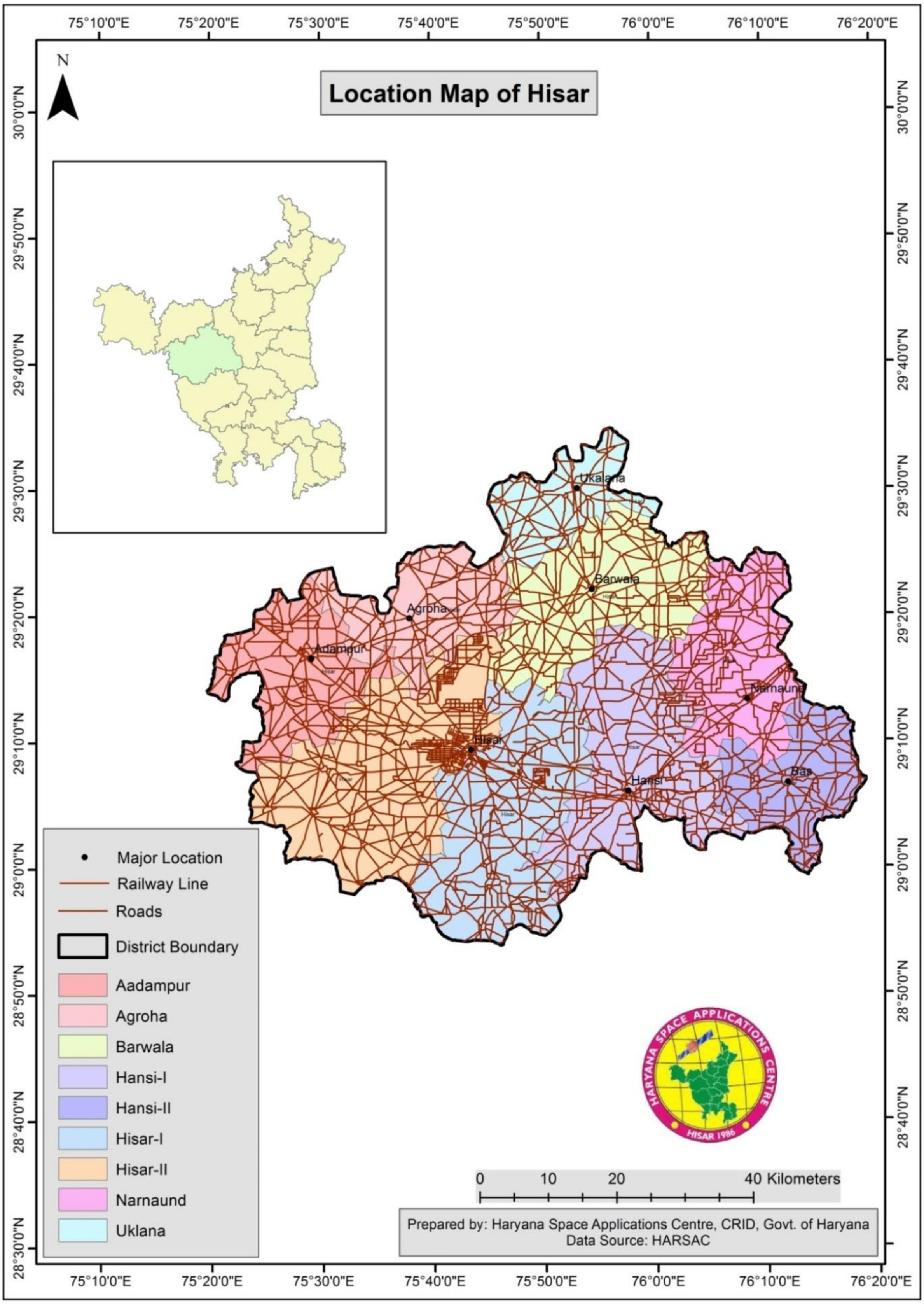


Figure 1 Location Map of Hisar District

1.3 Administrative Setup

The administrative setup of the District of Hisar has been described below, with specific sectoral development. The detailed administrative setup is shown in **Table 1**.

Table 1 Major Administrative Jurisdictional Setup of Hisar District

Country	India
State	Haryana
Division	Hisar
Headquarters	Hisar
Tehsil	1. Hisar, 2. Adampur, 3. Agroha, 4. Barwala 5. Balsamand 6. Bass7. Narnaund 8. Uklamandi
Total Area	3,983 km2 (1,538 sq. mi)
Total population (2011)	1,743,931
Density	438/km2 (1,130/sq. mi)
Demographics Literacy	64.83%
VidhanSabha constituencies	1. Pataudi, 2. Badshahpur, 3. Hisar and 4. Sohna
Website	http://hisar.gov.in
Location of Hisar	Southern most region of Haryana
Coordinates	28°56‘00‘‘to 29°38‘30‘‘North latitudes and 75°21‘12” to 76 ° 18‘12” East longitudes
Total Area	3983 sq. km
Elevation	212-215 meters above the mean sea level

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

Sub Divisions (4)	
Tehsils (6)	Hisar, Hansi, Narnaund, Barwala, Bass and Adampur
Sub-Tehsils (3)	Balsamand, Uklana and Kheri Jalab
Blocks (9)	
Municipal Corporation (1)	Municipal Corporation Hisar
Municipal Council (1)	Hansi

Municipal Committees (3)	Municipal Committee Barwala, Municipal Committee Uklana, Municipal Committee Narnaund
Population (Census 2011)	17,43, 931

Source: https://hisar.gov.in/about-district/administrative-setup/

Local Institutions: -

Total Villages	276
Total Panchayats	308
Village Level	Panchayat (308)
Block Level	Panchyat Samiti (225)
District Level	Zila Parishad (30)

Source: https://hisar.gov.in/about-district/administrative-setup/

1.4 Climate

Hisar has a continental climate, with very hot summers and relatively cool winters. The main characteristics of climate in Hisar are dryness, extremes of temperature, and scanty rainfall. The climate of Hisar owes to its continental location on the outer margins of the south-west (SW) monsoon region. It has tropical monsoonal climate and is characterized as arid type of climate. The district has characteristically four seasons during the year viz., Summer (March to May), SW Monsoon (June to September), Post-Monsoon (October to November) and Winter (December to February) season. SW monsoon also known as summer monsoon brings rain during last week of June to mid-September. The period from October onward until next June remains almost dry except, few light showers received due to westerly depressions/western disturbances (WDs). The summers are generally quite hot and winters are fairly cool. The main characteristics of climate of in the district are its dryness, extremes of temperature and scanty rainfall. Rainfall: Around 75 to 80 per cent of the annual rainfall is received during SW Monsoon season (June to September) with 50 per cent coefficient of variation (CV). Occasionally dust-storms are experienced during summer months and hail-storms during February to April. Fog prevails generally in December and January months.

1.4.1 Temperature

Weather can be divided into four seasons. It is cold between late November to middle of March, usually January is the coldest month. The maximum daytime temperature during the summer varies between 40 to 46 °C During winter, its ranges between 1.5 °C and 4 °C. July to September are the month of South-West monsoon. October to November are the months of post monsoon i.e., transition to winter. Except for July to September, air is generally dry and April to June witness hot desiccating winds(loo) and dust storms.

1.4.2 Rainfall

The normal annual rainfall of the district is 330 mm which is unevenly distributed over the area (**Figure 2**). Around 75 to 80 per cent of the annual rainfall is received during South West Monsoon season (June to September) with 50 per cent coefficient of variation (CV). The average annual rainfall is around 450 mm, of which the average monthly rainfall received during July and August months is 133.4 and 116.2 mm, respectively. The average monthly rainfall during September is 54.5 mm and June 49.8 mm. The average rainfall received during normal monsoon season is 283 mm. Generally, rainfall in the district increases from southwest to northeast.

The following Table (**Table 2**) shows the data for average annual rainfall and temperature recorded for the District of Hisar according to the District Hydrology Cell of Hisar. Through these rainfall **d**ata, the impact that external factors such as climate change may also possibly be tracked.

Table 2 Climate profile of Rainfall and Temperature

Normal Annual Rainfall	330 mm
Normal Monsoon Rainfall	283 mm
Mean Maximum Mean Minimum	43°C (May & June) 50°C
Normal Rainy days	22°C

The Indian Meteorological Department (IMD) monitors rainfall patterns throughout the country, at a District level as well as at a State Level. For the State of Haryana, piezometers, and there are 16 piezometers in the District of Hisar, according to the Central Groundwater Board (CGWB).

Table 3 Annual Rainfall Data obtained from District Hydrology Cell of Hisar District

Year	Jan	Feb	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
2000	8.3	10.7	0	0	4	48.9	59.9	8.7	4.7	0	0	0	145.2
2001	15	9.2	0	46.6	102.7	168.7	209.8	133.3	26.2	2.5	0	0	714
2002	0	35.2	2.1	0	87	20.3	12.9	22.6	35.9	0	0	10	226
2003	6.4	30.2	2	0	39.3	7.2	279.5	119.6	25.2	0	0	8.6	518
2004	16.9	0	0	21	55.1	61.7	0	86.6	41	36.4	0	2	320.7
2005	22.2	56.5	56.5	16.5	9.7	71.1	195.9	9.4	181.3	0	3.2	0	622.3
2006	0	0	27.2	0	69.2	74.7	91.3	7.9	69.8	0	0	6	346.1
2007	0	86.1	44.3	2	46.2	167.3	21	68.8	66.3	0	0	3.8	505.8
2008	3.3	0.9	0	13.9	52.7	122.9	148.1	129.1	96	5.3	3.2	0.8	576.2
2009	10.3	6.1	4.1	24.9	38.2	29.4	92.4	14	239.9	0	0	0	459.3
2010	11.5	7.6	2.5	0	1.9	50.3	300	209.9	147.6	0	0	43.6	774.9
2011	0	34.8	12.5	35.2	84.9	57	82.5	95.7	141.1	0	0	0	543.7
2012	14.4	0	0	33.3	29.8	26.5	76.6	282.5	32.9	5.4	0	5.5	506.9
2013	43	32.7	31.1	2.3	0	97.3	159.2	288.2	140.4	6.5	9.4	0	810.1
2014	2	12.5	47	17.1	56.5	71.6	74.6	34.2	81.5	21.3	0	9	427.3
2015	15.4	12.2	47	16.4	15.5	161	156.1	54.8	19.8	7	2.9	0	508.1

2016	0	5.3	25.2	0	44.3	91	244.8	80.4	2.8	12	0	0	505.8
2017	41.2	0	2.9	3.1	10.9	283.8	83	95.5	56.6	0	0	3.8	580.8
2018	10.9	1.2	0	14	0	58.9	158.8	23.5	115.8	0	0	0	383.1
2019	13.8	8.8	6	15.5	59.8	105.1	120.4	96.1	29.9	2.6	12.3	4.5	474.8
2020	10.4	10.9	95.2	5.3	36.2	48.8	172.9	62	39.5	0	19.9	0	501.1

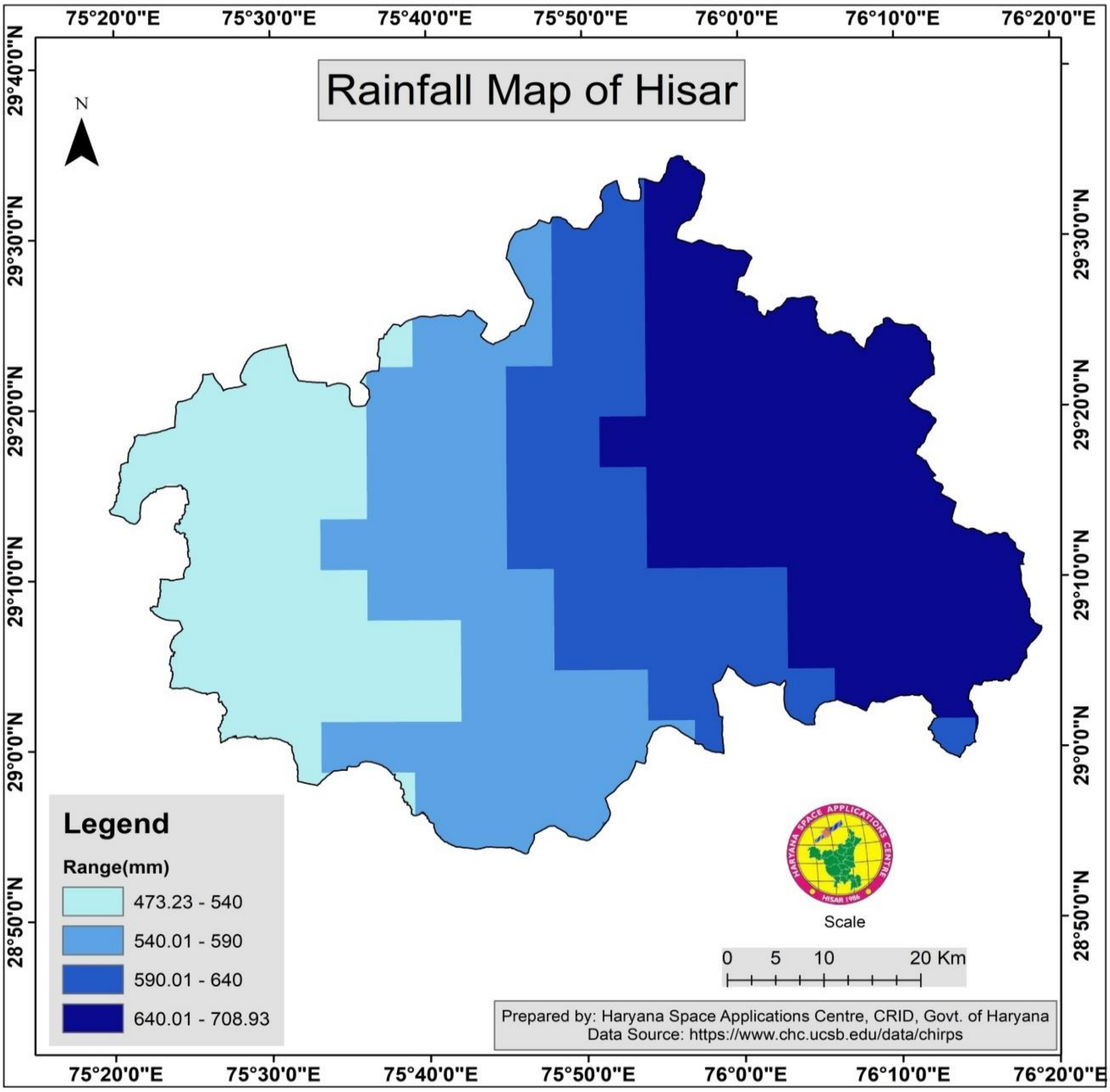


Figure 2 Rainfall Map of Hisar District

Another database that provides the past annual rainfall data (in mm) is Customised Rainfall Information System provided by IMD. The following **Table 3** shows the rainfall values recorded over the five years from 2016 to 2020.The green cells refer to the highest amount of rainfall experienced in the respective years. The following graph shows the variation of rainfall for the past five years for the District of Hisar

Table 4 The rainfall (in mm) recorded over the five years (CRIS, 2020)

Months	**Year**				
	2016	**2017**	**2018**	**2019**	**2020**
January	0	23.0	8.3	11.1	6.7
February	0	0	1.6	2.5	10.4
March	25.8	4.8	0.4	4.5	48.5
April	0	1.4	3.6	3.1`	2.9
May	23.2	5.3	1.3	42.6	34.6
June	47.6	132.8	48.7	42.1	26.1
July	144.6	47.6	89.8	83.5	150.3
August	47.6	43.2	18.4	32.5	40.4
September	0.3	24.3	76.1	1.8	32.5
October	3.9	0	1.3	2.9	0
November	0	1.5	0	12.9	9.3
December	0	3.5	0	1.2	0.3

1.5 Elevation and Topography

The height above mean sea level of the district as shown by Digital Elevation Model ranges from 190 to 244 m (**Figure 3**). Hisar is located at 29.09°N 75.43°E in western Haryana. The region is part of the alluvial Ghaggar-Yamuna plain and its southern and western portions mark a gradual transition to the desert. The Ghaggar and the Drishadvati rivers once flowed through the city. According to tectonic map, the district lies on Delhi-Lahore Ridge which is bounded by thrusts and no earthquake of any significance has originated in the zone in the past. Slope ranges from flat to >35 degree (**Figure 4**). Contours of 5 meters interval showed similar topography as in digital elevation model (**Figure 5**). Southern part of Adampur.

