Report No.-11

JSA-CTR

Scientific Action Plan for Karnal

सिंचाई एवं जल संसाधन विभाग
हरियाणा

Prepared By-

Haryana Space Applications Centre (HARSAC),

Citizen Resource Information Department (CRID)

Government of Haryana

2021

Table of Contents

1. Introduction 47
   1.1. History 47
   1.2. Location 47
   1.3. Administrative setup 49
   1.4. Climate 50
      1.4.1. Temperature 50
      1.4.2. Humidity 50
      1.4.3. Wind Velocity 50
      1.4.4. Rainfall 50
   1.5. Elevation and Topography 52
   1.6. Geology and Lithology 55
   1.7. Soil Profile 56
   1.8. Landuse ..... **Error! Bookmark not defined.**
2. District Water Profile 60
   2.1. Source of Water 60
      2.1.1. Canals 60
      2.1.2. Ponds 60
      2.1.3. Drain 62
   2.2 Water Harvesting System 65
      2.2.1 Roof Top Harvesting 65
      2.2.2 Water Harvesting System other than Roof Top 65
      2.1.4. Sewerage Treatment Plant 68
3. Irrigation Profile 69
   4. Water Availability 71
   4.1. Surface Water Availability 71
   4.2. Ground Water Availability 72
   4.3. Ground Water Quality 74
5. Aquifer System 76
6. Water Requirement/ Demand 77
6.1. Water Supply and Gap 77
   6.2. Water Budget 80
7. Strategies for Water Conservation 80

7.1. Artificial Sensitive Urban Design 80
7.2. Plantation (wasteland map) 82
7.3. Water Conservation & Artificial Recharge 84
7.4. Surface water management 84
7.4.1 Pond restoration and rejuvenation 84
7.4.2 Decentralize Treatment Plant 86
7.5. Information Education and Communication 88
8. Proposed Activity 6
8.1. Rainwater harvesting 6
8.2. Multicriteria 8
8.3. Based on Drainage 10
9. Conclusion 11

List of Figures

Figure 1 Location Map of Karnal District 48
Figure 2 Rainfall Map of Karnal District 51
Figure 3 Digital Elevation Model of Karnal District 53
Figure 4 Slope Map of Karnal District 54
Figure 5 Contour Map of Karnal District 55
Figure 6 Lithological Map of Karnal District 56
Figure 7 Soil Texture Map of Karnal District 57
Figure 8 Landuse and Landcover of Karnal District 58
Figure 9 Waterbodies of Karnal District 61
Figure 10 Drainage Map of Karnal District 63
Figure 11 Water Conservation Activity in Karnal District 66
Figure 12 Water Treatment Plant of Karnal District 69
Figure 13 Ground Water Availability Map of Karnal District 73
Figure 14 Water Quality Index of Karnal District 75
Figure 15 Blockwise Wasteland of Karnal District 83
Figure 16 The Various Stakeholders of IEC Activities 88
Figure 17 Site Suitability Map fo Rainfall Harvesting Structure in the Year 2020 7
Figure 18 Proposed Suitable Sites based on Multicriteria in Karnal District 9
Figure 19 Proposed suitable sites based on drainage in Karnal District 10

List of Tables

Table 1 Major Administrative Jurisdictional Setup of Karnal District 49
Table 2 Average Rainfall (mm) in various blocks of Karnal District 51
Table 3 Area used by types of Land in Karnal District 59
Table 4 Land Use Pattern in Karnal District 60
Table 5 Total Length of Stream Orders in Meters 62
Table 6 Water Harvesting Activities in Rural and Urban Area 67
Table 7 Distribution of Tubewells According to Size of tube well 70
Table 8 Distribution of Tubewells According to Depth of tube well 70
Table 9 Number of Irrigation tube wells with water distribution System 70
Table 10 Blockwise Irrigated Area 71
Table 11 Types of Water Resources available for Surface Irrigation 71
Table 12 Ground Water Availability and Status of Block as CPCB Notification 72
Table 13 Block wise average water quality index value in Karnal District 74
Table 14 Blockwise status of Ground Water Quality 74
Table 15 Blockwise Ground Water Resource potential in the Karnal district as per GEC-97 77
Table 16 Number of Extraction Structures Blockwise 78
Table 17 Water Budget Block wise 80
Table 18 Methods of water table recharge strategies in urban area 81
Table 19 The proposed targets for plantation in Karnal District 82
Table 20 Blockwise distribution of Water Conservation and Recharge Structures 84
Table 21 Indicators and factors to decide the type of decentralized treatment required 87
Table 22 The numerous activities and interventions that can be carried out for IEC 45
Table 23 Block wise area under very good suitable site proposed for rain water harvesting 6
Table 24 Assigned Weight for Criteria Parameters 6
Table 25 Block wise proposed suitable sites based on multi-criteria 8
Table 26 Proposed harvesting structures in Karnal based on drainage 11

1. Introduction

1.1. History

The city of Karnal, said to have been founded by Raja Karna, of the Mahabharat fame, spring into prominence in 1739 when Nadir Shah defeated Muhammad Shah at Karnal. Raja Gopal Singh of Jind seized Karnal in 1863, and the Marhattas established themselves at Karnal in 1785. Skirmishes however, followed between the Marhattas and the Sikhs. In 1795 the Marhattas finally wrested it from Raja Bhag Singh of Jind and made it over to the George Thomas, who took part in the fight. Meanwhile Raja Gurdit Singh of Ladwa obtained possession of Karnal. It was captured by the British in 1805 and made over to Muhamdi Khan (Mandal). Karnal, on being formed into a British cantonment, the fort which had been built by Raja Gajpat singh of Jind, was taken over by the British and converted into a residence for Dost Mohd. Khan Amir of Kabul. The fort was used as a jail, as quarters for native cavalry and as poor house. In 1862, it was made over to the Education Department, when the district school was moved into it from the city.

1.2. Location

Karnal district is bounded by north latitudes $29^0$25'16" and $29^0$58'01" and east longitudes $76^0$22'59" and $77^0$09'22". It falls in parts of Survey of India Top sheets nos.53C and 53G covering an area of 2350 sq.km. Karnal district covers 5.69% area of the state. The district is bordered by the river Yamuna in the east, Panipat district in the south, Kaithal district in the west and Kurukshetra district in the north. The district is well connected by roads and railways. The Sher Shah Suri Marg (NH No.1) runs through the entire length of the district. Abroad gauge railway line connecting Delhi with Ambala runs almost parallel to the NH No.1. Karnal is the district headquarters. The main townships are Karnal, Indri, Assandh, Nissing, Nilokheri and Gharaunda. The towns are well connected by roads. The Location Map of District Karnal is shown in **Figure 1**.

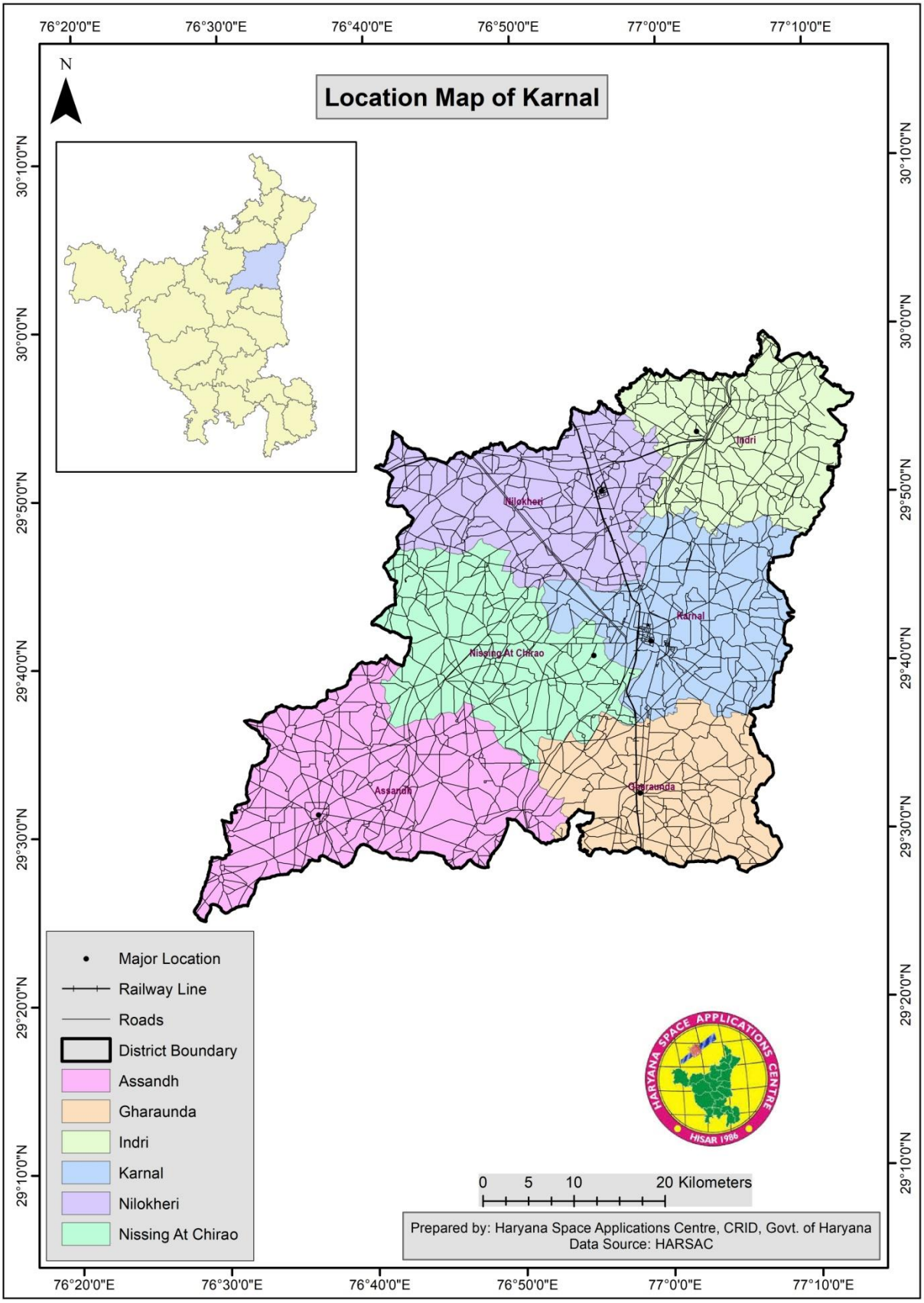


Figure 1 Location Map of Karnal District

1.3. Administrative setup

The administrative setup of the District of Karnal 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 Karnal District