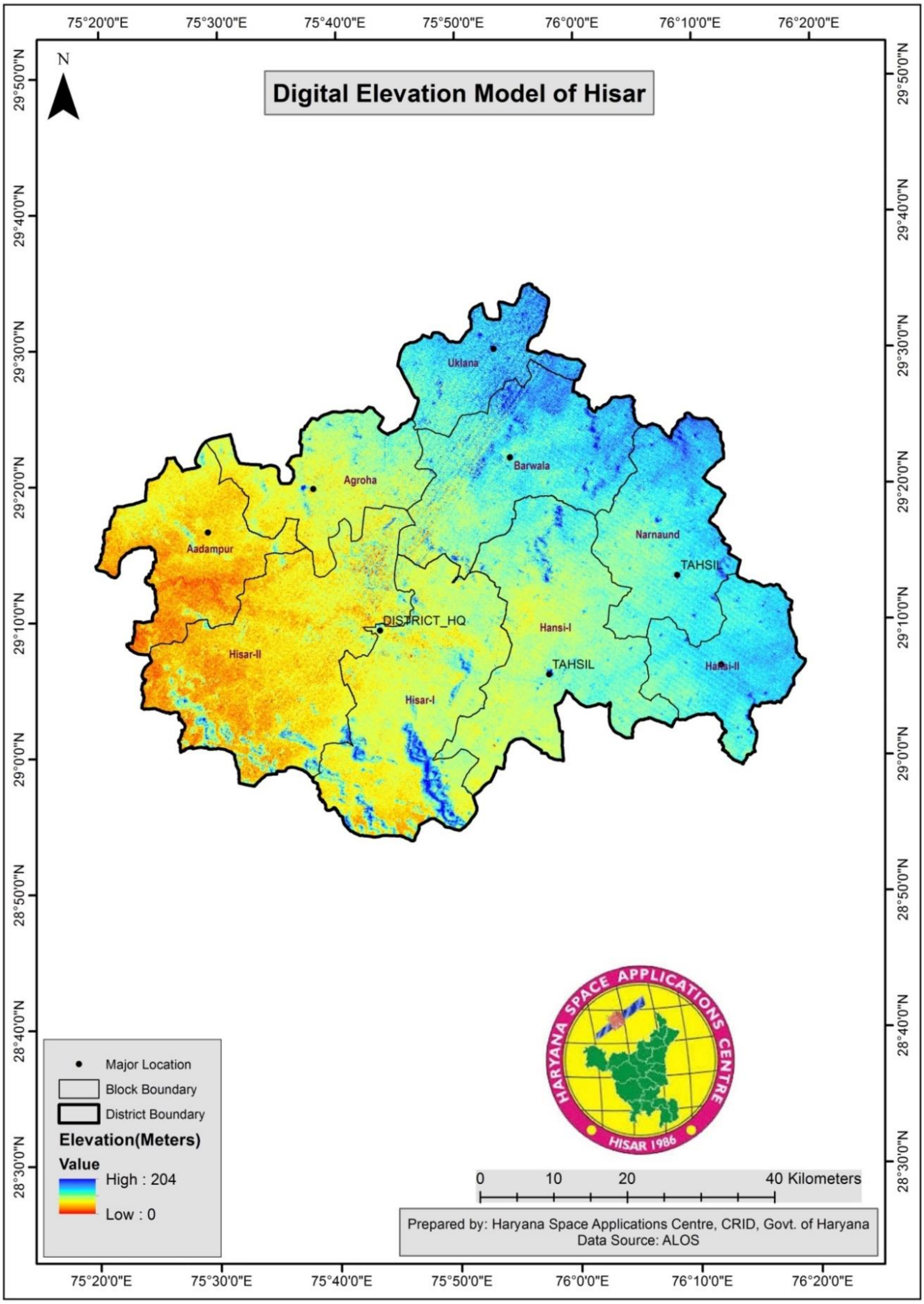


Figure 3 Digital Elevation Model of Hisar District

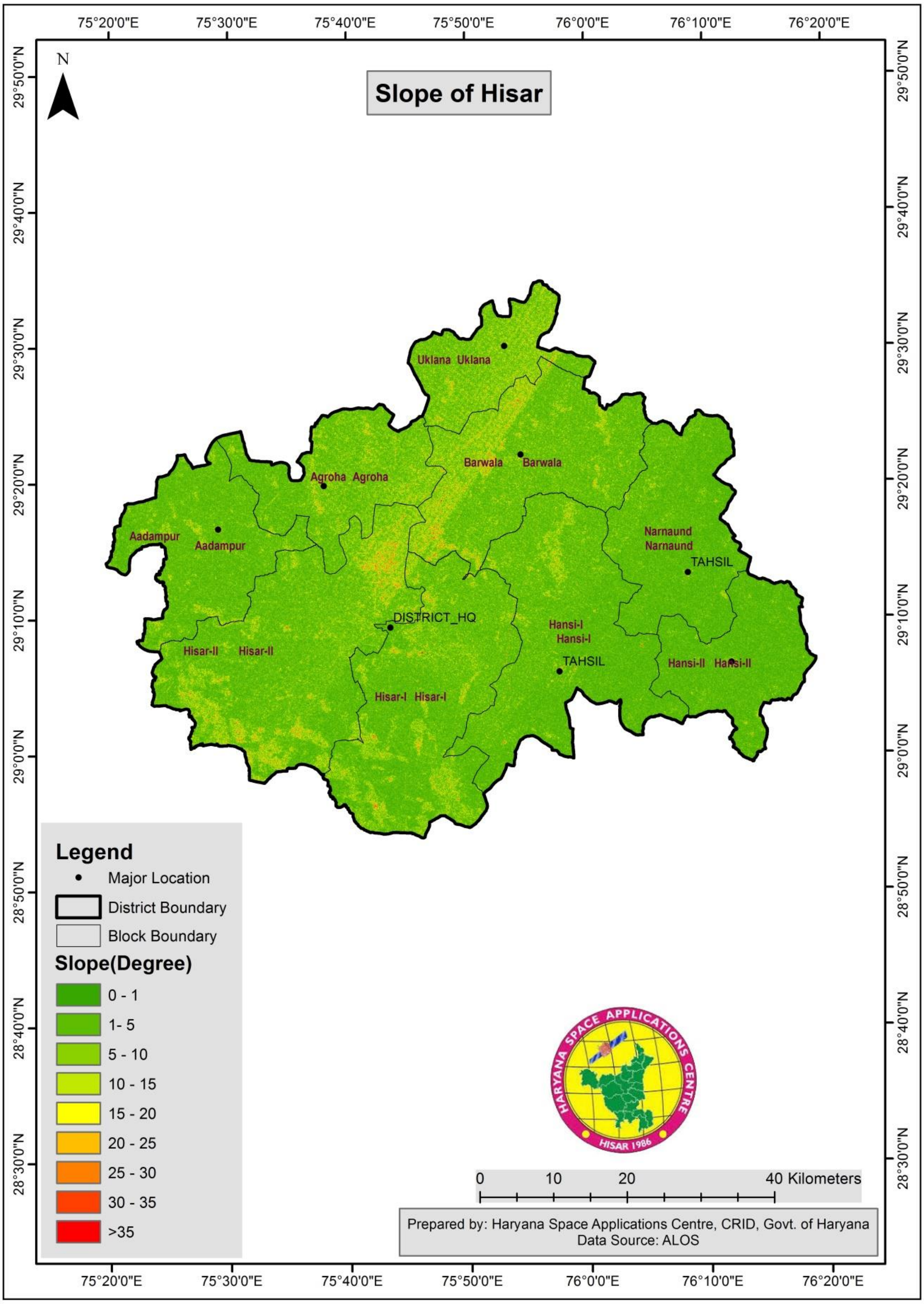


Figure 4 Slope of Hisar District

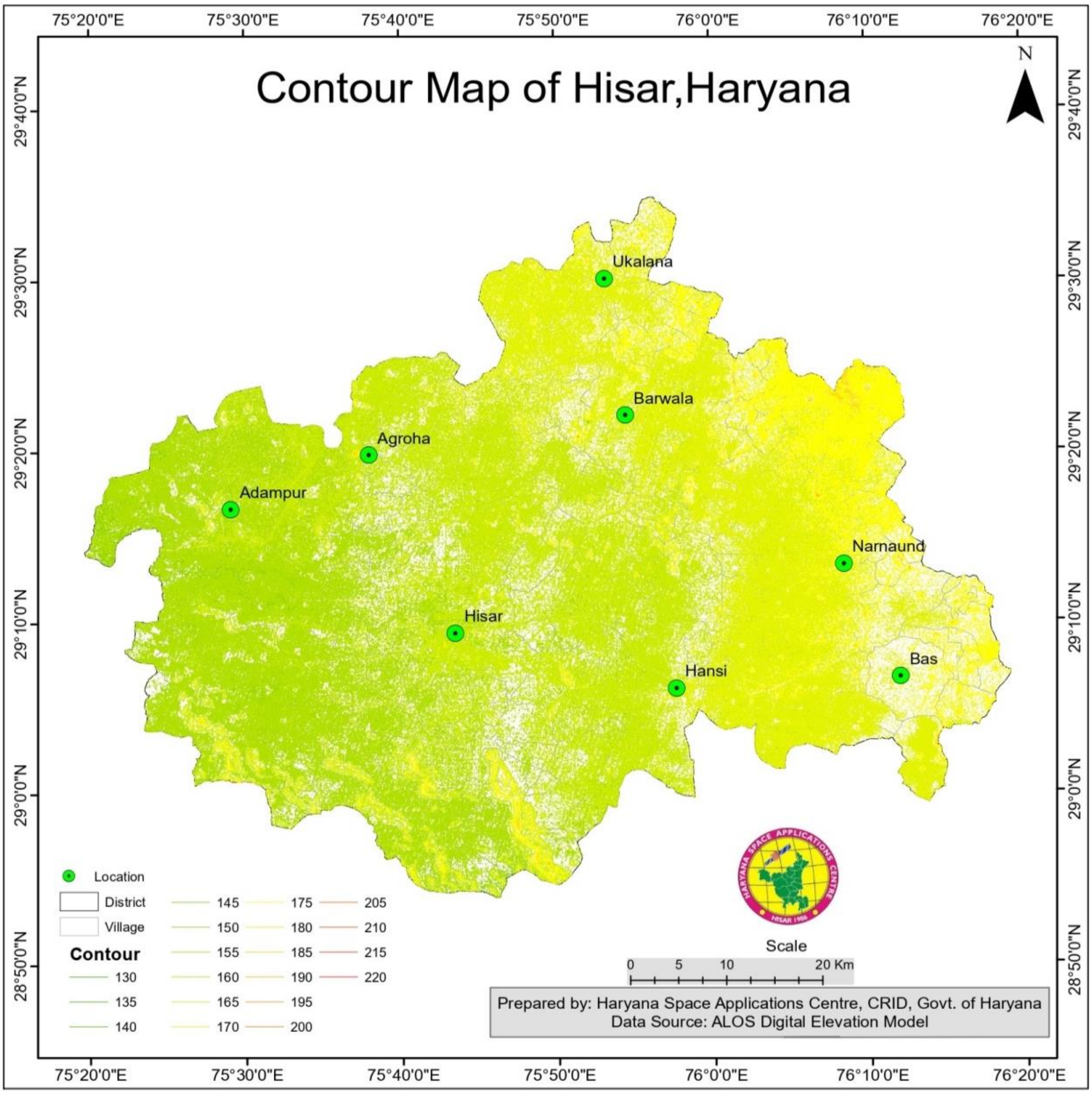


Figure 5 Contour Map of Hisar District

1.5.1 Geology and Lithology

The geomorphology of Hisar district is classified into two major categories they are fluvial origin and Aeolian origin landforms. The fluvial originated landforms existed in this district are older deep alluvial plains, paleo-channels etc and the other landforms i.e., dune complex, eolian plain deep, interdunal flat and sand dunes fall under eolian originated landforms. The details of landforms of the Hisar district are shown in **Figure 6.**

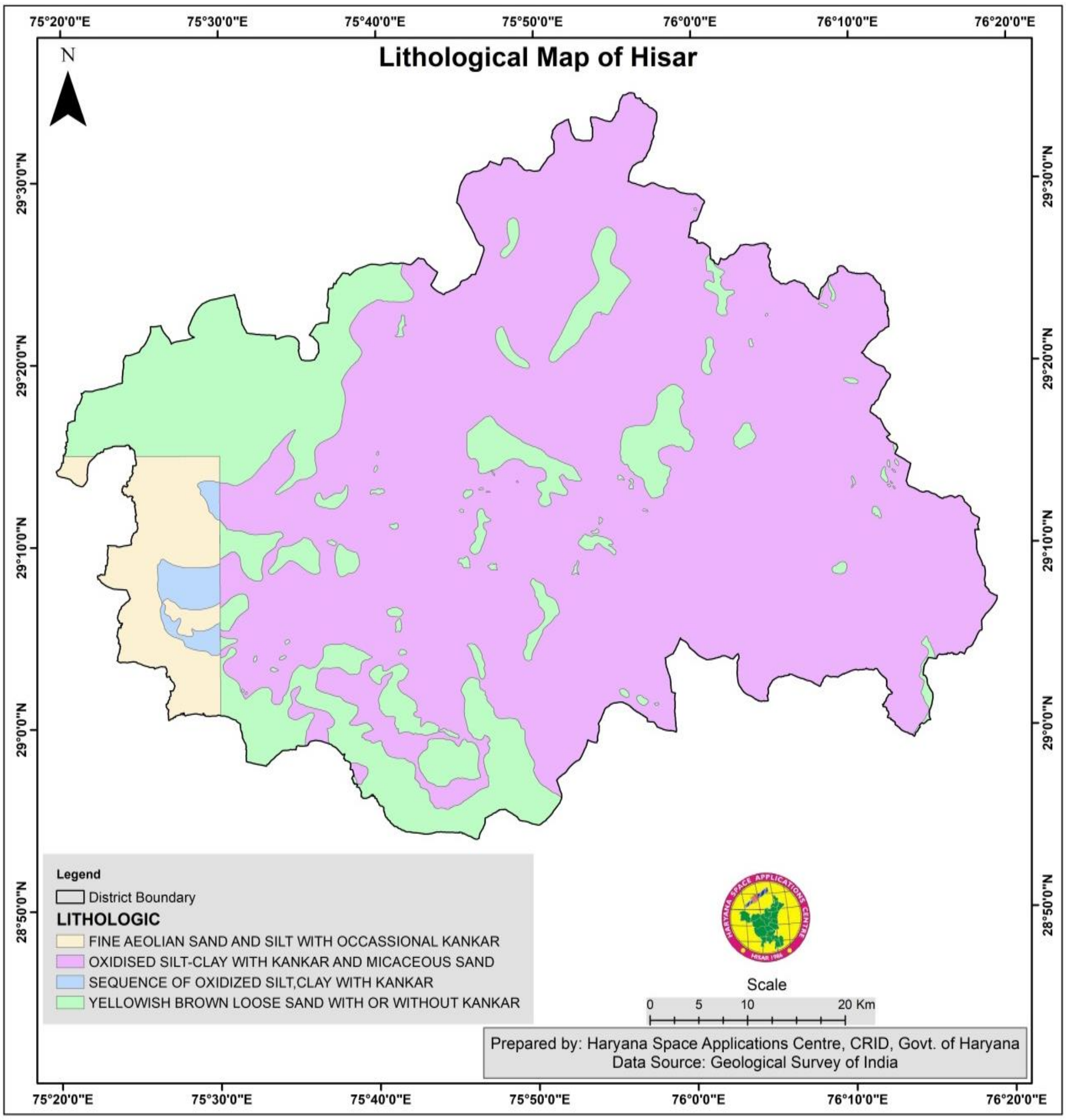


Figure 6 Lithological Map of Hisar District

1.5.2 Soil Profile

The soils of the district are of three types i.e., Arid brown Solonized (in north eastern parts covering north eastern part of Narnaund and Uklana Mandi blocks.), Sierozem (in major parts covering Barwala, Hansi-I, Bass (Hansi-II), Hisar-I & Agroha blocks and parts of Uklana, Narnaund, Adampur & Hisar-II blocks) and desert soils (in southern western parts covering part of Adampur and Hisar-II blocks). 81% of the total district.

The general profile of soil health of Haryana state is shown in **Figure 7**. The Soil Profile of Hisar district compromises of sandy soil sandy loam clay, and in Hisar. On an average, 61 % sandy Loam, 22 % sandy and 17% soils are clay soils as shown in **Figure 8.** The Detailed Soil Profile of Hisar for each block is given in **Table 5.**

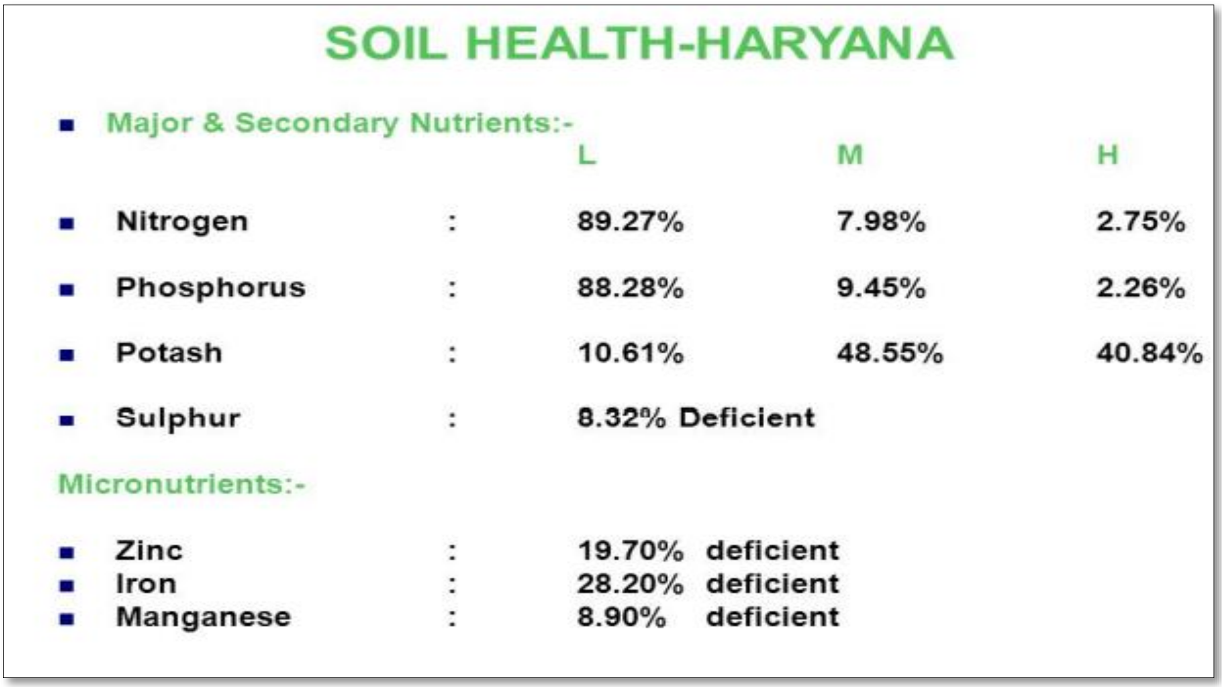


Figure 7 General Soil health profile of Haryana

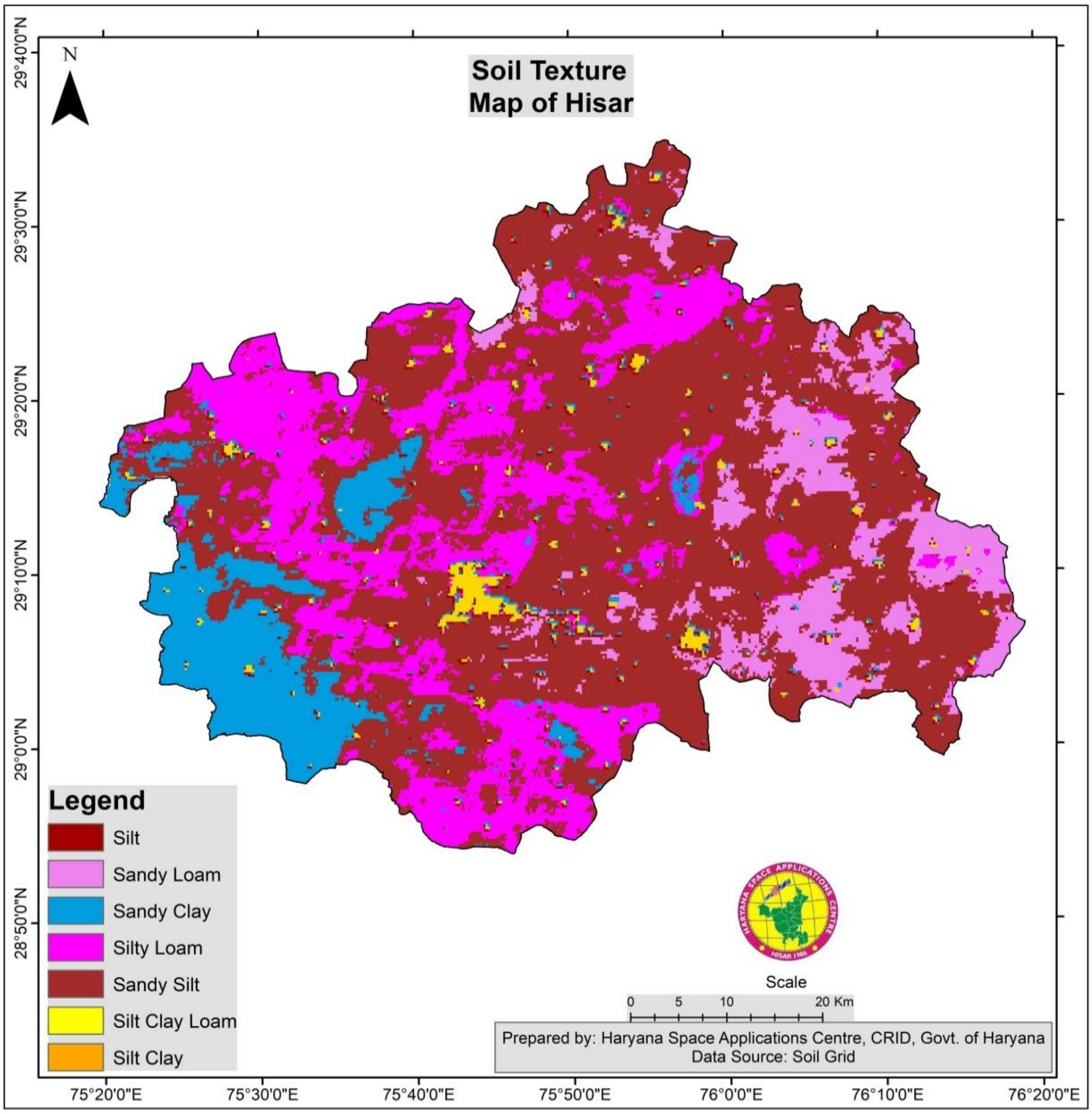


Figure 8 Soil texture map of Hisar District

Table 5 Block-wise Soil Profile of Hisar District

	1. Adampur 2. Agroha 3. Barwala 4. Hisar-I 5. Hisar-II 6. Uklana 7. Hansi-I 8. Hansi-II 9. Narnaund					
	Soil Type		Land Slope			
	Soil Classes	Area (ha)	0-3% (ha)	3-8% (ha)	8-25% (ha)	>25% (ha)
Adampur	Sandy Loam	24943	9036	7297	3012	5598
	Sandy Soil	8090	230	1025	2070	4765
	Total	33033	9266	8322	5082	10363
Agroha	Sandy	30028	10078	9025	9010	1915
	Total	30028	10078	9025	9010	1915
Barwala	Sandy Loam	24692	6450	8012	4512	5718
	Clay	18070	7112	5060	3012	2886
	Sandy	2050	120	740	340	850
	Total	44812	13682	13812	7864	9454
Hisar-I	Sandy Loam	15066	2324	4812	4012	3918
	Sandy	35730	8040	7012	8010	12668
	Total	50796	10364	11824	**12022**	**16586**
Hisar-II	Sandy Loam	32458	8070	10412	7018	6958
	Sandy Soil	25716	1050	4510	9070	11086
	Clay	5012	3015	750	890	397
	Total	63186	12135	15672	16978	18441
Uklana	Sandy Loam	9856	2572	4570	1570	1144
	Clay	10984	4004	4670	1450	860
	Total	20840	6576	9240	3020	2004
Hansi-1	Sandy Loam	56644	11666	25070	10090	9818
	Total	56644	11666	25070	10090	9818
Hansi-II	Sandy Loam	20063	4635	6803	4560	4065
	Sandy Soil	7015	150	760	3670	2435
	Total	27078	4785	7563	8230	6500
Narnaund	Clay	29815	15700	7206	4520	2389
	Sandy Loam	7503	5030	1973	450	50
	Total	37318	20730	9179	4970	2439

1.6 Landuse

Total geographical area of district is 404308 ha, out of which area under agriculture is 345548 ha., Forest 6313 ha. and waste land 3972 ha. Irrigated area of district Hisar is 294030ha, whereas rainfed area is 80831 ha.

Land use and Land cover of the study area are prepared based on the visual interpretation of satellite data and top sheets. The major land use class in this district is agricultural crop land, plantation and fallow type agricultural type and other land use classes observed in this district are build up rural and rural areas, forest area, barren land classes. The detailed land use classes of Hisar district are shown in the **Figure 9.** The Changes in Land cover and Land use from 1999-2015 are formulated in **Table 6** for Hisar district.

Table 6 Change in area of LU/LC under different category from 1999–2000 to 2014–2015

Category	Area in 1999–2000	Area in 2014–2015	Change in area
Built-up	127.52	155.93	28.40
Agricultural land	3829.68	3821.31	—8.37
Forest	28.92	39.43	10.51
Grass/grazing land	134.73	113.02	—21.71
Wasteland	24.11	15.23	—8.88
Wetland	0.66	0.40	—0.25
Water bodies	28.89	29.20	0.31
Total area	**4174.52**	**4174.52**	**0.00**

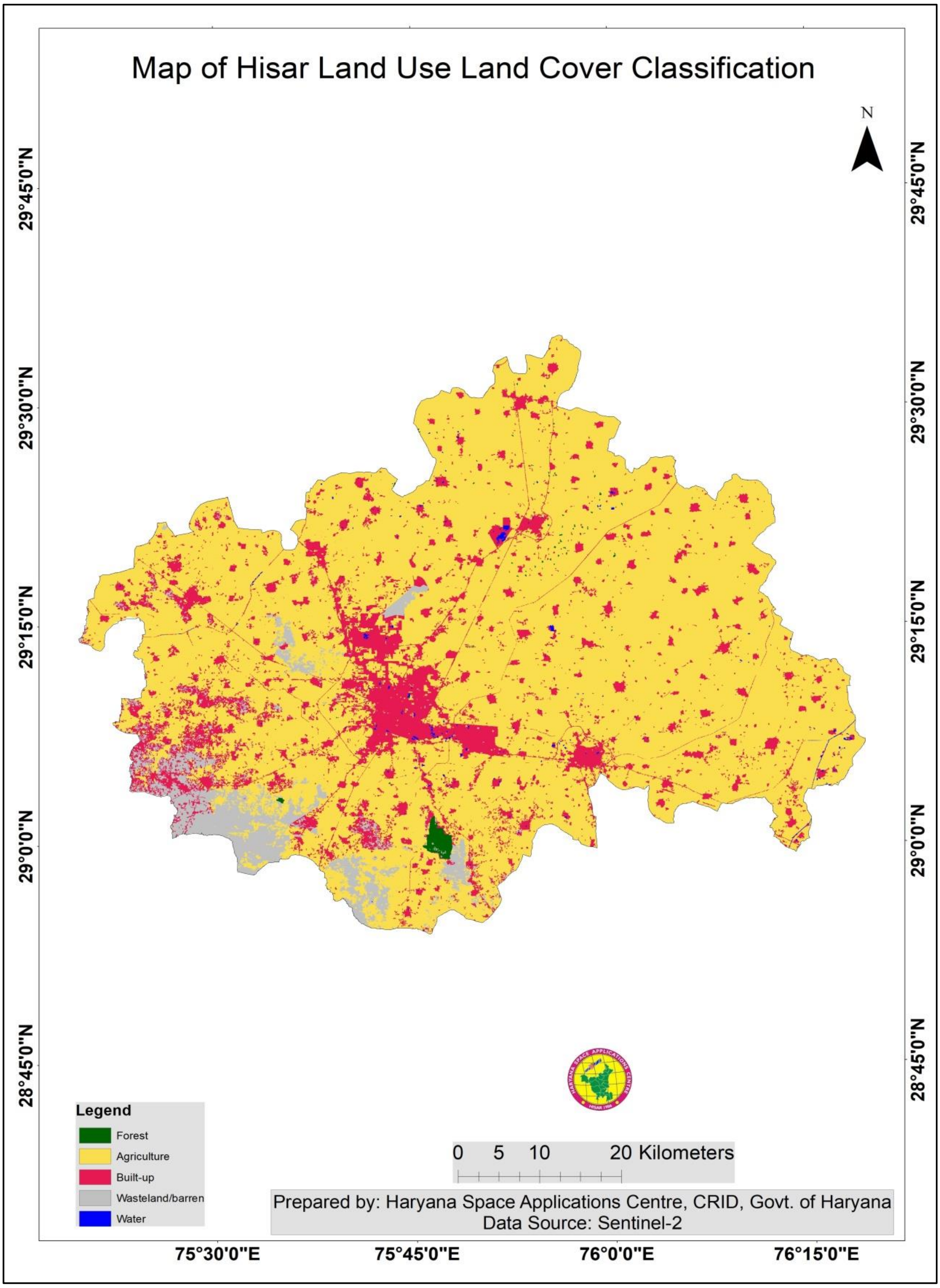


Figure 9 Landuse and Landcover of Hisar District

2 District Water Profile

2.1 Sources of Water

2.1.1 Rivers

There is no major river in the district yet there is a good network of canal irrigation system. The district is located in the arid zone of the State. Rainfall is scanty and unreliable. The sub soil water is deep and unfit for irrigation in most parts of the district. This uncertainty of rainfall necessitated the development of irrigation through artificial sources of irrigation like canals and tube-wells.

2.1.2 Canals

The area is irrigated by shallow tube wells and network of Bhakra Canal Systems and Western Yamuna Canal Systems. The main canals are the Fatehabad branch of Bhakra Canal, Barwala Branch, Balsamandh and Pabra Sub-branch of Barwala Link and Sirsa branch from Bhakra Main Line, Hisar major distributary and Deosar feeder of Western Yamuna canal System through Hansi branch. Canals are irrigating about 76.83 % (209000 ha) of the area, 23.17 % (63000 ha) is irrigated by ground water. There are sand dunes in canal command area, over which rain fed crops are grown. A total of 269 villages of the district come under Canal Irrigation System.