Country	India
State	Haryana
Division	Karnal
Headquarters	Karnal
Tehsil	1. Karnal 2. Nilokheri, 3. Indri, 4. Gharaunda, 5. Assandh
Area	
Total	2,520 km^2 (970 sq mi)
Population (2011)	
Total	1,505,324
Density	600/km^2 (1,500/sq mi)
Urban	26.51%
Literacy	74.73%
Website	http://karnal.gov.in
Location of Karnal	East-Central region of Haryana
Coordinates	29° 41' 8.2644" N and 76° 59' 25.9692" E
Total Area	970 sq. mi
Elevation	787.40 ft above the sea level

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

Sub Divisions (4)	Karnal, Assandh, Indri and Gharaunda
Tehsils (5)	Karnal, Assandh, Indri, Nilokheri and Gharaunda
Blocks (8)	Karnal, Indri, Nilokheri, Nissing, Assandh, Gharaunda, Kunjpura and Munak
Municipal Corporation (1)	Municipal Corporation, Karnal
Municipal Committees (6)	Assandh, Gharaunda, Indri, Karnal, Nissing, Taraori
Population (Census 2011)	3,57,000

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

Total Villages	442
Total Panchayats	380
Village Level	Panchayat (3754)
Block Level	Panchyat Samiti (179)
District Level	Zila Parishad (25)

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

1.4. Climate

The climate of the district is characterized by the dryness of the air with an intensely hot summer and a cold winter. The year may be divided in to four seasons. The cold season starts by late November and extends to the middle of March. It is followed by hot season which continues to the end of June when the southwest monsoon arrives over the district. July to September is the southwest monsoon season. The post monsoon season period is from October to December.

1.4.1. Temperature

January is the coldest month with mean daily maximum temp. of 20.200C and mean daily minimum temp. of 7.0^0C. May is the hottest month with mean daily maximum temp. of 39.70^0C. In May and June, the maximum temp, sometimes reaches about 47^0C.

1.4.2. Humidity

The air is dry during the greater part of the year. In the monsoon months, June-Sept, humidity is high which is on an average at about 60%. April and May are usually the driest months, where in the afternoons the humidity is less than 20%. On the average, humidity ranges from 19.0% in May to 71% in August in the mornings and ranges from 45% in April to 85% in January in the evenings.

1.4.3. Wind Velocity

Winds are generally light during the post-monsoon and winter months. They strengthen a little during the summer and monsoon months. Winds are predominantly easterly and southeasterly in the monsoon months. April to June is the period with highest incidence of thunderstorms. Rain during the monsoon months is often accompanied with thunder. Thunderstorms also occur in the winter months in association with western disturbances.

1.4.4. Rainfall

The normal annual rainfall of the district, based on the record for the period 1978-2005 is 695.80mm recorded in 33.20 rainy days in a year. About 82.39% of the annual rainfall is recorded during the southwest monsoon from June-September. August is the wettest month of the year with an average of 8.4 rainy days and 213.90mm rainfall. Maximum rainfall of 1404 mm and minimum rainfall of 255mm were observed in the years 1998 and 1987 respectively. The satellite derived average annual rainfall map (showing average annual rainfall from 2010 to 2020) of Karnal district is shown in **Figure 2.** Average rainfall range lies between 767.22 mm to 1310.74 mm. Average rainfall in various blocks of district Karnal from 2010 to 2019 is as follow:

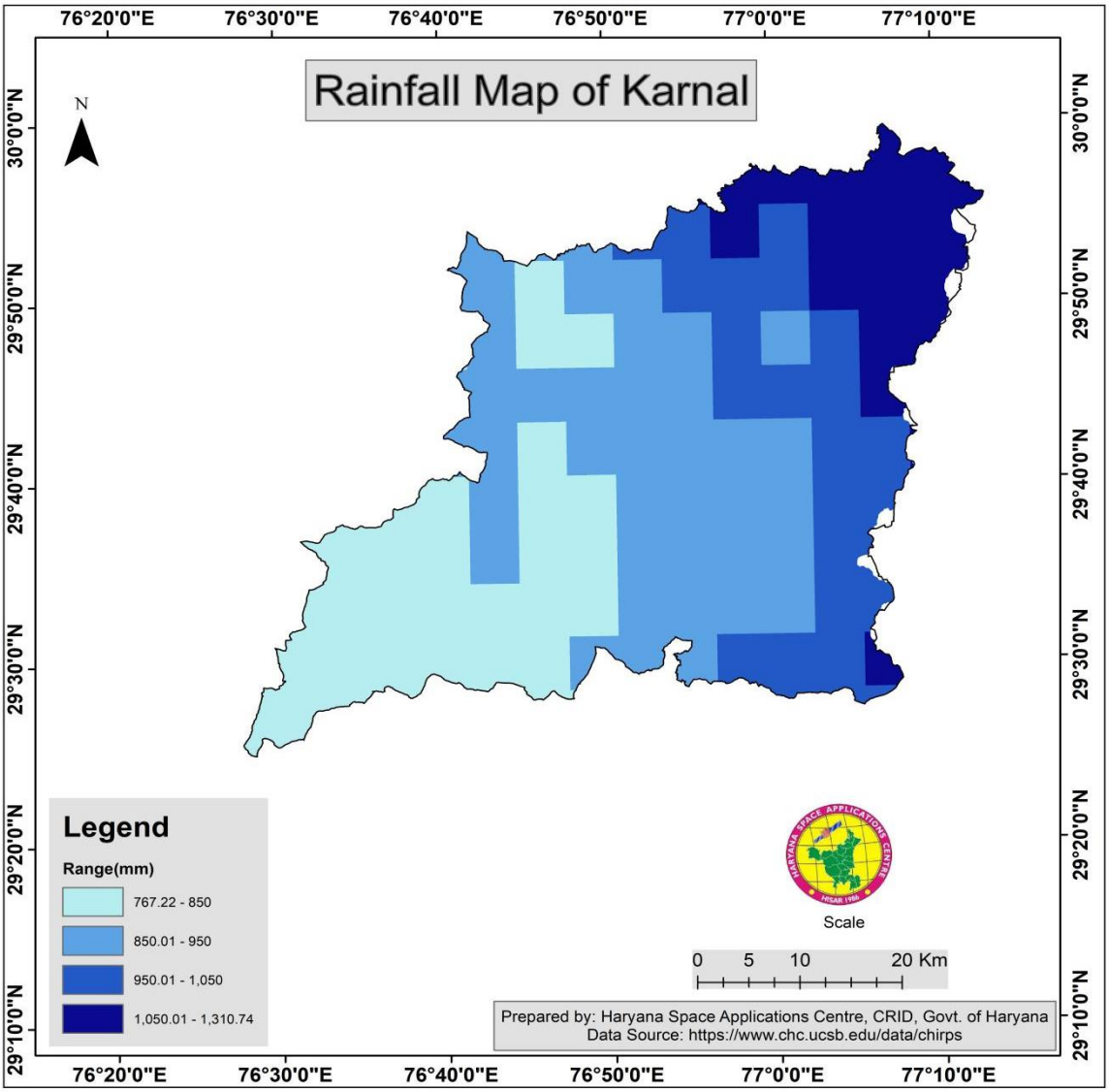


Figure 2 Rainfall Map of Karnal District

Table 2 Average Rainfall (mm) in various blocks of Karnal District

Sr.No.	Block	Average Rainfall from 2010 to 2019
1	Karnal	650 mm
2	Indri	641 mm
3	Nilokheri	588.89 mm
4	Gharaunda	472.95 mm
5	Assandh	521.75 mm

1.5. Elevation and Topography

The district is a plain area, which slopes from northeast to southwest. The height above mean sea level of the district as shown by Digital Elevation Model ranges from 0 to 225 m (**Figure 3**). The Plain is a flat and within it, there is a narrow low lying flood plain area known as khadar of the Yamuna River. Topographically, the district can be sub-divided into three parts viz. Karnal Plain; Karnal Bhangar and Yamuna Khadar. Karnal Plain extends over western part of the district. The area is a level land having a gentle slope towards southwest as shown in **Figure 4**. Karnal Bhangar covers the major portion of the district lying between Karnal Plain and Yamuna Khadar covering the district in north-south direction. Yamuna Khadar extends over eastern parts of the district along the Yamuna River. Its slope is towards south in which direction the Yamuna River flows. The floodplain is low-lying and slightly undulating in topography. Contours of 5 meters interval showed similar topography as in digital elevation model (**Figure 5**).