2.1.3 Ponds

A pond is a body of standing water, either natural or man-made, that is usually smaller than a lake (**Figure 10**). 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 Hisar district total 3040 ponds/waterbodies found on satellite data. The map of total ponds/waterbodies that include ponds, canals are shown in **Figure 10.**

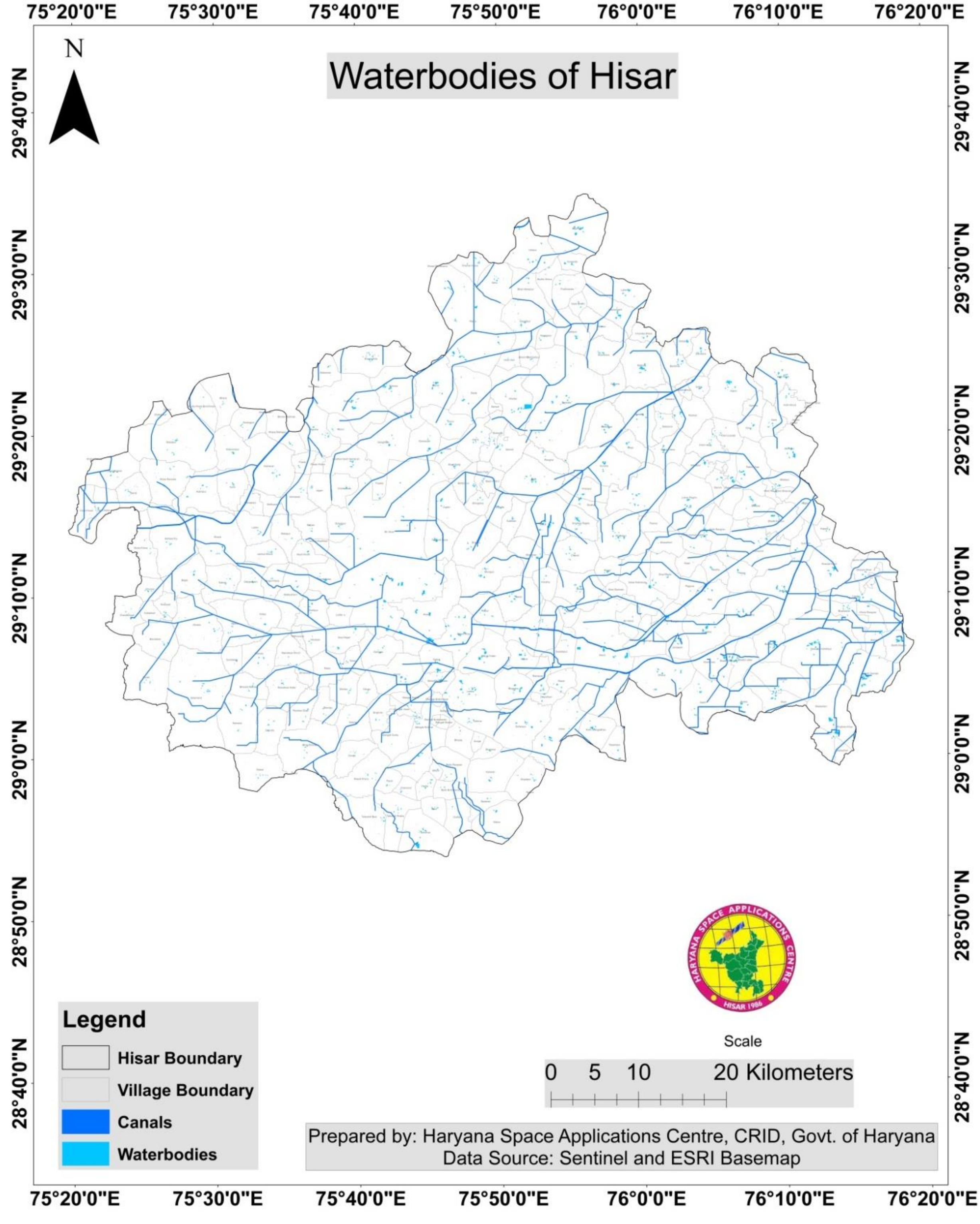


Figure 10 Water bodies of Hisar District

2.1.4 Drain

Natural 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 district falls in Ghaggar basin of Indo-Gangetic plains. The area is traversed by two artificial drains which are confined in Bass, Hansi-I, Narnaund and Barwala blocks. There are a total of 39 drains existing in the area The drainage map of Hisar District is shown in **Figure 11.** The statistics of length of drainages under each order are shown in **Table 7**.

Table 7 Drainage order and total length of the drains in Hisar district

Sr. No.	**Order of Drainage**	**Total Length (in meter)**
1	1st Order	3970277.90
2	2nd Order	2114232.15
3	3rd Order	1066387.84
4	4th Order	425153.99
5	5th Order	286851.60
6	6th Order	206269.18

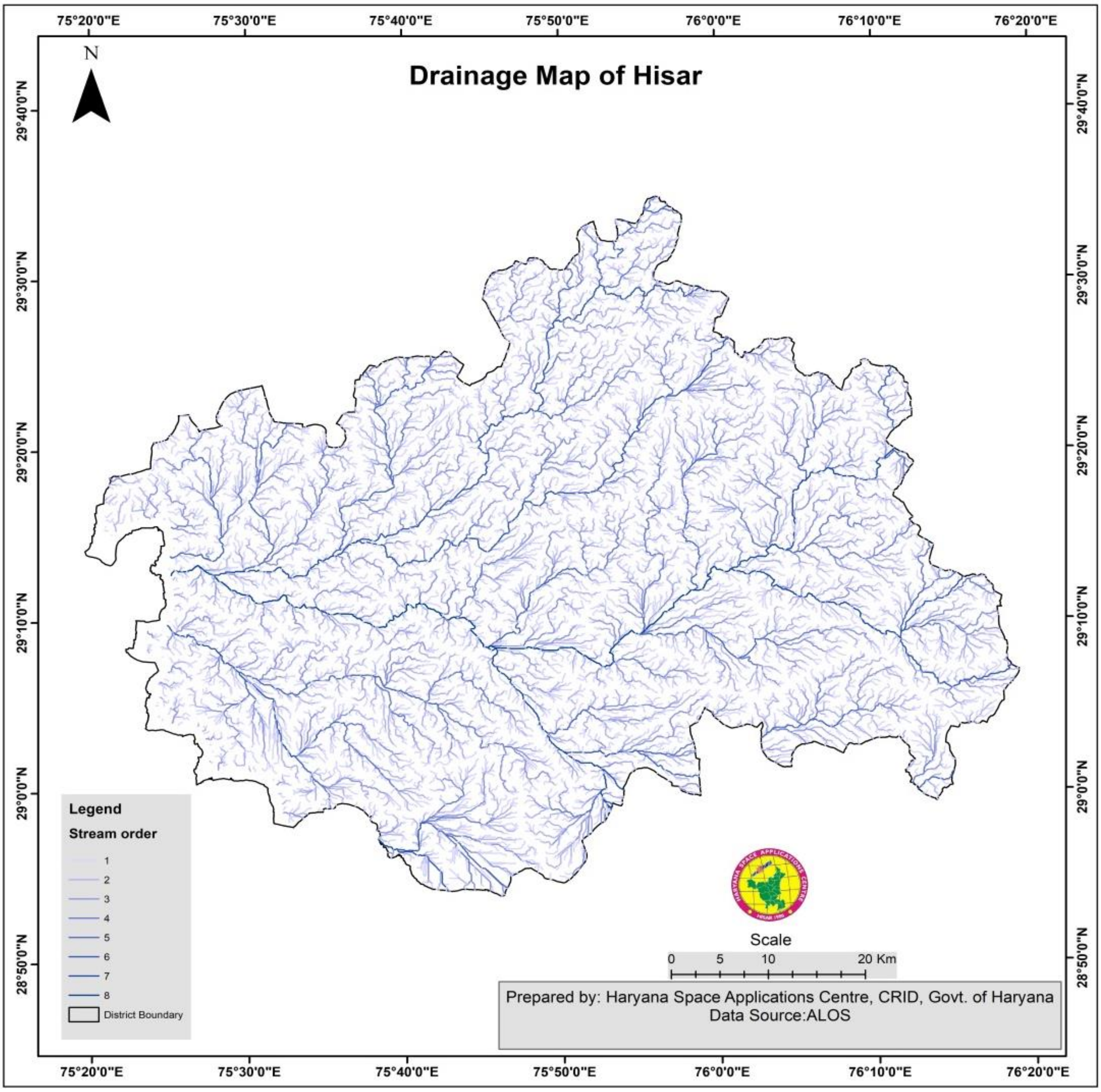


Figure 11 Drainage Map of Hisar District

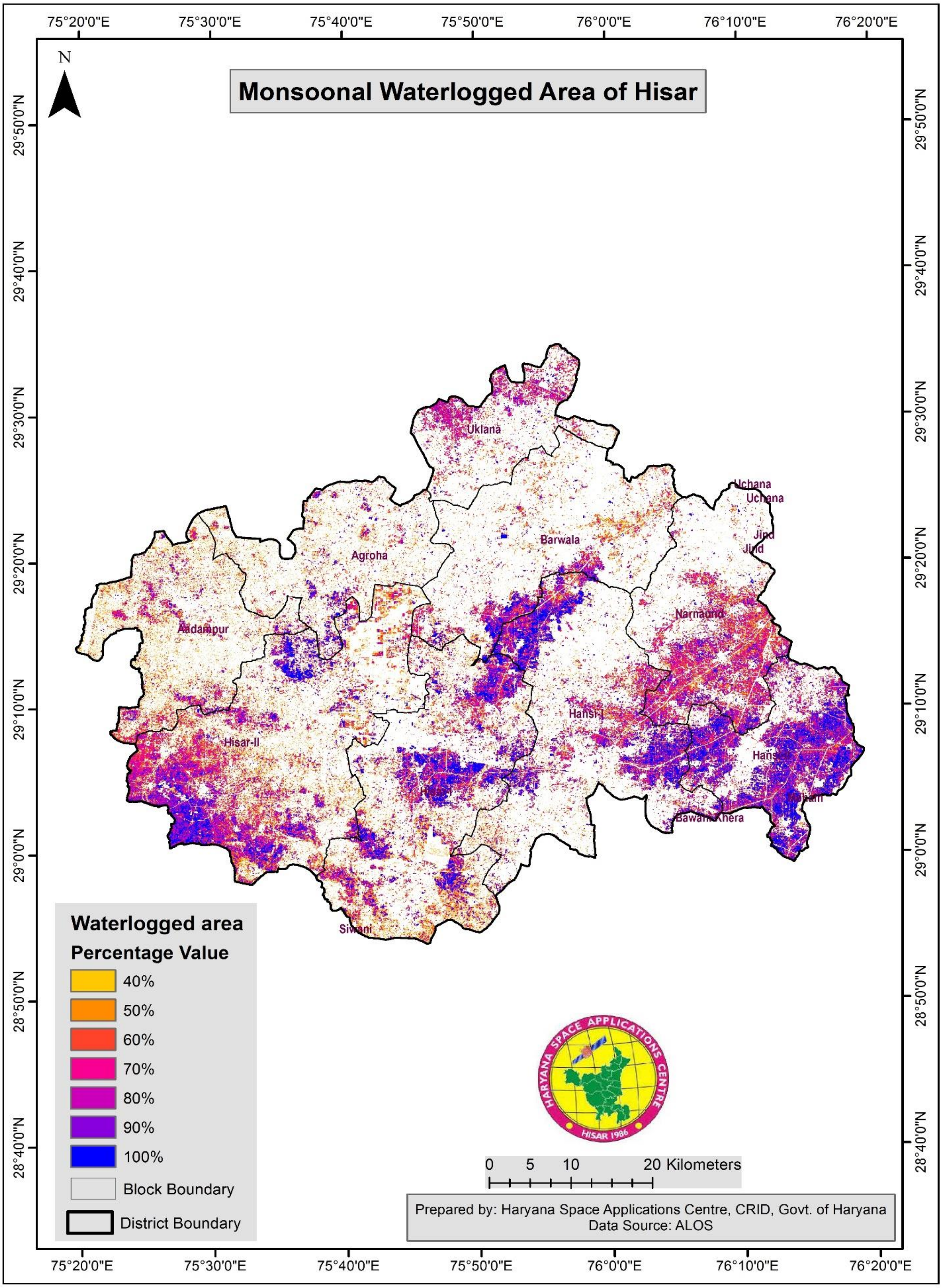


Figure 12 Monsoon water logged area of Hisar

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. Water harvesting profile of Hisar district is shown as followed:

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 supplement 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. The 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. 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. Mentioned below (**Table 8**) is some of the most popular rain water harvesting techniques whereas in **Table 9** is potential recharge through Artificial Recharge structures in rural and urban areas of Hisar district The Main Objective of rooftop rain water harvesting is to make water available for future use.

Artificial recharge structures are to be constructed in rural and urban houses to conserve the rainwater harvesting to groundwater recharge in over-exploited blocks. The suitable methodology is adopted and estimations are made for rural village households, urban households and explained in block wise recharge in over-exploited blocks in mcm and reductions in stage of development are mentioned in below **Table 9.**

Table 8 Rainwater Harvesting Technique used in Hisar

NAME OF DEPARTMENT	Water Conservation and rainwater harvesting structures (No.)		Renovation of Traditional and water bodies/tanks (In Nos)		Reuse, borewell recharge structures (In Nos.			Watershed Developments (In No.)	Krishi Vigyan Kendra	Urban Waste Water Reuse	
	Rooftop Water Harvesting on public building (in no.)	Rooftop Water Harvesting on private building (in no.)	Rural area (In no.)	Urban area (In no.)	Soak pit in rural area (In no.)	Soak pit in urban area (In no.)	Abandoned borewell to be used for water recharge (In no.)	Check dams and trenches (In no.)	(In no.)	Quantity generated (In MLD)	Quantity of water reused (in MLD)
Rural Development	9		50		600						
Irrigation	15		700								
Public Health	25		350	40			200				
PW0 B& R	50		25								
Education	25										
Power Department	20										
Agriculture	5		300					10	1000		
Town & Country	5										
Urban Local Bodies	25	200		4	4	300					
HSVP	20	400								22.5	22.5

Table 9 Potential recharge through Artificial Recharge structures in rural and urban areas of Hisar district

Assessment Unit	Net Annual Ground Water Availability (mcm)	Total Draft (present) (mcm)	Present SOD %	AR in Rural & Urban (mcm)	Draft reduced in mcm	Draft reduced in %	Change in SOD% by AR
	1	*2*	*3*	*4*	*5*	*6*	*7*
Adampur	45.21	49.69	110	0.73	49.0	108.3	1.6
Agroha	64.32	51.94	81	0.00	51.9	80.8	0.0
Barwala	129.7	109.95	85	0.00	110.0	84.8	0.0
Hansi-I	87.65	115.89	132	0.00	115.9	132.2	0.0
Hansi-II	60.22	91.99	153	0.00	92.0	152.8	0.0
Hisar-I	88.66	68.00	77	0.00	68.0	76.7	0.0
Hisar-II	82.72	63.21	76	0.00	63.2	76.4	0.0
Narnaund	91.98	185.76	202	1.25	184.5	200.6	1.4
Uklana	51.32	46.57	91	0.00	46.6	90.7	0.0

2.2.2 Water Harvesting System other than Roof Top

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 Hisar District for rain water harvesting is shown in **Table 10** at rural and urban area. The map of water conservation activity in Hisar at rural and urban level is shown in **Figure 12**.

Table 10 Water Harvesting activities in Rural area and Urban Area

In Rural Area		
Sr. No	**Block Name**	**Total No of Activity (no.)**
1	Agroha	36
2	Barwala	588
3	Hansi-I	81
4	Hisar-I	88
5	Narnaund	15
6	Uklana	84
In Urban Area		
1	Hisar	218

Conservation of water in the agricultural sector is essential since water is necessary for the growth of plants and crops. A depleting water table and a rise in salinity Due to overuse of chemical fertilizers and pesticides has made matters serious. Various methods of water harvesting and recharging have been and are being applied all over the world to tackle the problem. In areas where rainfall is low and water is scarce, the local people have used simple techniques that are suited to their region and reduce the demand for water.