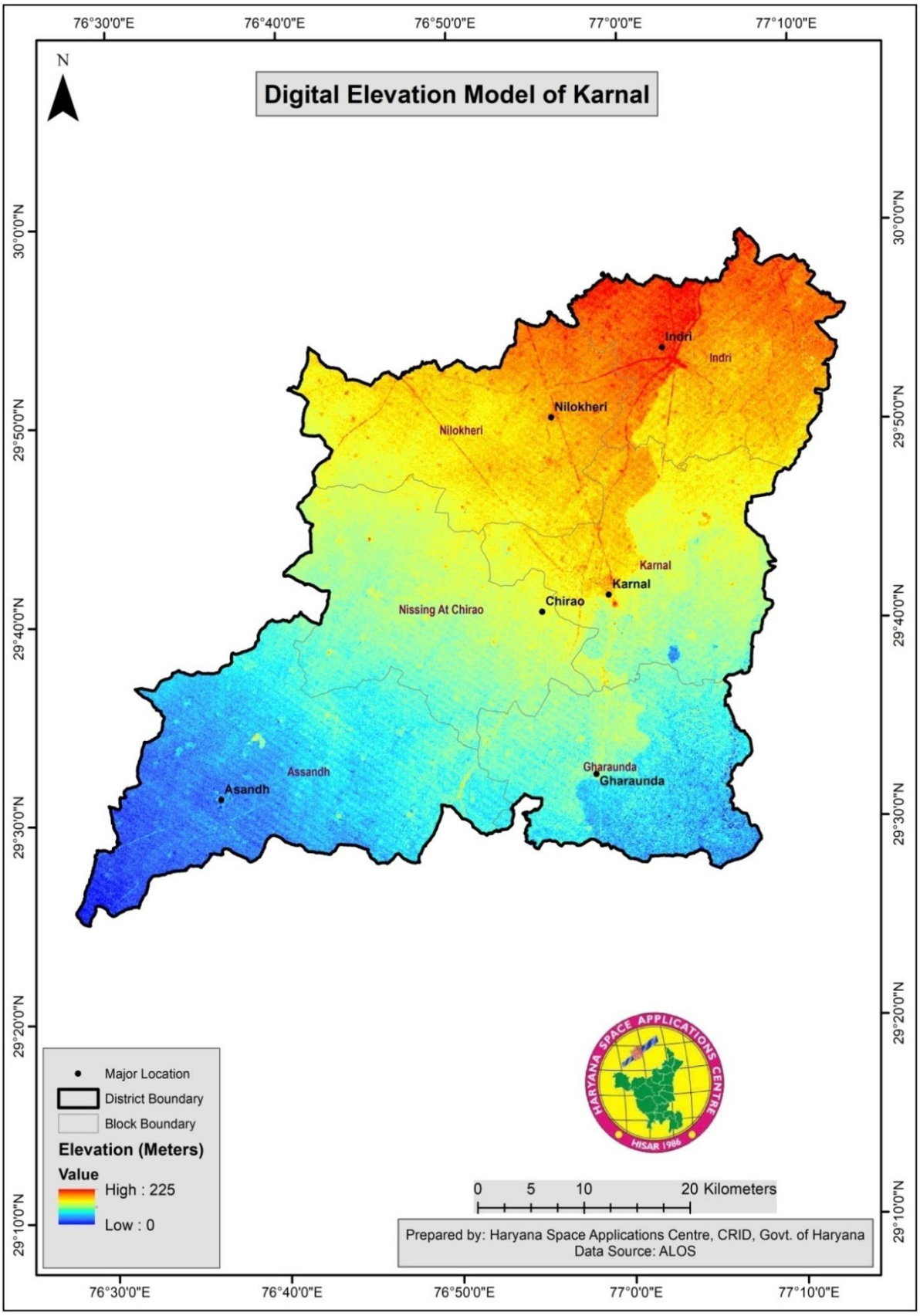


Figure 3 Digital Elevation Model of Karnal District

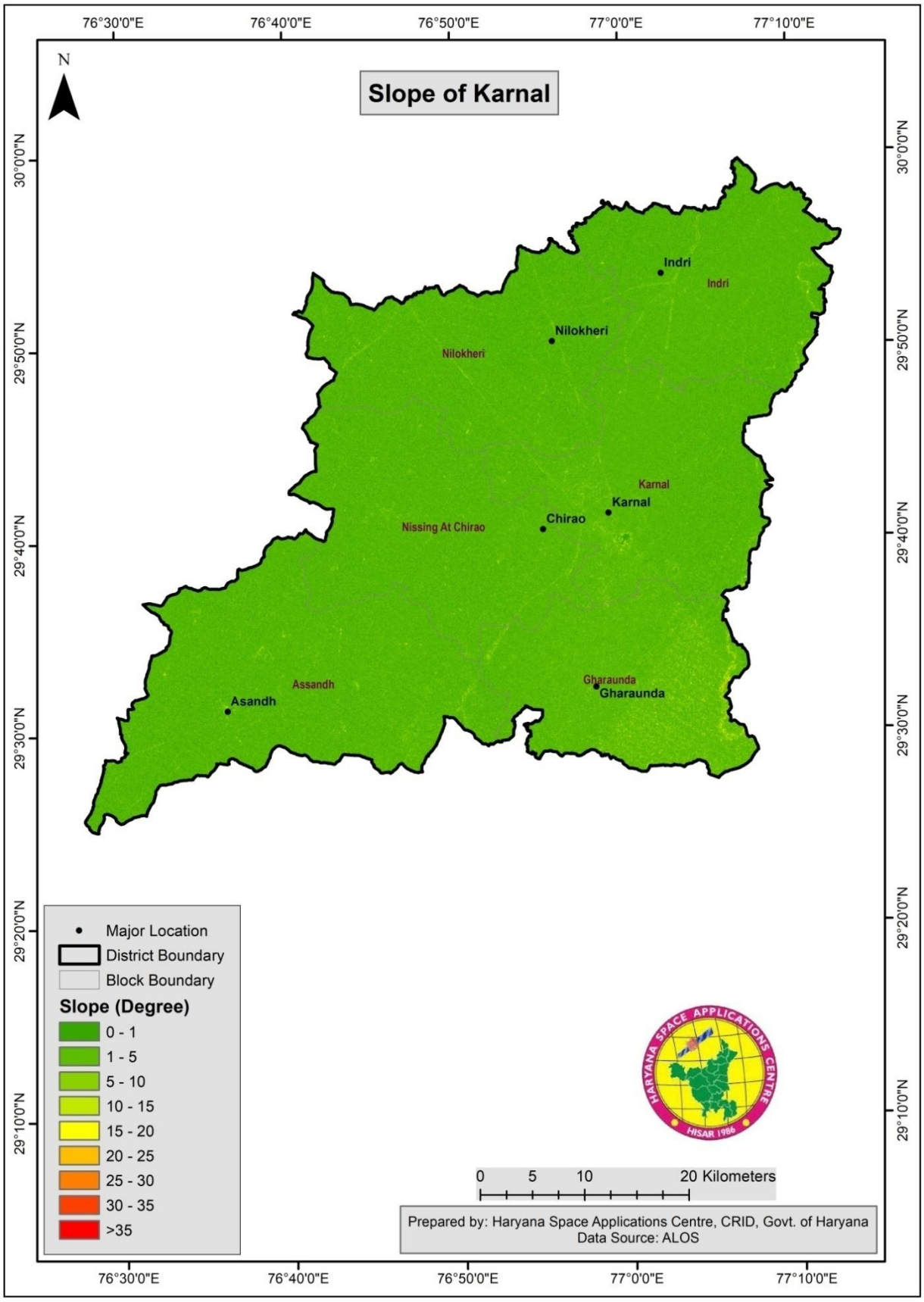


Figure 4 Slope Map of Karnal District

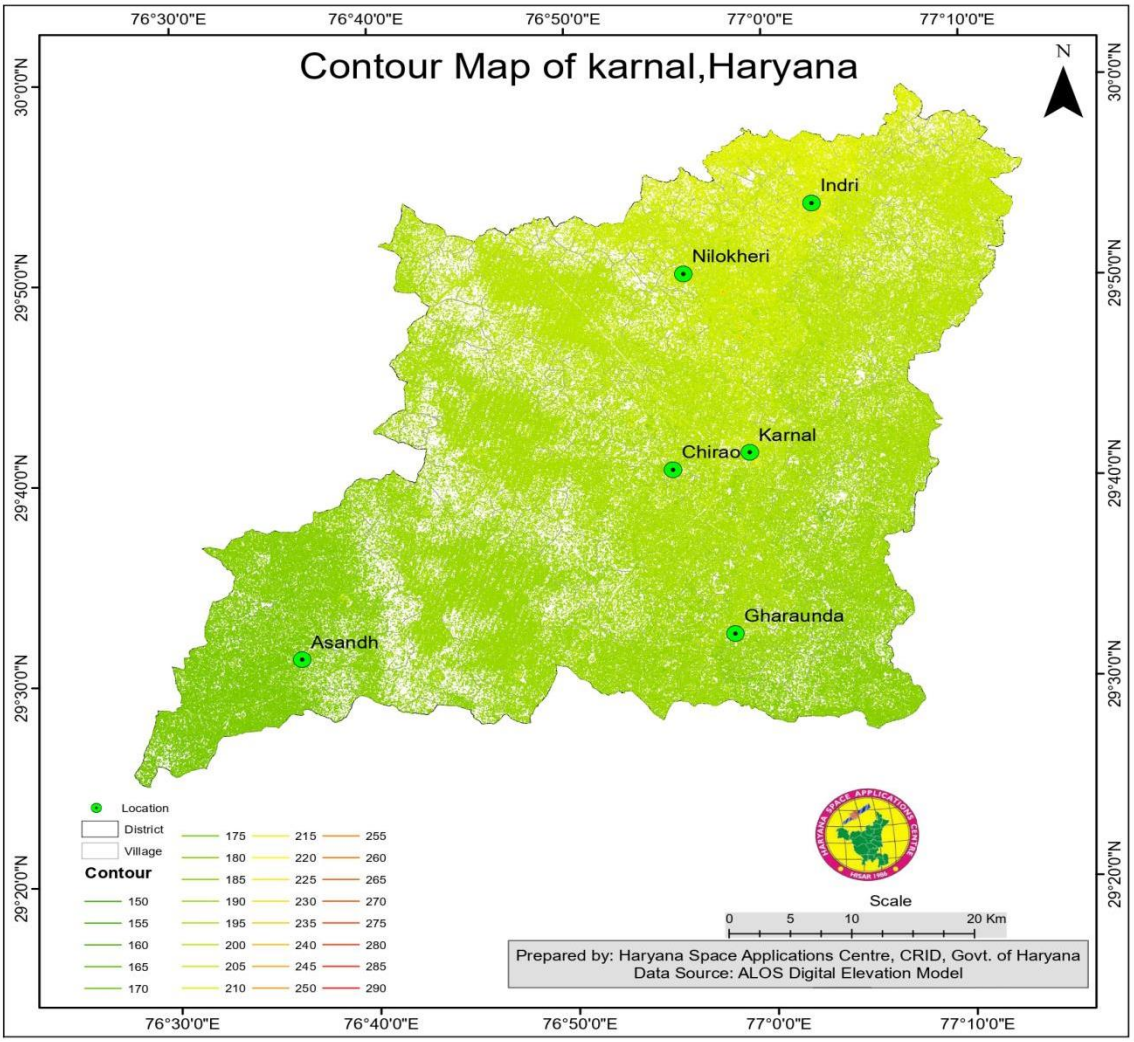


Figure 5 Contour Map of Karnal District

1.6. Geology and Lithology

The area constitutes almost alluvial plain without any conspicuous topographical features and forms a part of the vast Indo-Gangetic plain (**Figure 6**). The elevation of the area above mean sea level ranges from 256 m Above Mean Sea Level (asml) in the north to 245 m asml in the south with an average elevation of 240m amsl. The general slope of the area is southwards. In the north western part of the district the land slopes south west wards. There are many topographical depressions in the area of which the most pronounced is at Daha, south of Kamal.

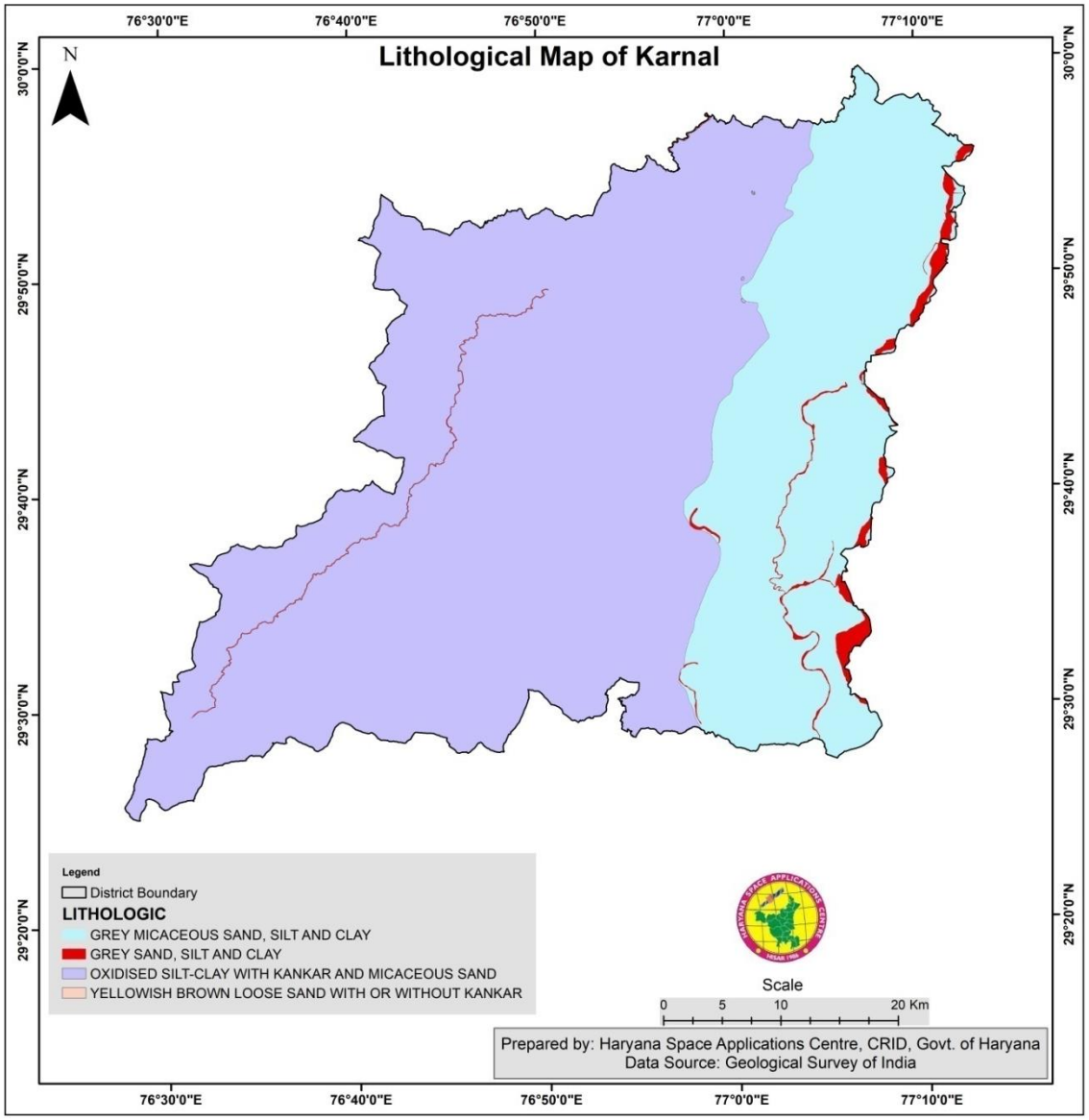


Figure 6 Lithological Map of Karnal District

1.7. Soil Profile

The soils in Gharaunda and half of Karnal blocks are young, stratified with no profile development. They are sandy to fine sandy loams (**Figure 7**). The soils in half of Nilokheri, Saw extremity of Karnal block touching Nilokheri, eastern portion of Nissing, Western half of Gharaunda block are heavily textured varying from sandy loam at the surface to clayey loam at about one meter depth. The soils of central part of Nilokheri and major portion of Nissing and Assandh blocks are mostly sandy loam to fine sandy loam.