For crop irrigation, optimal water efficiency means minimizing losses due to evaporation, runoff or subsurface drainage. An evaporation pan can be used to determine how much water is required to irrigate the land. Flood irrigation, the oldest and most common type, is often very uneven in distribution, as parts of a field may receive excess water in order to deliver sufficient quantities to other parts. Overhead irrigation, using centre-pivot or lateral-moving sprinklers, gives a much more equal and controlled distribution pattern. Drip irrigation is the most expensive and least-used type, but offers the best results in delivering water to plant roots with minimal losses.

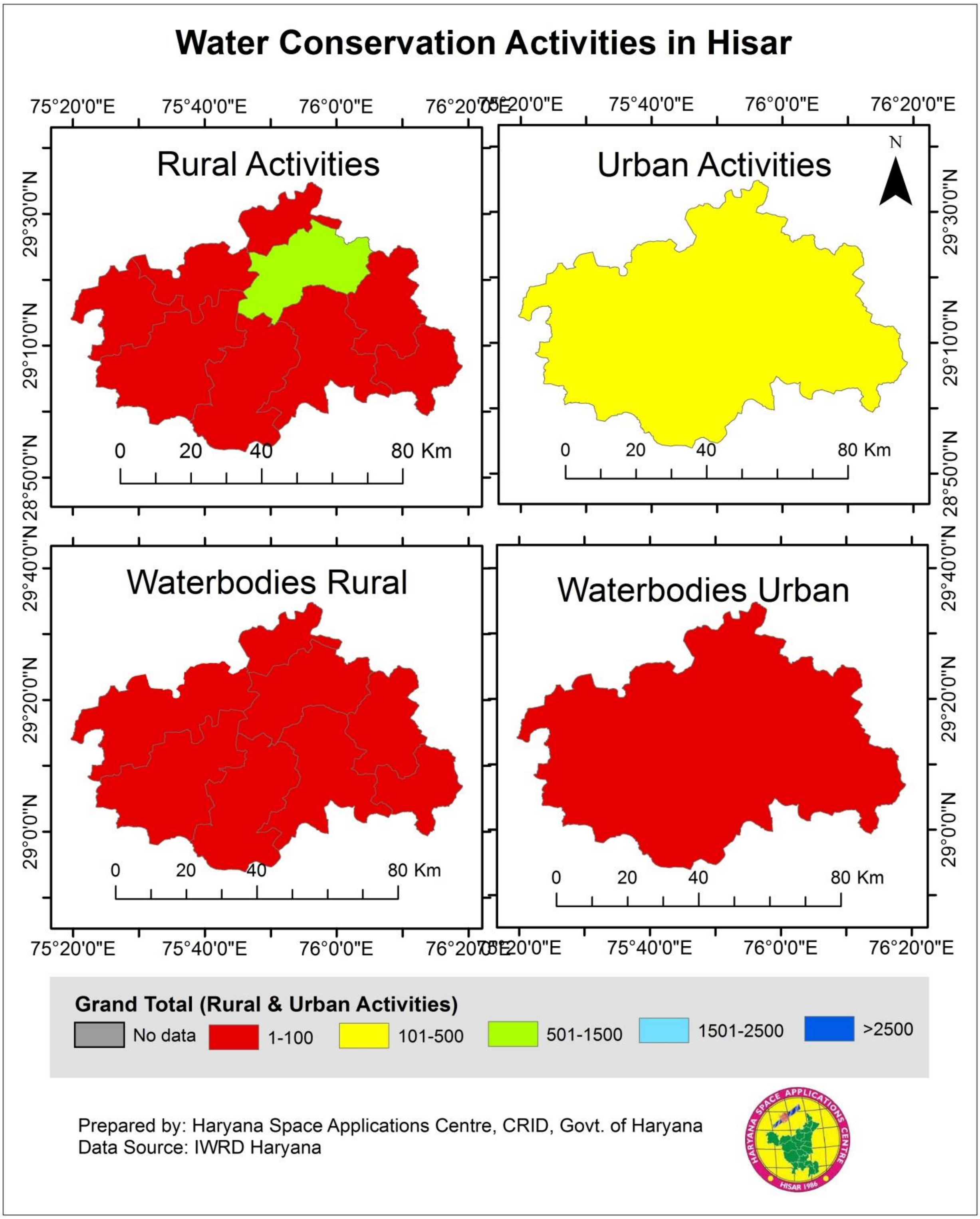


Figure 13 Water Conservation Activity in Hisar District

2.2.3 Sewerage Treatment Plants

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 No 13. In Hisar District a total of 6 treatment plant are installed having total capacity of approx. 50-60 MLD. In Hisar District there is one major biomedical waste management site in Hisar-I Block.

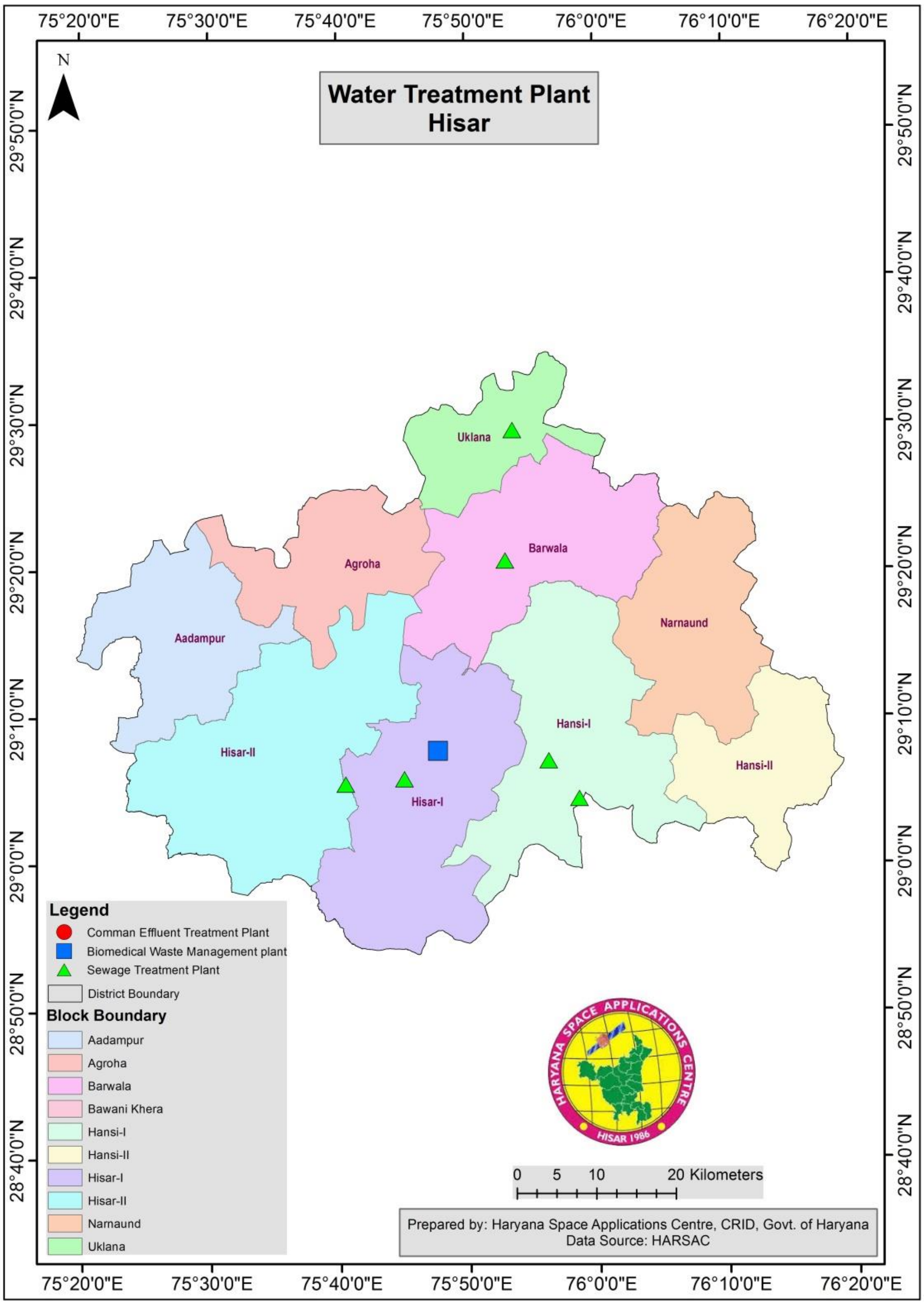


Figure 14 Water Treatment Plant in Hisar District

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 create greening over 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. Unmanaged and unplanned irrigation requirements due to various reasons costs water availability and affect the water resources drastically. This a managed plan for improving irrigation profile of the district is required. Irrigation based classification for Hisar may be based on water availability and described below.

If the condition is "Delayed/ limited release of water in canals due to low rainfall" measures like Change in crop/cropping system, Agronomic measures etc. is required. For Sandy soils/sandy loam soils irrigated with canal Pearl millet + Moong- Raya is suggested in place of Pearl millet/Wheat. For Well drained, medium alluvial soils, canal irrigated conditions, Cotton-Wheat is suggested. For Clay soils, canal irrigated condition, Summer Moong-Rice is suggested in place of Rice-Wheat cropping pattern and Vegetables/ flowers in place of Sorghum fodder- Wheat. Similarly, for a major condition "Non release of water in canals under delayed onset of monsoon in catchment" where the dominance of Sandy soils, and canal tubewell irrigated system is present the Pulses-Raya is suggested in place of Pearl millet-Raya. For the similar major condition where well drained, medium alluvial soils, canal irrigated system is present the Cotton-Wheat is suggested in place of Cluster bean-Barley.

Similar measures in of crop pattern changes, agronomic measures etc. are required for condition like "Lack of inflows into tanks due to insufficient /delayed onset of monsoon", and "Insufficient groundwater recharge due to low rainfall". For unusual rainfall the suggested contingency measures would be different for Vegetative stage, Flowering stage, Crop maturity stage, and post-harvesting stage. Continuous high rainfall in a short span leading to water logging, where the crops like Rice and Cotton are grown after suitable conditions arrived. Drainage of excess water from these areas is suggested specially if the depth of standing water is > 5-6 cm in vegetation stages, flowering stage and fruiting stage. The Shifting the produce to dry place is suggested during the post-harvest stage.

The total area under cultivation in the district under different crops is 170608 Ha Out of the total gross cropped area in the district, 60658 ha is under Kharif while rest ha under rabi crops. The major reason behind large area under rabi crops is due to the fact that the region is mostly under wheat and oilseed cultivation. The total irrigated area under Kharif is 85% of the total Kharif area while the rest is under rainfed cultivation. The total area under irrigation in the district is 86 32% and the rest comes under rainfed area which is 13.68%.

Table 11 Area wise, crop wise irrigation status of agricultural crops

Tehsil wise	Kharif area in Ha	Rabi area in Ha
Hisar	5979	70821
Hansi	30340	13458
Narnaund	16758	10522
Adampur	2946	24600
Barwala	4635	51207
Total	60658	170608

4 Water Availability

4.1 Surface Water Availability

From the description of surface and ground water sources discussed in previous sections above, we summarize below, the direct source water availability at present in the Hisar district of Haryana sub-region. **Table 7** shows the type of water resources available in Hisar District.

Table 12 Type of water resources available in Hisar District

1.	Surface Irrigation	0.0000031	0.0000025	--	0.0000056	
(i)	Canal (Major & Medium Irrigation)	--	--	--	--	
(ii)	Minor Irrigation tanks Horticulture Depart. (665 Nos) & ASCO(1Nos)	--	--	--	666	
(iii)	Lift Irrigation/Diversion	0.0000326	0.0000223	-	0.0000549	
(iv)	Various Water Bodies including Rain Water Harvesting	-	-	-	21	
(v)	Treated Effluent Received from STP	33.50	33.50	33.50	33.50	
(vi)	Untreated Effluent	57.60	57.60	57.60	57.60	
(vii)	Perennial sources of water	`--	-	-	-	
2.	Ground Water					

S. No	Source	Number of T/ Wells	Kharif	Rabi	Summer	Total
(i)	Open Well	0	-	-	-	-

Source: GMDA Hisar

4.2 Ground Water Availability

In general, the water table contours follow the surface topography. Ground Water Resources are available 1.18 bcm (0.04 bcm fresh and 1.14 bcm saline water resources) in the single aquifer group up to the depth of 300m. The fresh water resources are estimated up to the depth of 15 m based on geophysical interpretations interface. The potential granular zones are available for fresh water in this block as 5 m. Saline water resources are estimated based on the available depth of wells existed in this block i.e., average depth of 73 m and the granular zones are counted after the depth of 15 m and available zones are 59 m. this block is falling. The following map (**Figure 16**) depicts the ground water depth in Hisar district and the **Table No 13** gives the description of ground water resource and development potential of Hisar District whereas **Table 14** shows the groundwater avaibility for each block of Hisar District.

Table 13 The Ground water resource and development potential of Hisar district as on 31st march, 2009 in ham

Assessment Unit	**Net Annual Ground Water Availability (mcm)**	**Total Draft (present) (mcm)**	**Present SOD %**	**AR in Rural & Urban (mcm)**	**Draft reduced in mcm**	**Draft reduced in %**	**Change in SOD% by AR**
	1	2	3	4	5	6	7
Adampur	45.21	49.69	110	0.73	49.0	108.3	1.6
Agroha	64.32	51.94	81	0.00	51.9	80.8	0.0
Barwala	129.7	109.95	85	0.00	110.0	84.8	0.0
Hansi-I	87.65	115.89	132	0.00	115.9	132.2	0.0

Hansi-II	60.22	91.99	153	0.00	92.0	152.8	0.0
Hisar-I	88.66	68.00	77	0.00	68.0	76.7	0.0
Hisar-II	82.72	63.21	76	0.00	63.2	76.4	0.0
Narnaund	91.98	185.76	202	1.25	184.5	200.6	1.4
Uklana	51.32	46.57	91	0.00	46.6	90.7	0.0

Table 14 Blockwise Groundwater Avaibility of Hisar District

Adampur					
Status of Block as per Central Ground Water Board Notification			Ground Water (BCM)		
Critical	Semi-Critical	Safe	Draft	Recharge	Gap
No	No	Yes	4.122	5.343	1.221
Agroha					
Status of Block as per Central Ground Water Board Notification			Ground Water (BCM)		
Critical	Semi-Critical	Safe	Draft	Recharge	Gap
No	No	Yes	2.448	5.896	3.448
Barwala					
Status of Block as per Central Ground Water Board Notification			Ground Water (BCM)		
Critical	Semi-Critical	Safe	Draft	Recharge	Gap
No	No	Yes	4.285	9.585	5.3

Hansi I					
Status of Block as per Central Ground Water Board Notification			Ground Water (BCM)		
Critical	Semi-Critical	Safe	Draft	Recharge	Gap
No	No	Yes	10.172	10.356	0.184
Hansi II					
Status of Block as per Central Ground Water Board Notification			Ground Water (BCM)		
Critical	Semi-Critical	Safe	Draft	Recharge	Gap
Yes (Over exploited)	No	No	6.689	6.702	0.013
Hisar I					
Status of Block as per Central Ground Water Board Notification			Ground Water (BCM)		
Critical	Semi-Critical	Safe	Draft	Recharge	Gap
No	No	Yes	4.705	8.095	3.39
Hisar II					
Status of Block as per Central Ground Water Board Notification			Ground Water (BCM)		
Critical	Semi-Critical	Safe	Draft	Recharge	Gap
No	No	Yes	4.202	8.596	4.394
Narnaund					
Status of Block as per Central Ground Water			Ground Water (BCM)		