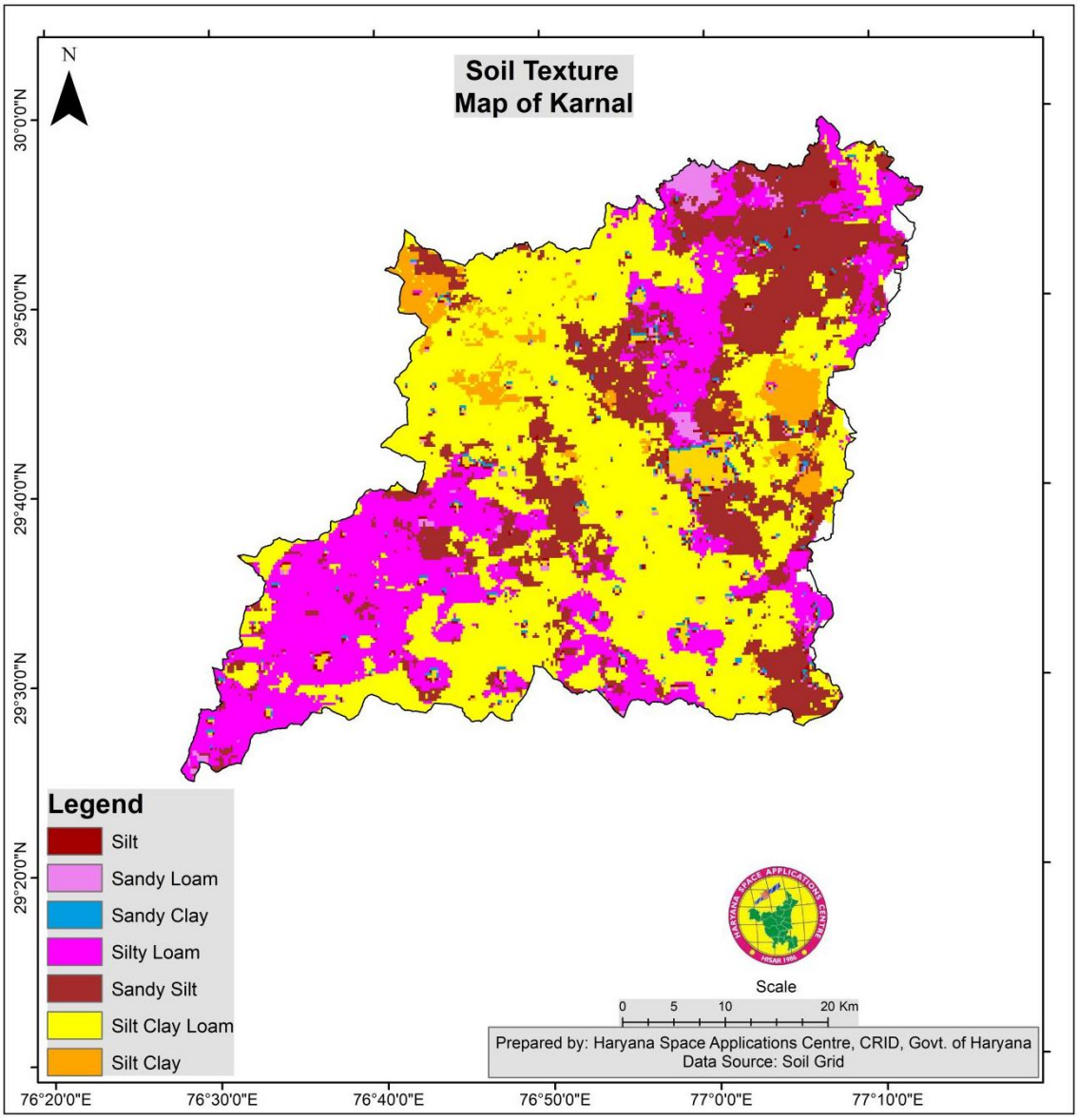


Figure 7 Soil Texture Map of Karnal District

1.8. Land use

In the year 2010-11, against a geographical area of 2520.00* sq.kms (includes 68.95 sq.kms. of urban area); the area of the district according to village papers supplied by the revenue authorities is 2,392.95 sq. Kms (rural area only). This shows difference in two sets of areas arrived at by different methods of measurement adopted by two separate agencies. However, we will discuss here land use as per village records. Of the total area of 239,295 hectares, 312 hectares under forest: 207,817 hectares is net sown area; 1,275 hectares is culturable waste (including gauchar and groves) and 314 hectares of area is not available for cultivation to which we may call barren and unculturable land. Net area sown in the district is 86.85 per cent of total area. The land use land cover map of Karnal District is shown in **Figure 8**.

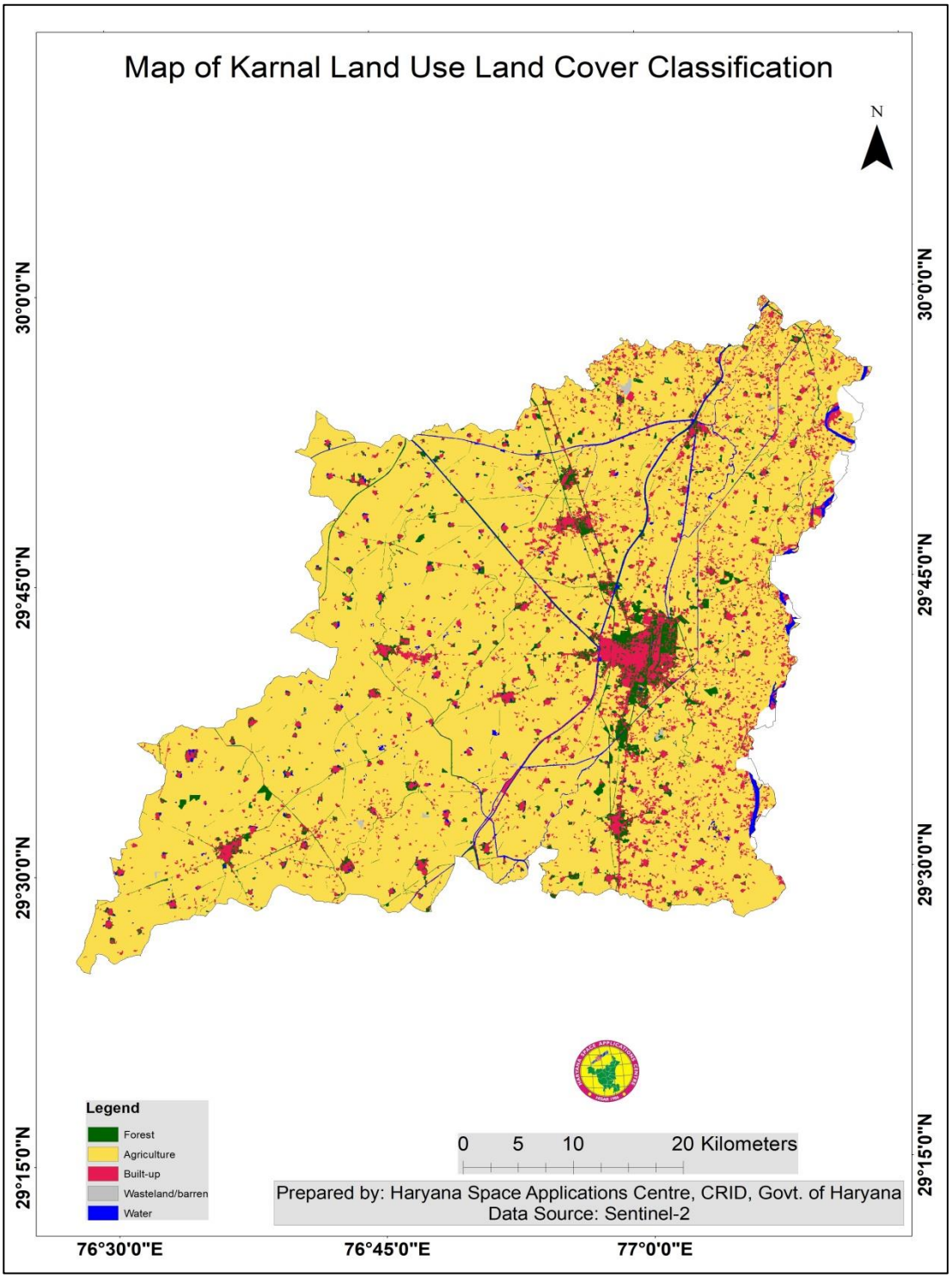


Figure 8 Landuse and Landcover of Karnal District

Karnal tehsil has an area of 831.86 sq.kms whereas Assandh, Nilokheri, Indri and Gharaunda tahsils possess 555.44 sq.kms 388.39 sq.kms 341.48 sq.kms and 275.78 sq.kms of area respectively.

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** and land use pattern of Karnal district, Haryana in **Table 4.**

Table 3 Area used by types of Land in Karnal District

Sr.No.	Type of Land use	Area (thousand hectares)
1.	Total area	246
2.	Forest	1
3.	Land put to non-agricultural use	23
4.	Barren and unculturable land	13
5.	Permanent pastures and other grazing lands	8
6.	Land under misc. tree crops and grooves not included in net area sown	1
7.	Current fallows	10
8.	Net area sown	190
9.	Culturable area	209
10.	Area sown more than once	190
11.	Total cropped area	380

Table 4 Land Use Pattern in Karnal District

Block	Total Area (Ha)	Total Cultivable Area (Ha)	Cropped Area (Ha)
Karnal	40434	34251	62946
Gharaunda	40725	35438	58128
Assandh	50390	45404	79843
Nissing	40731	36371	68742
Nilokheri	39887	36625	68062
Indri	33978	28769	52507
Total	**246145**	**216858**	**390228**

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 Karnal. Western part of the district the ground water is saline to marginally saline.