Board Notification					
Critical	Semi-Critical	Safe	Draft	Recharge	Gap
Yes (Over exploited)	No	No	17.949	9.736	-8.213
Uklana					
Status of Block as per Central Ground Water Board Notification			Ground Water (BCM)		
Critical	Semi-Critical	Safe	Draft	Recharge	Gap
No	Yes	Yes	3.721	4.609	0.888

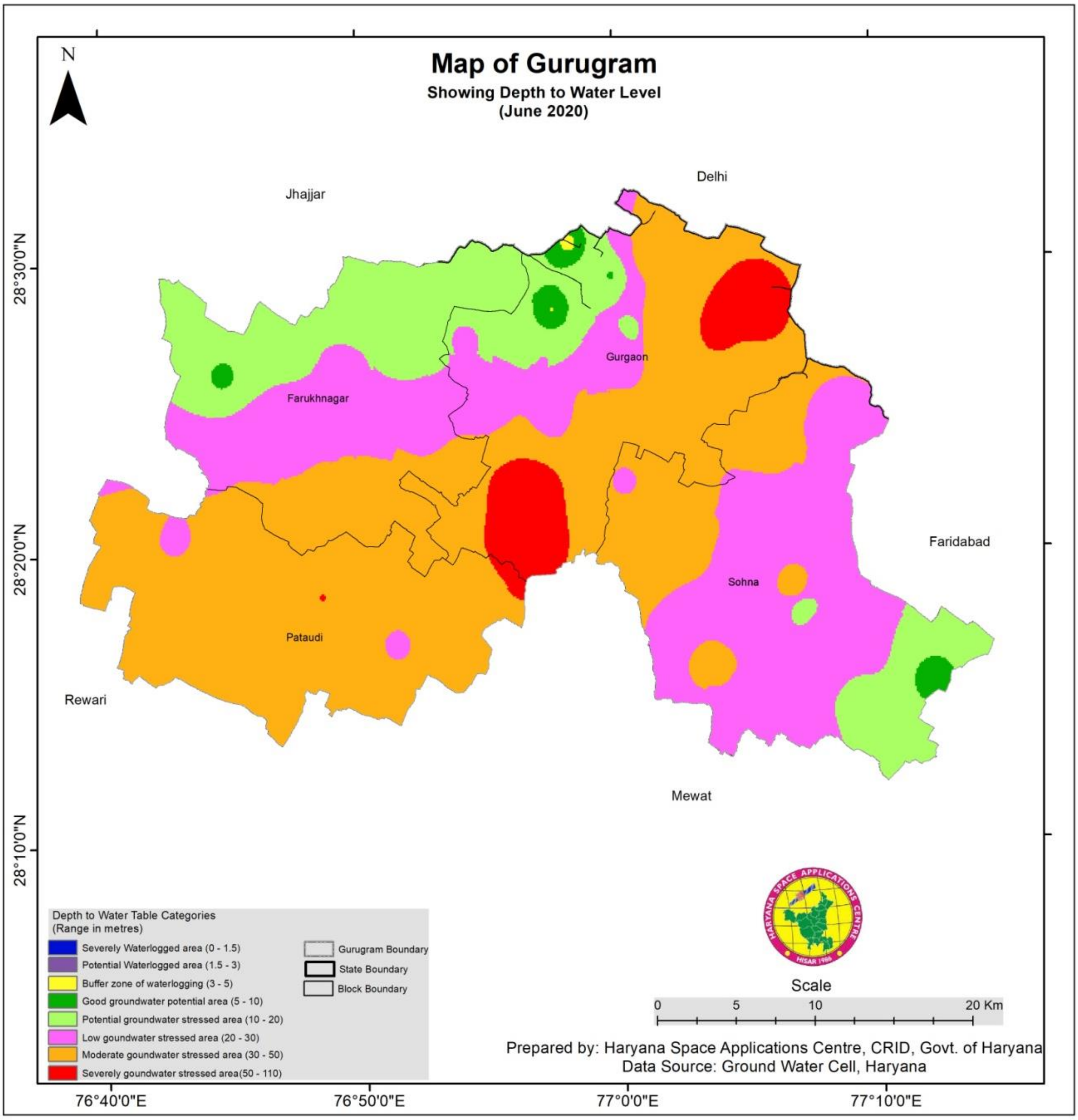


Figure 15 Ground water Availability Map of Hisar District

4.2.1 Ground Water Quality

Groundwater is the water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers. Ground water quality index determines the purity of water. Higher the values on index represent the more turbid water which cannot be used for drinking purpose. In contrast to those lower values on quality index represent the purity of water and are suitable for drinking purpose. According to (http://www.sarasota.wateratlas.usf.edu/library/learn-more/learnmore.aspx?toolsection=lm_wqi) water quality range from 0-45 is good, 45-60 is fair and >60 is very poor quality of water. So, based on that Hisar district's water quality varies from good to poor (**Figure 15**) for the whole district. Whereas block wise water quality index value is shown in **Table 9**.

Table 15 Block wise average water quality index value in Hisar District

Block Name	**Average Water Quality Index Value**
Adampur	179.14
Agroha	178.03
Barwala	210.29
Hansi-I	255.76
Hansi-II	255.76
Hisar-I	162.42
Hisar-II	149.05
Narnaund	227.56
Uklana	113.75

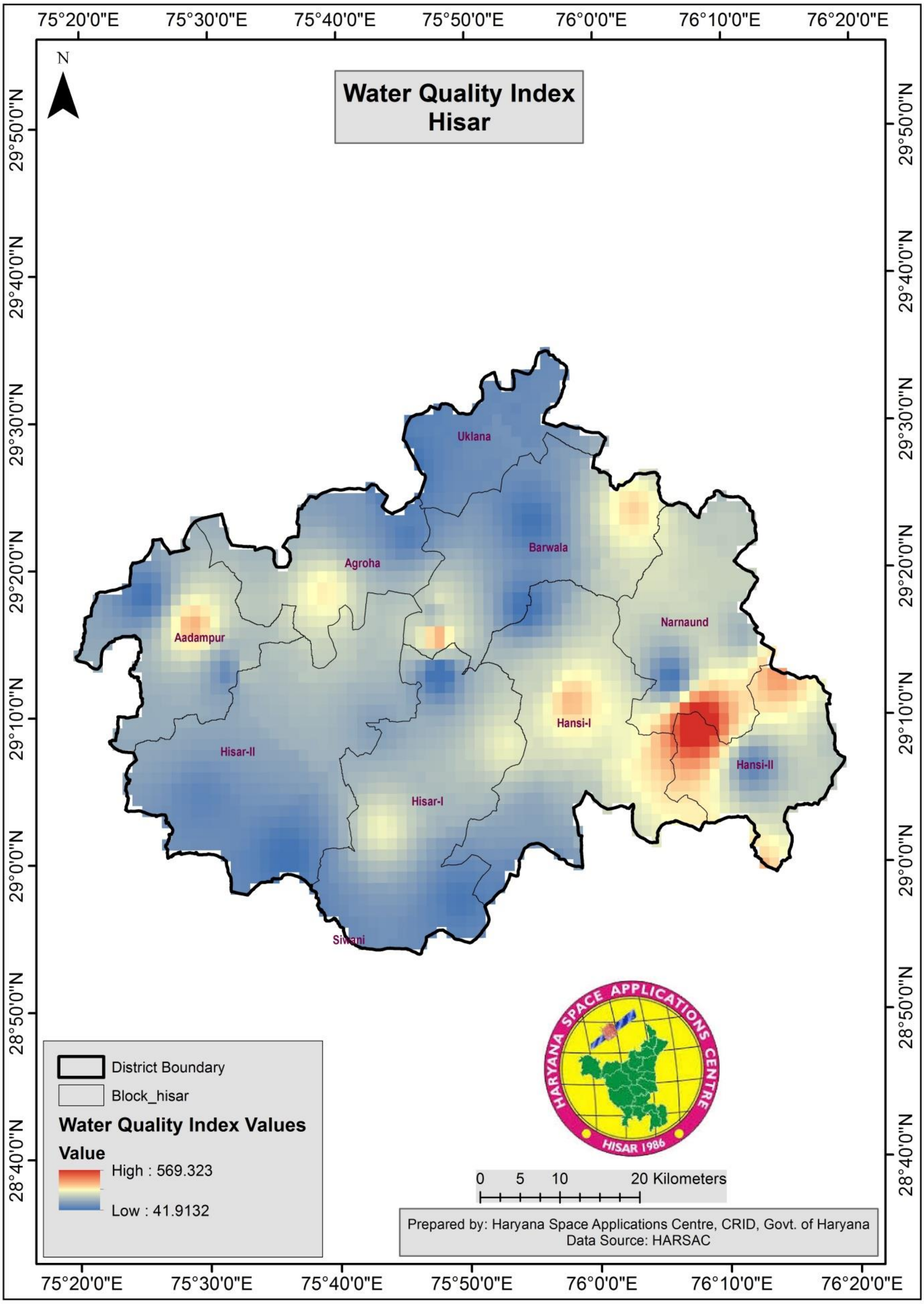


Figure 16 Water quality index of Hisar District

5 Aquifer System

The area of Hisar district occupied in Ghaggar basin and geological formations belongs to Quaternary age comprising of Aeolian deposits and older alluvial deposits of major Indus plains. Ground water at shallow depth occurs under unconfined to semi confined condition and deeper water levels under semi confined to confined conditions with huge clay dominance at deeper depths.

The major aquifer system of the Hisar district is composed of older alluvium in maximum area and aeolian deposits at minor part in western direction. The alluvium in major single aquifer group category mainly comprised of sand, clay, kankar and sand/clay with kankar lithology. In lithology model concept, the concise lithological formations are made in to two major lithological groups that are sand and clay only. Thick layering of clay with sand at many places and can be observed at deeper depths and also thin inter-layered of sand with saline water bearing zones in the thick clay beds at deeper levels observed in middle areas and its surroundings. The saline water is dominant resources below after 20-60 m to up to the depth of 300 m at relatively all places in Hisar district. The fresh water resources are limited in aquifer up to maximum depth of 60m in north and northeast, south east etc but towards west and southwestern side of the district salinity started from 3 m to 10 m depth range, the detailed explanations are below given sub-chapter.

In major part of district Hisar, sand content decreases and aquifers become thinner and quality of ground water also deteriorates to marginal and saline category below average 30 m depth, clay invariably forms the major portion of alluvium. Aquifers in these saline areas are mostly thin and pinch out at short distances, thus restricting the movement of ground water. In the clay predominant region Kankar (nodules of CaCo3 of secondary origin) is mixed with clay and also occasionally present in the sand layers. Kankar layers are distinctly present at different depth ranges. This is considered to be a characteristic of older alluvium and is mostly associated with saline ground water regime.

Table 16 Aquifers thickness at different depths data of different agencies in Hisar

Aquifer system Type	Agency	Maximum depth ranges available (m bgl)		Thickness of Aquifer (m)	
		From	To	Min	Max
Single Aquifer system up to 300m depth	CGWB	102	311	15	153
	Private	244	300	60	119

The hydrogeological details of Aquifers for each block of Hisar district by Central Ground Water Board and state Govt. agencies are given in Table 15.

Table 17 Blockwise Aquifer System of Hisar District

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m2/day)	Specific Yield %	Storativity
Adampur Single aquifer system	Quaternary Alluvial deposits	Unconfined to Semi Confined	36	--	12	--
			Wells abandoned due to bad quality of water			
Agroha Single aquifer system	Quaternary Alluvial deposits	Unconfined to Semi Confined	64	--	12	--
			Wells abandoned due to bad quality of water			
Barwala Single aquifer system	Quaternary Alluvial deposits	Unconfined to Semi Confined	71	--	12	--
			Wells abandoned due to bad quality of water			
Hansi-I Single aquifer system	Quaternary Alluvial deposits	Unconfined to Semi Confined	72	--	12	--
			Wells abandoned due to bad quality of water			

Hansi-II Single aquifer system	Quaternary Alluvial deposits	Unconfined to Semi Confined	41	--	12	--
			Wells abandoned due to bad quality of water			
Hisar-I Single aquifer system	Quaternary Alluvial deposits	Unconfined to Semi Confined	72	--	12	--
			Wells abandoned due to absence of granular zones and bad quality of water			
Hisar-II Single aquifer system	Quaternary Alluvial deposits	Unconfined to Semi Confined	88	--	12	--
			Wells abandoned due to bad quality of water			
Narnaund Single aquifer system	Quaternary Alluvial deposits	Unconfined to Semi Confined	63	2240	12	--

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Uklana Single aquifer system	Quaternary Alluvial deposits	Unconfined to Semi Confined	64	--	12	--
			Wells abandoned due to bad quality of water			

6 Water Requirement/ Demand

6.1 Water Supply and Gap

Depth to water level in the district ranges from 1.50 mbgl at Gurana (Hansi block) to17.88 mbgl at Basra (Adampur block) during pre-monsoon 2020 and post-monsoon, 2020 water levels ranges from 2.10 to 16.76 mbgl in respective locations. About 60% of the Ground Water Monitoring Wells are showing rising of water levels and remaining 40% shows declining in water levels. The water levels are declining seasonal fluctuation in south west part, north east part, south east and north western parts of the Hisar district. The long-term trend in the water level reflected by water level hydrographs is indicative of the change in groundwater storage in phreatic zone with time. Maximum ground water monitoring stations show rising trend and this may be due to local hydrogeological conditions prevailing in the area. Whereas hydrographs of few GWMS show declining trend which may be due to over exploitation of ground water and these areas require careful management of surface water and conjunctive use of surface water and ground water. For the rest of the stations, hydrograph neither indicate any substantial rise nor decline thus indicating that the storage (Dynamic) is being maintained at the normal level which is not disturbed by the present level of ground water development.

In general, the ground water table varies from 203 to 225 m asml. and the regional ground water flow direction is towards western side or southwestern of the district and it may be due to water divide or local hydrological conditions existence in the area. The following table shows the net water draft (consumption) according to each of the block of the Hisar is given in the following **Table 11** as per estimations made by Malik et al. (2015) for the year of 2006 to 2010 in Ha-m.

Table 18 Groundwater Demand Block wise for domestic and Livestock use in the District of Hisar.

Block	**Annual Draft of Ground Water Resources**		
	Domestic (Liter/Day)	**Livestock (Liter/Day)**	**Total**
Adampur	12350012	4230053	16580065
Agroha	10501312	4770558	5820689
Barwala	15486625	5431500	20918125
Hansi-I	22039150	7975000	101794150
Hansi-II	17368750	7369200	24737950
Hisar-I	9612487	4700000	14312487
Hisar-II	21576625	5753400	27330025
Narnaund	9610212	6762560	16372772
Uklana	12852350	3343860	16196210

Moreover, research also suggests, that as population further increases, the demand will increase as shown in the graph below in **Table 19.**

Table 19 Blockwise Crop Water Requirement for Hisar District

Crop Water Requirement							
Block	**Crop**	**Area Sown (ha)**	**Irrigated Area(ha)**	**Crop Water demand (million cubic meter)**	**Water Potential required (BCM)**	**Existing Water potential (BCM)**	**Water Potential to be created (BCM)**
Narnaund	Rabi	32845	28318	1673.7	0.0522	0.0435	0.0087
	Kharif	32845	25774	2275.2	0.0678	0.0565	0.0113
Hansi-I	Rabi	38712	29336	1673.7	0.0648	0.054	0.0108
	Kharif	38712	26766	2275.2	0.0792	0.066	0.0132
Hansi-ii	Rabi	33178	25095	1673.7	0.0516	0.043	0.0086
	Kharif	33178	22780	2275.2	0.0564	0.047	0.0094
Hisar-I	Rabi	37874	26600	1673.7	0.0516	0.043	0.0086
	Kharif	37894	23390	2275.2	0.0564	0.047	0.0094
Hisar-II	Rabi	45517	29131	1673.7	0.0522	0.0435	0.0087
	Kharif	45517	24579	2275.2	0.0678	0.0565	0.0113
Adampur	Rabi	39859	34007	1673.7	0.12144	0.1104	0.01104
	Kharif	39933	27939	2275.2	0.12133	0.1103	0.01103
Agroha	Rabi	21900	18758	1673.7	0.066	0.06	0.00600
	Kharif	22008	15408	2275.2	0.066	0.06	0.00600
Uklana	Rabi	37300	31889	1673.7	0.11	0.10	0.01000

	Kharif	37344	29193	2275.2	0.11	0.10	0.01000
Barwala	Rabi	50888	34478	1673.7	0.1155	0.105	0.0105
	Kharif	50972	28923	2275.2	0.1265	0.115	0.0115
Total		577695	477148	3948.9	1.43677	1.2607	0.17607

Table 20 Total Water Demand of the district for Various sectors for Hisar District.

Sr.No.	Block	Components				
		Domestic (MLD)	**Crop (million cubic meter)**	**Livestock /MLD**	**Industrial CFT in Lac)**	**Power Generation**
1.	Hisar District	220.04MLD	3948.9	50.32 MLD	459.26	120000 kilo Ltr per Day

While several laws and acts have been passed post-independence regarding the abatement of unregulated pollution activities, much remains to be done in order for better enforcement of these regulations on ground in order to gain control of India's water ways.

6.2 Water Budget

1. Domestic Water Demand

Table 21 Expected estimation of domestic (Rural) water demand till year 2022

Block	Population in 2015	Projected population in 2020	Gross Water Demand (BCM)
Adampur	1283612	141143	12350012
Agroha	109105	120015	10501312

Barwala	160900	176990	15486625
Hisar-I	228979	251876	22039150
Hisar-II	180455	198500	17368750
Uklana	99870	109857	9612487
Hansi	224173	246590	21576625
Hansi-II(Bass)	99847	109831	9610212
Narnaund	133531	146884	12852350
Total	2520472	1501686	131397523

Table 22 Expected estimation of domestic (Urban) water demand till year 2022

Block	Population in 2015	Projected population in 2020	Gross Water Demand (BCM)
Hisar City	349876	384764	61050550
Uklana Mandi	14270	15697	2448668
Narnaund	18621	20483	6456506
Hansi	93712	103083	17395256
Barwala	48855	54040	882837
Total	525334	578067	88233817

2. Water Budget (MCM)

Table 23 Block wise water budget

Name of Block	Existing Water	Total (BCM)	Water Demand (BCM)	Water Gap (BCM)

	Availability						
	Surface Water	Ground Water		Present	Projected (2020)	Present	Projected (2020)
Narnaund	0.10	--	0.100	0.110	0.120	0.010	0.020
Hansi-I	0.12	--	0.120	0.132	0.144	0.012	0.024
Hansi-II	0.09	--	0.090	0.099	0.108	0.009	0.018
Hisar-I	0.09	--	0.90	0.99	0.108	0.009	0.018
Hisar-II	0.10	--	0.100	0.110	0.120	0.010	0.020
Adampur	0.2107	--	0.2107	0.2212	0.2318	0.0105	0.0211
Agroha	0.110	--	0.110	0.1155	0.1210	0.0055	0.0110
Uklana	0.200	--	0.200	0.2100	0.2200	0.0100	0.0200
Barwala	0.22	--	0.220	0.231	0.242	0.011	0.2200
Total	1.2407	--	2.0507	2.2187	1.4148	0.087	0.3721

Table no 21,22 and **Table 23** depict the block wise domestic water demand and block wise water budget in Hisar district.

7 Strategies for Water Conservation

The strategies for water conservation may be demand oriented or supply oriented and/or management oriented. The strategies may vary depending upon the field of water use, domestic, irrigation or industrial use. Here are some of the water conservation technologies stated briefly. The over exploitation of this vital resource along with the ground water pollution may lead to adverse environmental impact. Thus, there is an urgent need for protection of this vital resource by adopting the following measures.

1. In order to arrest the declining trend of water levels in the district, the rooftop rainwater harvesting technology should be adopted and recharge structures may also be constructed in depression areas where water gets accumulated during rainy season. This will help in enhancing the recharge to ground water reservoir.

2. The crops consuming less quantity of water may be grown in place of crops requiring more water in the over exploited block

3. The abandoned dug wells may be cleaned and should be used for recharging the ground water by utilizing the surface monsoon runoff.

4. The water level monitoring network needs to be increased in the block.

5. The contribution of surface water to irrigation in the district is very less. Measures should be made to increase the canal water supply for irrigation and also for drinking purposes.

6. Local populaces to be educate regarding consequences of mining of ground water and need for its effective and economic use.

7. Roof top rain water harvesting for factories institutional buildings, housing complexes and other big buildings has been made mandatory to augment the ground water recharge and may be included in building laws. The law should be strictly implemented.

8. The industrial effluents causing ground water pollution should be treated before discharge so as to curb ground water pollution.

9. Strict regulatory measures are required for ground water pump age, particularly for industrial use. Water meter should be fitted on every tubewell and be allowed to withdraw fixed quantity of ground water.

10. Industries should be persuaded to recycle the effluents to minimize consumption of water.

11. Construction of new tubewells by individuals for domestic purpose should be regulated.

12. The municipal sewage should be treated properly to avoid ground water contamination. The same may be utilized for horticulture and other industrial uses, thus reducing the pressure on ground water.

13. Periodic monitoring of chemical quality should be carried out, particularly with reference to heavy metals, fertilizers, nitrates etc.

14. Strict regulatory measures are required for ground water pump age, particularly for construction and infrastructural development purposes.

19. More artificial recharge structures should be constructed by factories, NGO and state government department where water level is declining at fast rate.

20. To achieve Watershed Development Effective management of runoff water and improved soil & moisture conservation activities such as ridge area treatment, drainage line treatment, rain water harvesting and other allied activities on watershed basis.

21. Diversion of water from source of different location where it is plenty to nearby water scarce areas, lift irrigation from water bodies/rivers at lower elevation to supplement requirements beyond IWMP and MGNREGS irrespective of irrigation command.

Understanding the climatic water crises that India could potentially face, the Jal Shakti Abhiyan was launched as a dedicated mission by the Hon'ble Prime Minister of India, in order to ensure that the maximum amount of water was being conserved, treated and reused. While all of the schemes introduced under the campaign are not applicable to the water conservation efforts for the district, the notable suggestions of authorities and research institutions have been mentioned in this chapter. This will thus serve as a strategic framework for which water conservation structures are to be made.

7.1 Artificial Recharge

Given the decreasing trend of rainfall received in Hisar, as discussed in Chapter 1, it is further imperative to put in measures that can The District has the target of implementing the following measures and construction of both infrastructural and non-infrastructural methods to increase the artificial recharge rates. Artificial Recharge rural, urban and also through recharge pits in farm.

Artificial recharge structures are to be constructed in rural and urban houses to conserve the rainwater harvesting to groundwater recharge in over-exploited blocks. The suitable methodology is adopted and estimations are made for rural village households, urban households and explained in block wise recharge in over-exploited blocks in mcm and reductions in stage of development are mentioned in below Table 23.

Table 24 Potential recharge through Artificial Recharge structures in rural and urban areas of Hisar district

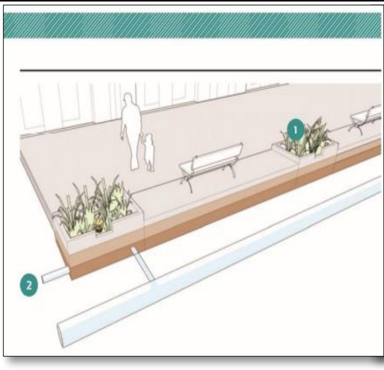
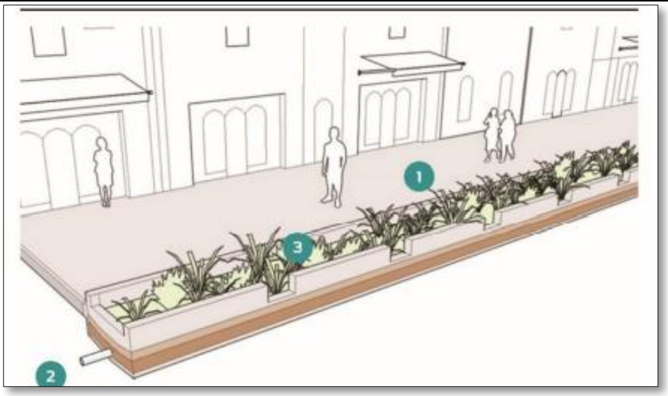
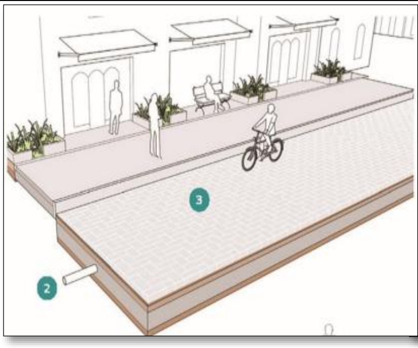
Assessment Unit	Net Annual Ground Water Availability (mcm)	Total Draft (present) (mcm)	Present SOD %	AR in Rural & Urban (mcm)	Draft reduced in mcm	Draft reduced in %	Change in SOD% by AR
	1	2	3	4	5	6	7
Adampur	45.21	49.69	110	0.73	49.0	108.3	1.6
Agroha	64.32	51.94	81	0.00	51.9	80.8	0.0
Barwala	129.7	109.95	85	0.00	110.0	84.8	0.0
Hansi-I	87.65	115.89	132	0.00	115.9	132.2	0.0
Hansi-II	60.22	91.99	153	0.00	92.0	152.8	0.0
Hisar-I	88.66	68.00	77	0.00	68.0	76.7	0.0
Hisar-II	82.72	63.21	76	0.00	63.2	76.4	0.0
Narnaund	91.98	185.76	202	1.25	184.5	200.6	1.4
Uklana	51.32	46.57	91	0.00	46.6	90.7	0.0

In fact, in order to encourage WSUD element design, major building certification and by laws, including the Haryana Building Code of 2016, has made it mandatory for the construction and presence of rainwater harvesting structures in any property of above 500 m^2 and has recommended it for any property above 100 m2 to have a recharge structure on the premises.

7.2 Water 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 Hisar. 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 no 14**.

Table 25 The 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**	

7.3 Plantation

Forests are a crucial natural resource that plays a vital role in water conservation and water retention in the soil. Forest Survey of India report indicated that water bodies inside forests have increased by 2,647 square km during last decade (2005 to 2015). Trees play an important role in intercepting precipitation in the foliage, absorbing and filtering water that infiltrates into the soil. Trees also improve water quality by reducing soil erosion and preventing sediments chocking water bodies.

Existing Central Govt Schemes like National Afforestation Programme (NAP) and Green Highway Policy that can be potential funding source for Afforestation.

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 Hisar is being undertaken both within and outside of government with the engagement of several active citizen stakeholders and non-governmental organisations. Geo-tagging of these plantations and survival monitoring would be undertaken actively by engagement of the mentioned stakeholders.

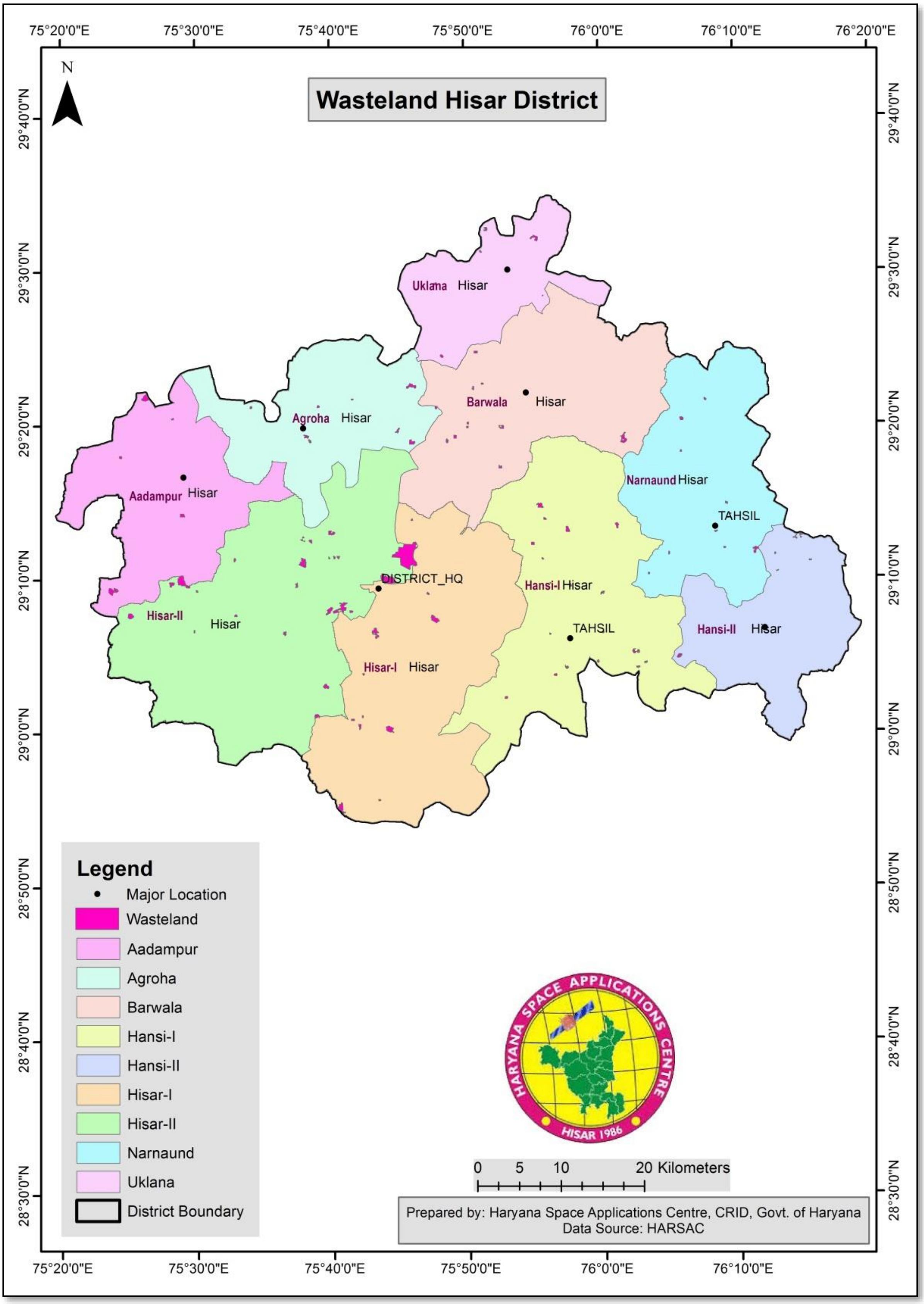


Figure 17 Wasteland Map of Hisar District

Table 26 The proposed targets for plantation in Hisar District

Block Name	Wasteland Area (acre)	Plantation at 5 feet spacing
Adampur	538	4687375
Agroha	266	2323591
Barwala	289	2518619
Hansi-I	407	3551892
Hansi-II	153	1339677
Hisar-I	2168	188888156
Hisar-II	2697	23497395
Narnaund	166.5	1450957
Uklana	140.6	1225525

7.4 Surface water management

7.4.1 Pond restoration and rejuvenation

As earlier mentioned, in Chapter II, 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.

These traditional water bodies are what saved drought hit villages from the brink of extinction and starvation in the great spell of droughts that the nation faced in the 1970’s. Examples led by pioneers such as Anna Hazare and P R Mishra who revolutionized and reinstated the importance of having water storage and wise utilization for increasing crop yield have served as models for reviving these traditional lifelines within the rural eco-system, while setting important benchmarks for its urban counterparts. Culturally, due to its life-sustaining properties, ponds have also been the centres or natural hubs for monthly or annual fairs to be held, and have been biodiversity hotspots that encourage the link between human and wildlife.