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 northern part of 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 Karnal district total 1582 ponds/waterbodies found on satellite data. The map of total ponds/waterbodies that include ponds, canals are shown in **Figure 9.**

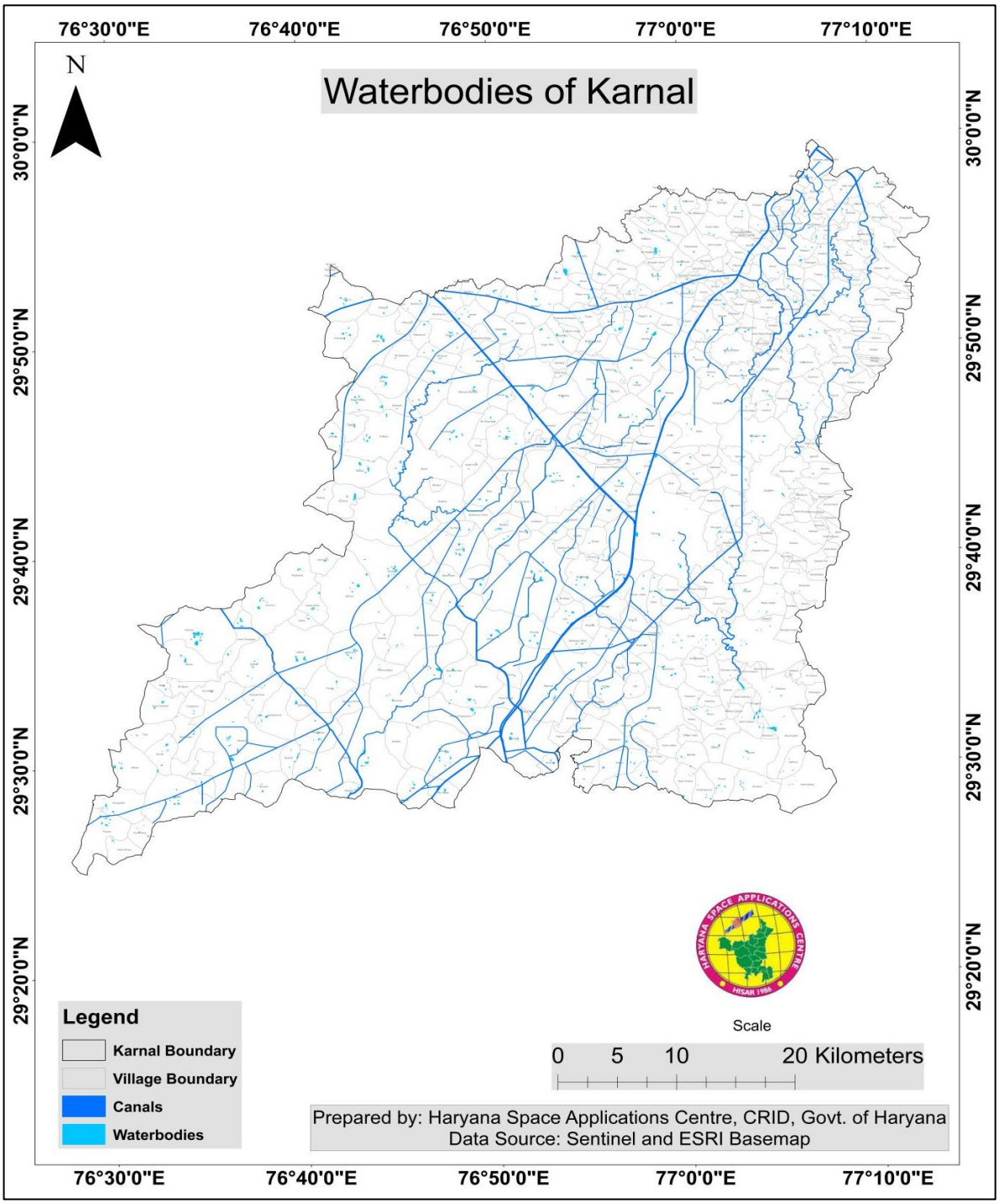


Figure 9 Waterbodies of Karnal District

2.1.3. 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 drainage map of Karnal District is shown in **Figure 10.** The statistics of length of drainages under each order are shown in **Table 5**.