Therefore, ponds form a fundamental part of the hydrological cycle in the environment and has allowed a rich cultural, agricultural and societal practices to flourish in India Since ponds can be formed in a much broader range of environments and landscapes, they demonstrate a wide range of physiochemical activities that allows a wide range of flora and fauna to flourish. Currently Hisar has a gap of 32 MLD of untreated wastewater, according the National Green Tribunal Status Report of February 2020 on Yamuna Action Plan that is being discharged directly into the Najafgarh Drain that directly drains into the Yamuna River. However, the ground reality suggests that there are a lot of unmapped points of discharge of wastewater that pollute the local waterbodies. These localized incidents of pollution of water bodies contribute to the loss of biodiversity and pose a threat to water security. In the recent years, it has been realized that wastewater may be an essential commodity and tool that may be used to close the demand supply gap and augment freshwater supply.

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 is 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

While the above methodology has been described in a step wise fashion, the cycle of pond rejuvenation and restoration functions on a feedback system and therefore inputs from each step can integrated into steps proceeding and after as well.

7.4.2 Decentralize Treatment Plant

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 exist outside the city centre and rural areas where open drainage systems still exist. Over the past three decades, the city limits of Hisar 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, decentralised systems must be properly designed, maintained, and operated to provide optimum benefits.

The following table (**Table 27**) shows a list of generic conditions that are most often found in Hisar according to the type of treatment considerations and other main constraints such as land availability and population, given that finances are a constant.

Table 27 Indicators and factors to decide the type of decentralised 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

Currently, the District has the following target for activities related to Pond Restoration and Rejuvenation (**Table 17**).

7.3 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. The following image shows the various stakeholders involved in IEC Activities (**Figure 17**) and **Table 28** shows the numerous activities and interventions that can be carried out for IEC.

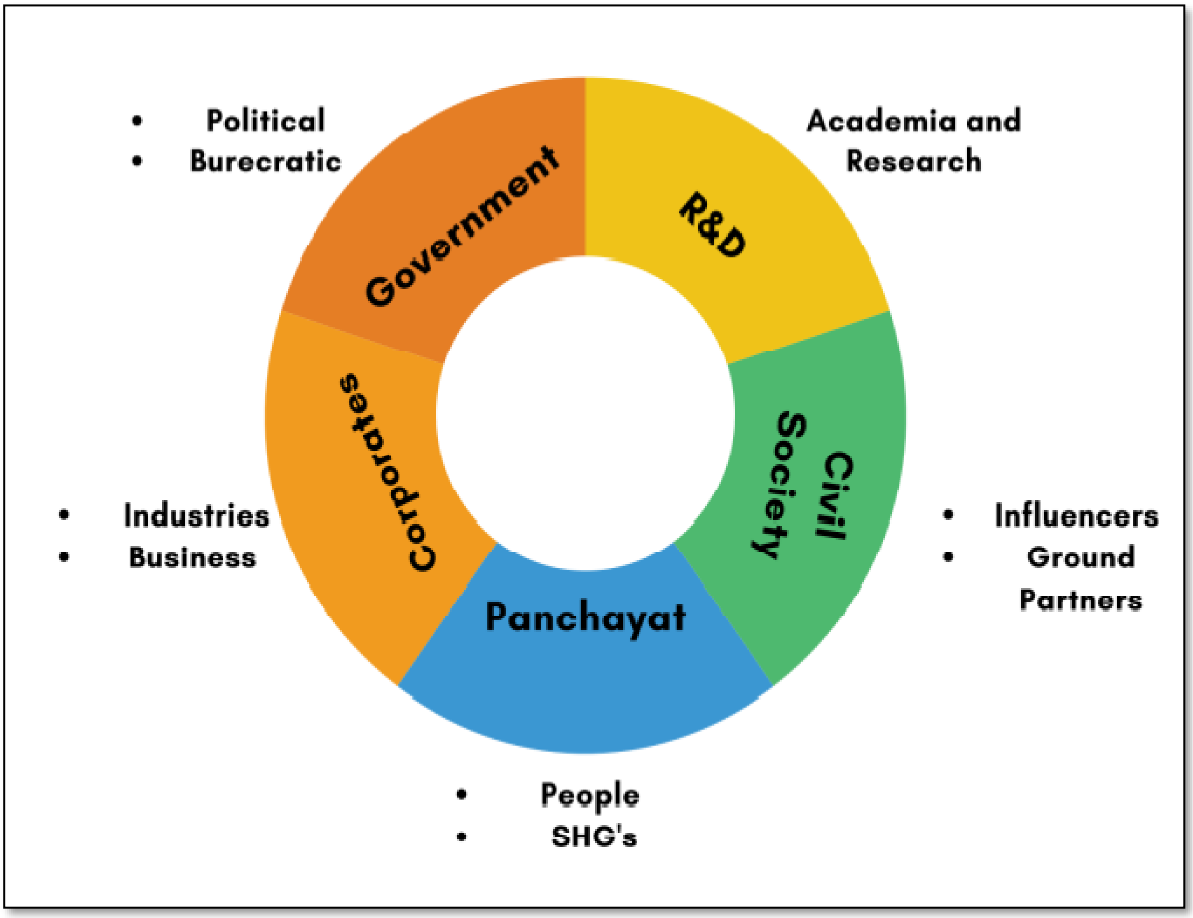


Figure 18 The various stakeholders of IEC Activities

Table 28 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 Man agent 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 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 recognice 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	- Urban (RWA, MCG, MC) - Rural (Pond Sites) - Schools -NGO's	-To increase the green Cover To increase the water holding Capacity	- Plant List Nursery Database - Distribution Chain Management Posters	Better environment for Future Generations
13	Collaborations	- For IEC	- NYK - District Youth Affairs and Sports -Kalagram -NGO's -Durga Shakthi -Civil Defence -Lion Club	To involve stakeholders to facilitate sessions	- Letter of Collaboration -Google form	- 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 19.** For the process of calculating suitable site a fixed weightage is needed to be applies on the above-mentioned criteria (**Table 20).**

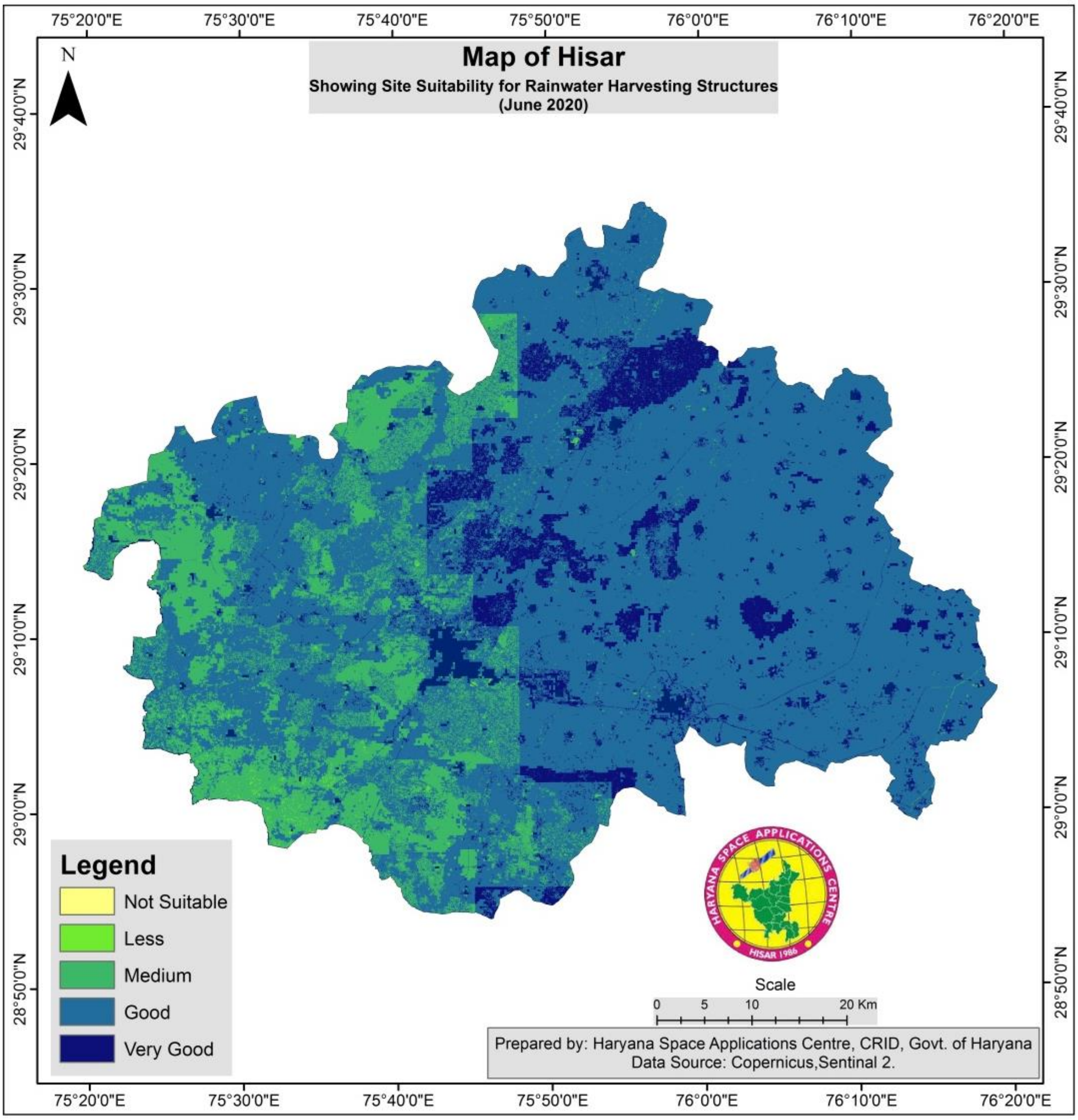


Figure 19 Proposed Site Suitable Map for rain water harvesting

Table 29 Block wise area under very good suitable site proposed for rain water harvesting

Block Name	Area (Very Good suitability area in Sq. meter)
Adampur	233563080
Agroha	224996407
Barwala	495699234
Narnaund	409722634
Uklana	212020908

Table 30 Assigned Weight for Criteria Parameters

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

8.2 Proposed Suitable Site based on Drainage

The drainages that are created from satellite imagery can be used as base for the water harvesting structure **(Figure 20).**

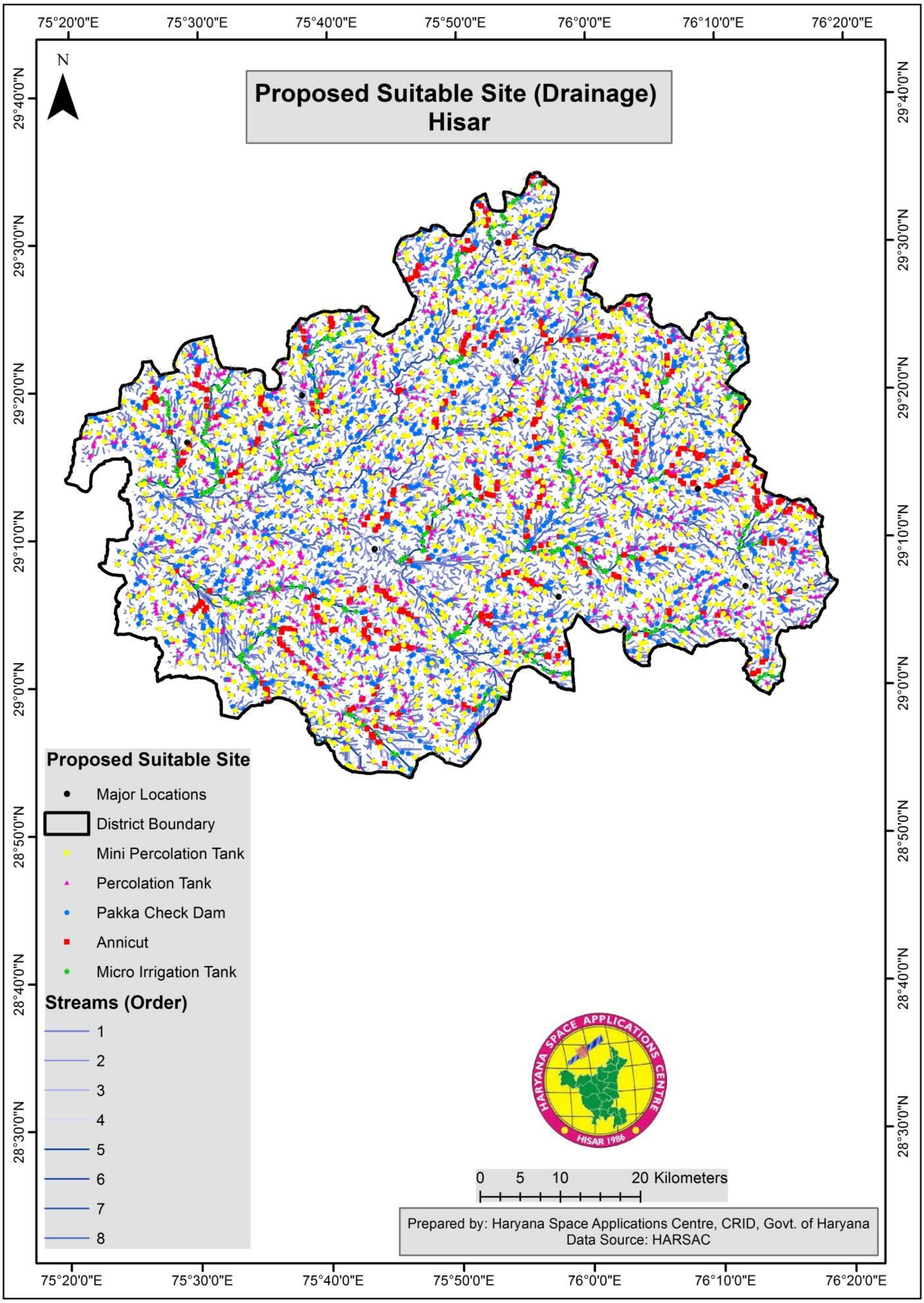


Figure 20 Proposed suitable sites based on drainage in Hisar District

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 Ist order Stream, percolation Tanks on 2nd Order Stream, pakka check Dams 3rd Order Stream, Annicut on 4th order, Micro Irrigation tanks 5th Order can be built. **Figure 20** shows the proposed suitable sites based on drainage structure in Hisar district. Proposed harvesting structures in Hisar based on drainage **Table 22.**

Table 31-Proposed harvesting structures in Hisar based on drainage

Sl. No.	Block Name	Mini percolation Tank	Percolation Tank	Pakka Check Dam	Annicut	Micro Irrigation Tank
1	**Adampur**	110	118	99	39	56
2	**Agroha**	117	112	116	39	36
3	**Barwala**	197	170	181	65	15
4	**Hansi-I**	213	164	192	80	91
5	**Hansi-II**	93	109	75	49	16
6	**Hisar-I**	208	183	176	90	48
7	**Hisar-II**	244	230	223	58	16
8	**Narnaund**	146	118	121	75	41
9	**Uklana**	81	59	101	36	28

9 Conclusion

Water problem will not go away by themselves. On the contrary, they will worsen unless we, as a global community, respond and use water responsibly. So, before it is too late, let us all, as individuals, families, communities, companies & institutions, pledge towards using water wisely. Intelligence is not in lavishness but in conservation, so that our future generations can continue to enjoy the blissful feeling and touch of water.

Due to rapid urbanization, the Hisar 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.

Water being an ongoing reliable source around the world, it will not be available forever. When top energy consumers include the United States and China, along with environmental factors affecting these two regions, there is no doubt that this valuable resource will be limited on Earth. Water scarcity is no joke and shouldn't be taken lightly for it has great effects on food production, our farm lands, our health, and our economies. Droughts are common factors of this scarcity of water by drying up land and all the life contained in it. The land for crops is shrinking and are in need of more and more water everyday causing limited amounts of fruits and vegetables to be produced according to the research found by Daryanto and Gilis. When there is low food production, there come high demands which affect the economy.

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

PIKU