Table 5 Total Length of Stream Orders in Meters

Stream Order	Length in meters
1	11527
2	5780
3	2835
4	1963
5	803
6	570

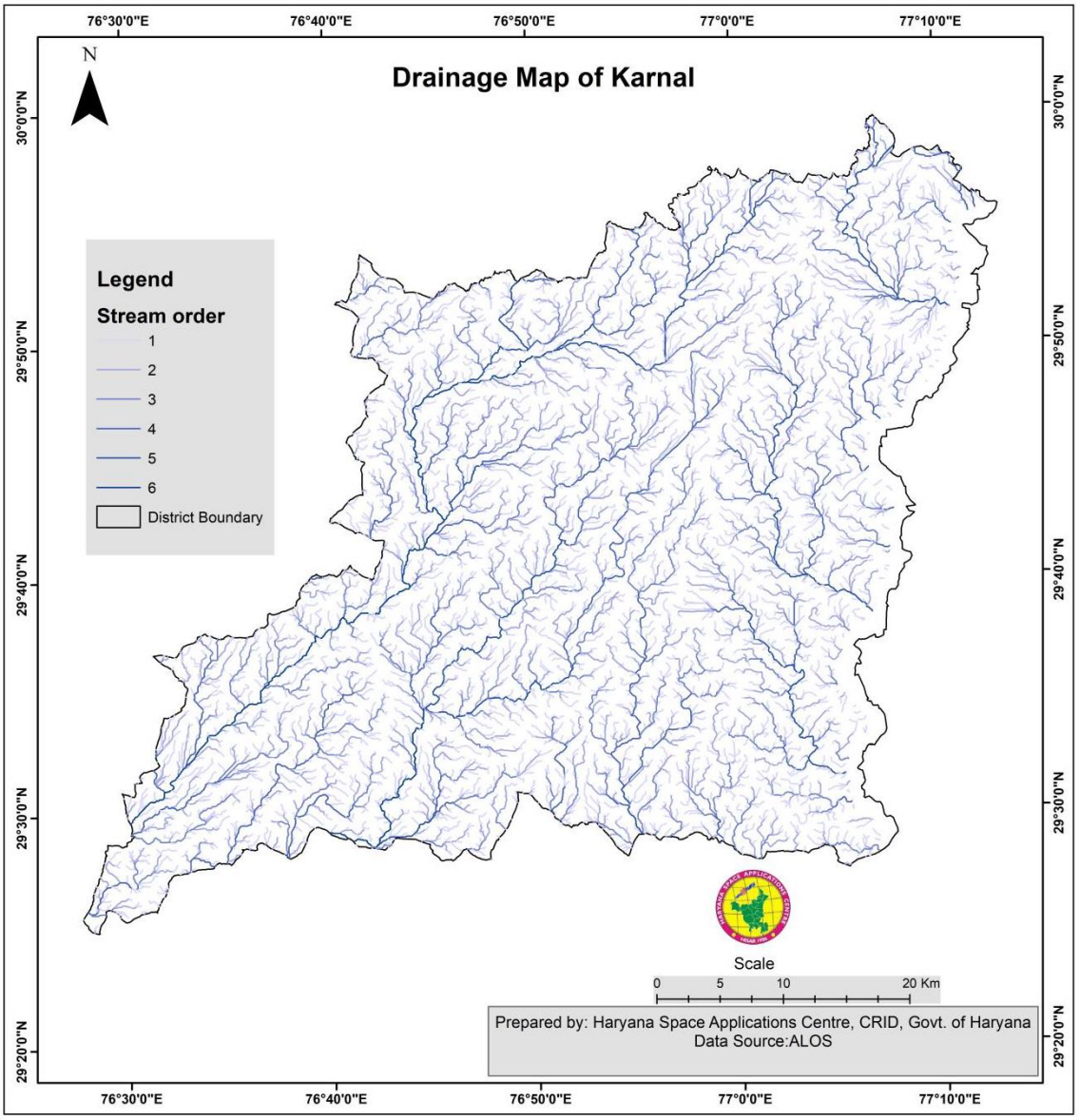


Figure 10(a) Drainage Map of Karnal District

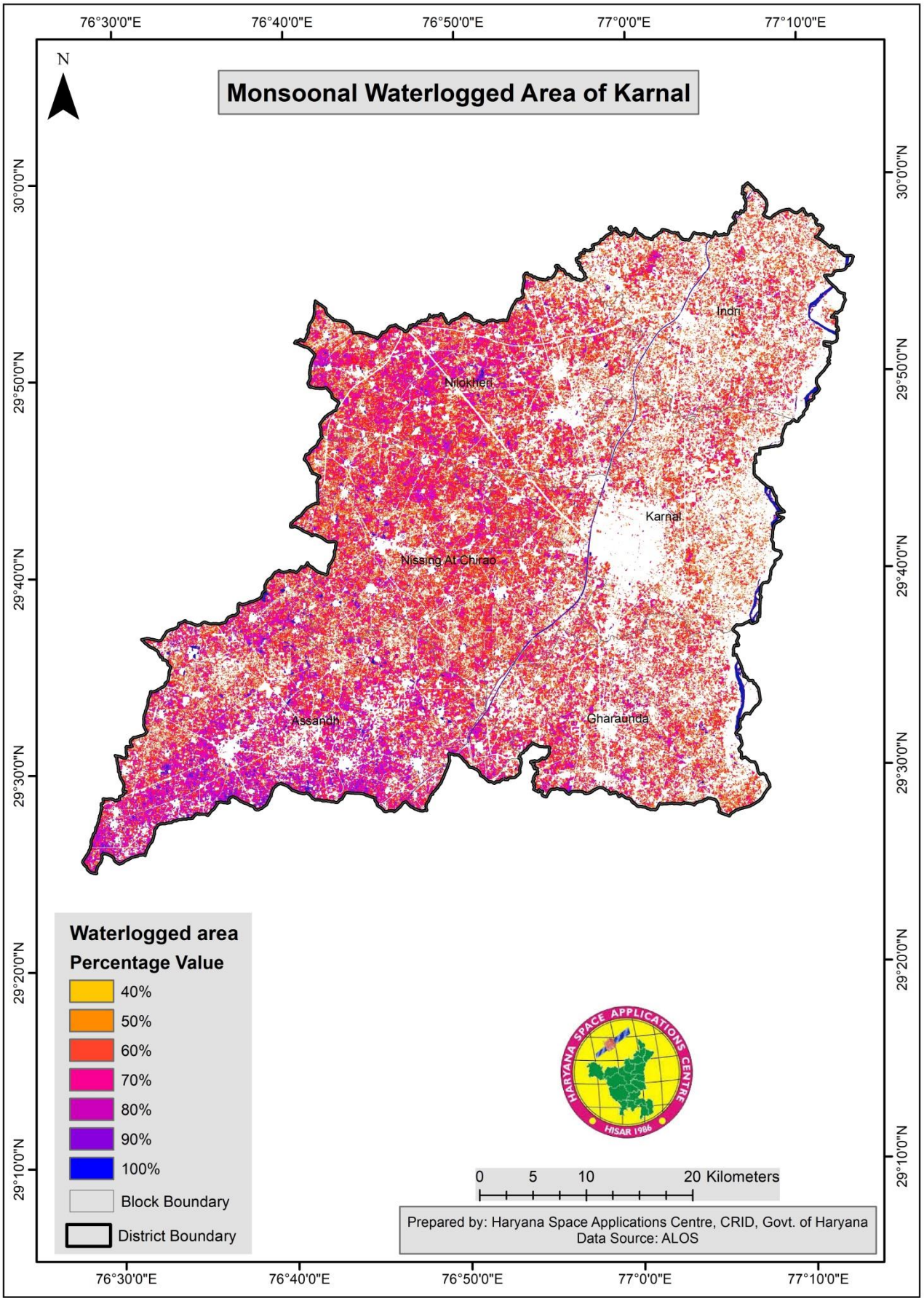


Figure 11 (b) Monsoonal Waterlogged Area Map of Karnal District

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 demand. People in the cities becomes 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. 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 dryland, hilly, urban and coastal areas.

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 Karnal District for rain water harvesting is shown in **Table 6** at rural and urban area. The map of water conservation activity in Karnal at rural and urban level is shown in **Figure 11**.

Water harvesting profile of Karnal district is shown as followed in **Figure 11**:

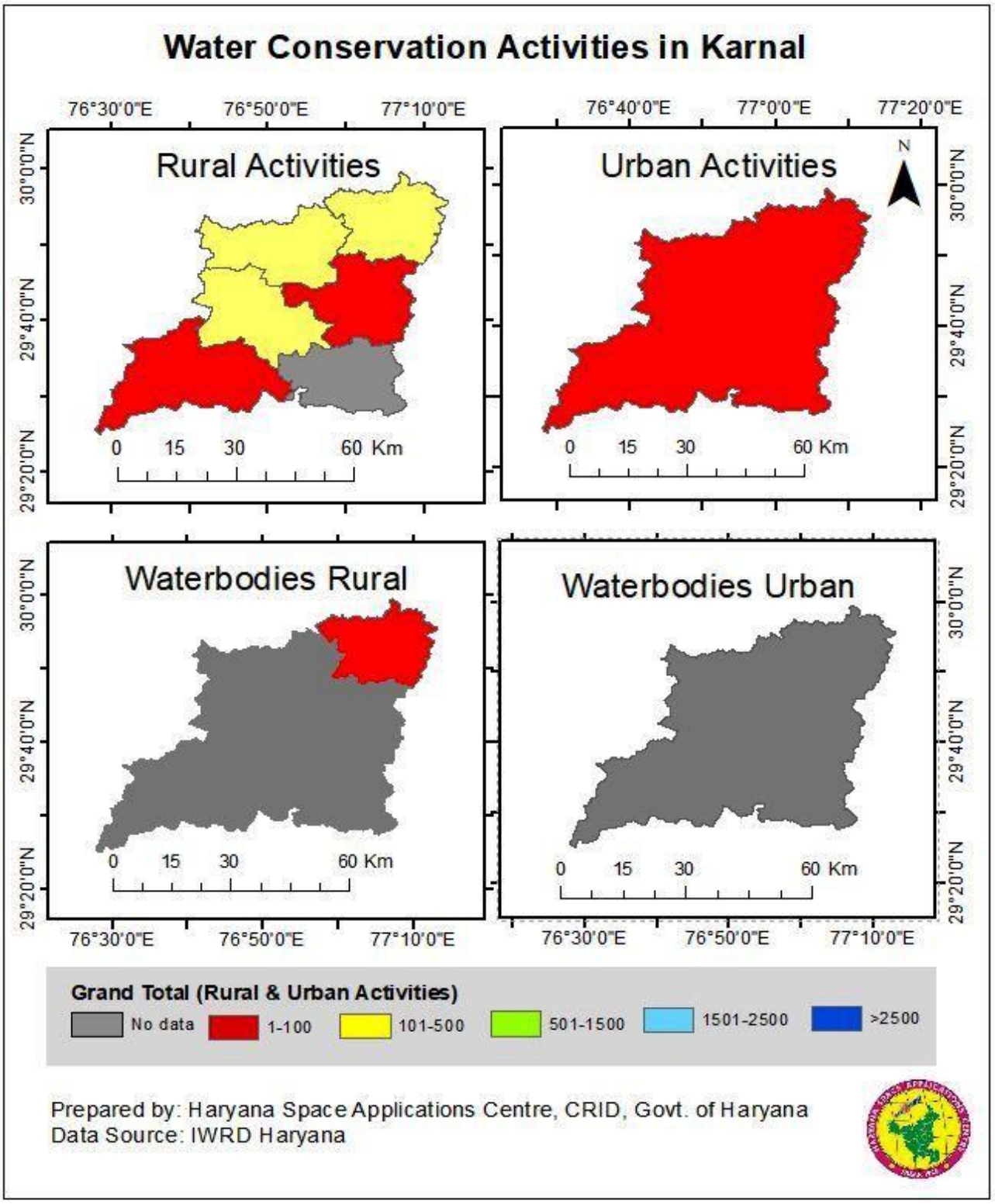


Figure 12 Water Conservation Activity in Karnal District

Table 6 Water Harvesting Activities in Rural and Urban Area

In Rural Area		
Sr. No	**Block Name**	**Total No of Activity (no.)**
1	Assandh	50
2	Karnal	72
3	Indri	199
4	Nilokheri	107
5	Gharaunda	0
6	Nissing	111
In Urban Area		
1	Karnal	92

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 No 12**. In Karnal District a total of 8 treatment plant are installed having total capacity of approx. 70-80 MLD. In Karnal District there is one major biomedical waste management site at the border of Karnal and Nissing Block.

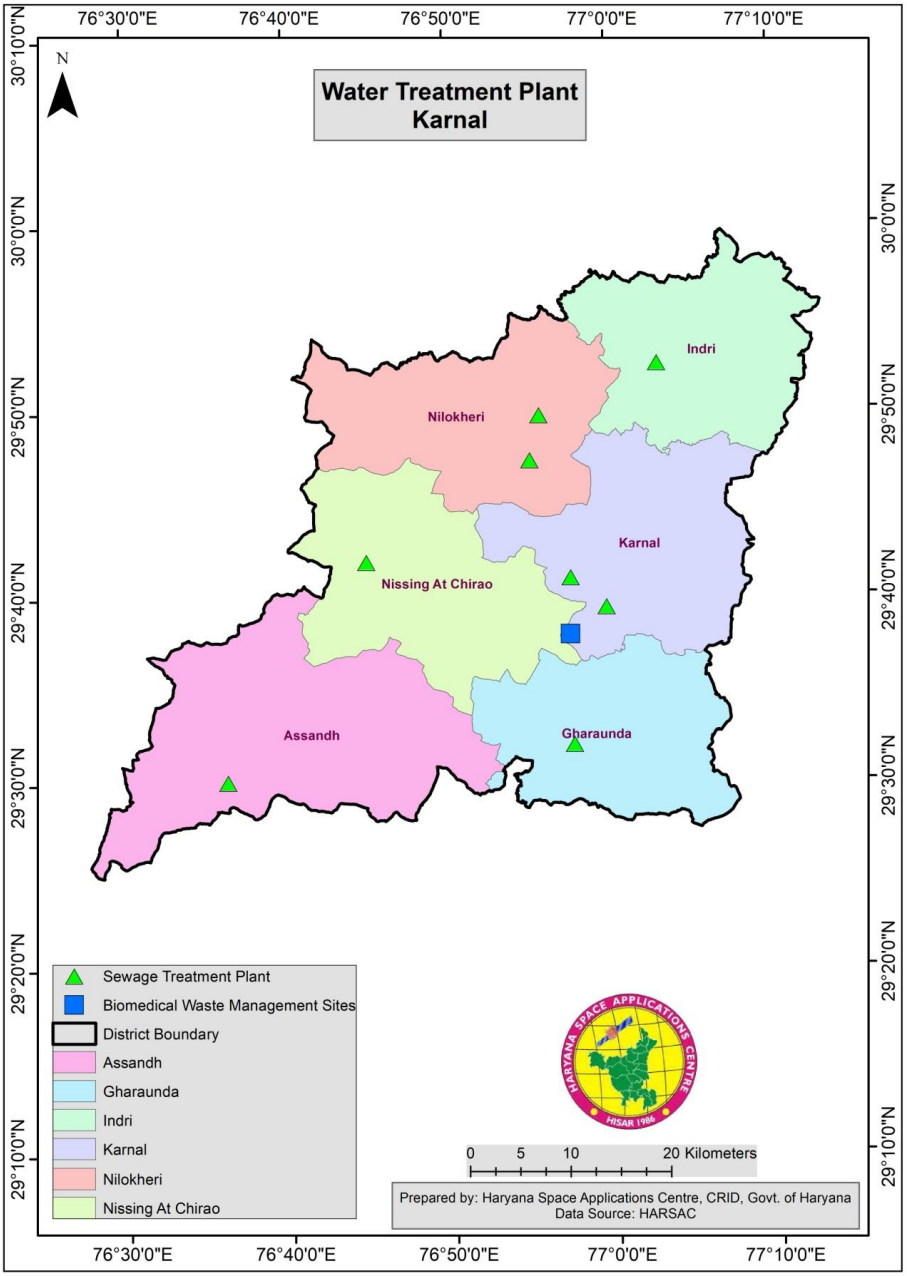


Figure 13 Water Treatment Plant of Karnal District

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.

Ground water irrigation scenario

As per the data available from minor irrigation census 2006-07 the detailed number of shallow, deep, tubewells, lined, unlined water distribution system, land holdings of wells are given below in **Table 7** for reference, Total Distribution of Tubewells According to Owner's Holding Size. The distributions of tubewells according to depth of tube well and number of irrigation tube wells with water distribution system are given in **Table 8** and **Table 9** respectively.

Table 7 Distribution of Tubewells According to Size of tube well

Sr.No.	District	Marginal (0-1 ha)	Small (1-2 ha)	Semi-Medium (2-4 ha)	Medium (4-10 ha)	Public	Group of Farmers	Total
1	Karnal	66	743	5903	5805	930	32975	46422

Table 8 Distribution of Tubewells According to Depth of tube well

No. by the depth of Tube well						
Sr.No.	**District**	**40-60 mts**	**60-70 mts**	**70-90 mts**	**90-110**	**Total**
1	Karnal		37018	4137	4290	46422

Table 9 Number of Irrigation tube wells with water distribution System

Ground Water Schemes according to water Distribution System				
	Open Water Channel			
Sr.No.	**District**	**Lined / Pucca**	**Unlined / Katcha**	**Total**
1	Karnal	41320	5102	46422

The Gross irrigated area of Karnal District is 359855 Hectare which is 100% of the Gross Cropped Area of the District is given in **Table 10**.

Table 10 Blockwise Irrigated Area

Block	Total Irrigated Area	Gross Irrigated Area (Canal)	Partially Irrigated / Protective Irrigation	Unirrigated
Assandh		88281	0	--
Gharaunda		42943	0	--
Indri		46714	0	--
Karnal		122020	0	--
Nilokheri		59817	0	--
Total		**359855**	0	--

4. Water Availability

4.1. Surface Water Availability

River Yamuna is the only river flowing along the entire eastern boundary of Karnal district. Total length of river Yamuna in the district is 70 Km. District is equipped with good drainage system in the shape of Nai Nallah drain, Nissing drain, Phurlak drain, Barota drains and Assandh drain which is sufficient to discharge excessive rain/flood water in the area. However, there are some low line areas where excessive rain water accumulates and creates flood like situation. Nissing and Assandh fall in this category. The types of water resources available for Surface Irrigation are given in **Table 11**.

Table 11 Types of Water Resources available for Surface Irrigation

SI.	Source		Kharif		Rabi		Total
I.	**Surface Irrigation**						
(i)	Canal, Major & Medium Irrigation	32536	219.87	30910	29.75	63446	249.62
(ii)	Minor Irrigation Tank (FIS)						
(iii)	Lift Irrigation/ Diversion						
(iv)	Various Water Bodies including						

	RWH						
(v)	Treated Effluent received from STP						35.59
(vi)	Un treated Effluent						
(vii)	Perennial sources of water						
II.	**Ground Water**						
(i)	Open well						
(ii)	Deep Tubewell						
(iii)	Medium Tubewell						
(iv)	Shallow Tubewell	NA	178.47	NA	218.13	NA	396.6

Source: YWS Circle, Irrigation Department, Karnal

It is evident from the above table that there are two major sources of irrigation in the district. Canal irrigation is available throughout the district and it is available during Kharif and Rabi season. In case of ground water irrigation, shallow tube wells are used mostly. The other source of water in the district is Treated Effluent received from STP which is under Public Health Department.

4.2. Ground Water Availability

Karnal falls in the Upper Yamuna Basin and the principal ground water reservoir in the area is unconsolidated alluvial deposits of Quaternary age. Ground water in near surface zone occurs under water table conditions and occurs under semi confined to confined conditions in deeper aquifers. Rainfall and seepage from the river Yamuna, canal networks and irrigation is the principal source of ground water recharge in the area and the block wise status of ground water availability as per CPCB notification is given in **Table 12.**

Table 12 Ground Water Availability and Status of Block as CPCB Notification

Block	**Status of Block as per Central Ground Water Board Notification**			**Ground Water (MCM)**		
	Critical	Semi Critical	Safe	Draft	Recharge	Gap
Assandh	□	-	-	216.92	116.33	100.59
Gharaunda	□	-	-	157.43	124.21	33.22

Indri	□	-	-	217.78	202.59	15.19
Karnal	□	-	-	211.46	178.35	33.11
Nilokheri	□	-	-	172.60	125.36	47.24
Nissing	□	-	-	242.72	155.59	87.13
Total				**1218.91**	**902.43**	**316.48**

Source: Ground Water Cell, Karnal

The following map (**Figure 13**) depicts the ground water depth in Karnal district.

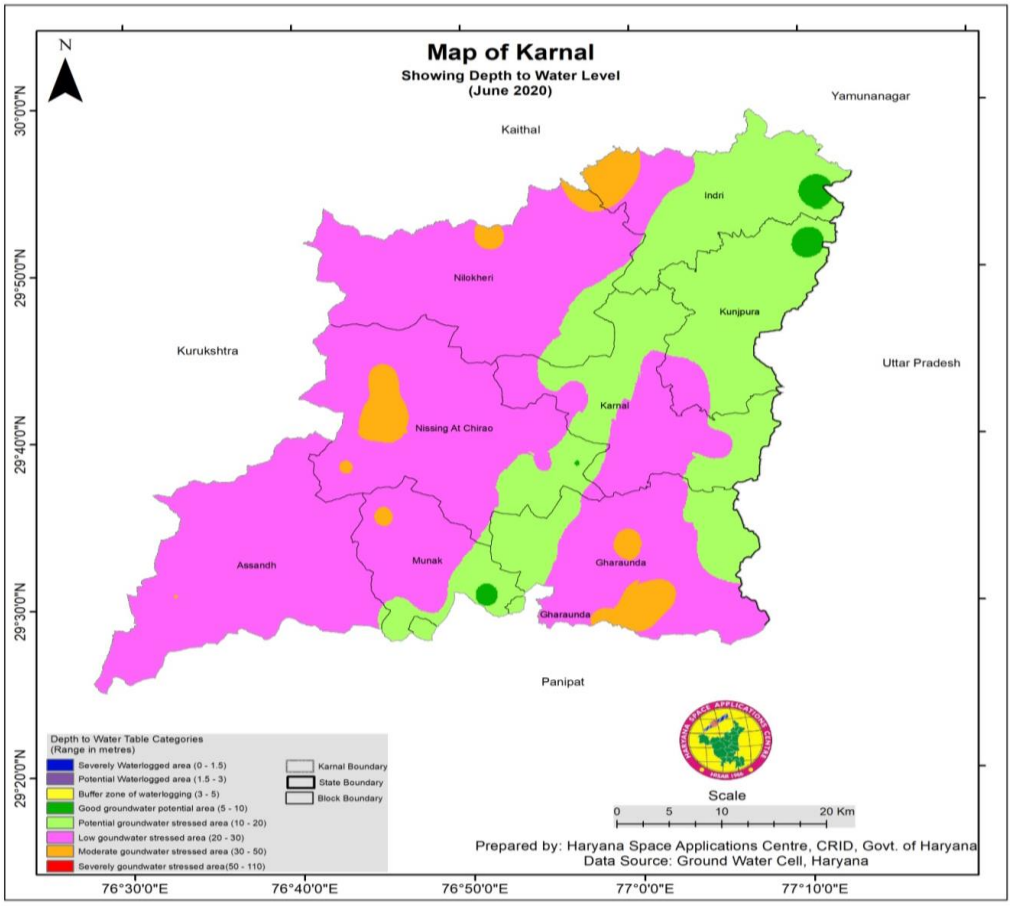


Figure 14 Ground Water Availability Map of Karnal District

4.3. 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 Karnal district's water quality vary from good to poor. The block wise average water quality index value and status of Ground water quality of Karnal District is given in **Table 13** and **Table 14** respectively. Whereas **Figure 14** shows the Water quality Index of Karnal District.

Table 13 Block wise average water quality index value in Karnal District

Block Name	Average Water Quality Index Value
Nissing	70.96
Nilokheri	57.23
Karnal	48.53
Indri	45.16
Gharaunda	57.15
Assandh	117.77

Table 14 Blockwise status of Ground Water Quality

Block	Ground Water Quality	Remarks
Assandh	Fresh Except 04 Nos. Villages	Villages Gangatehri, Popra, Jhimrikhera, Kaul Khera are identified as sub marginal in Ground Water Quality.
Gharaunda	Fresh / Potable	
Indri	Fresh / Potable	
Karnal	Fresh / Potable	
Nilokheri	Fresh / Potable	
Nissing	Fresh / Potable	

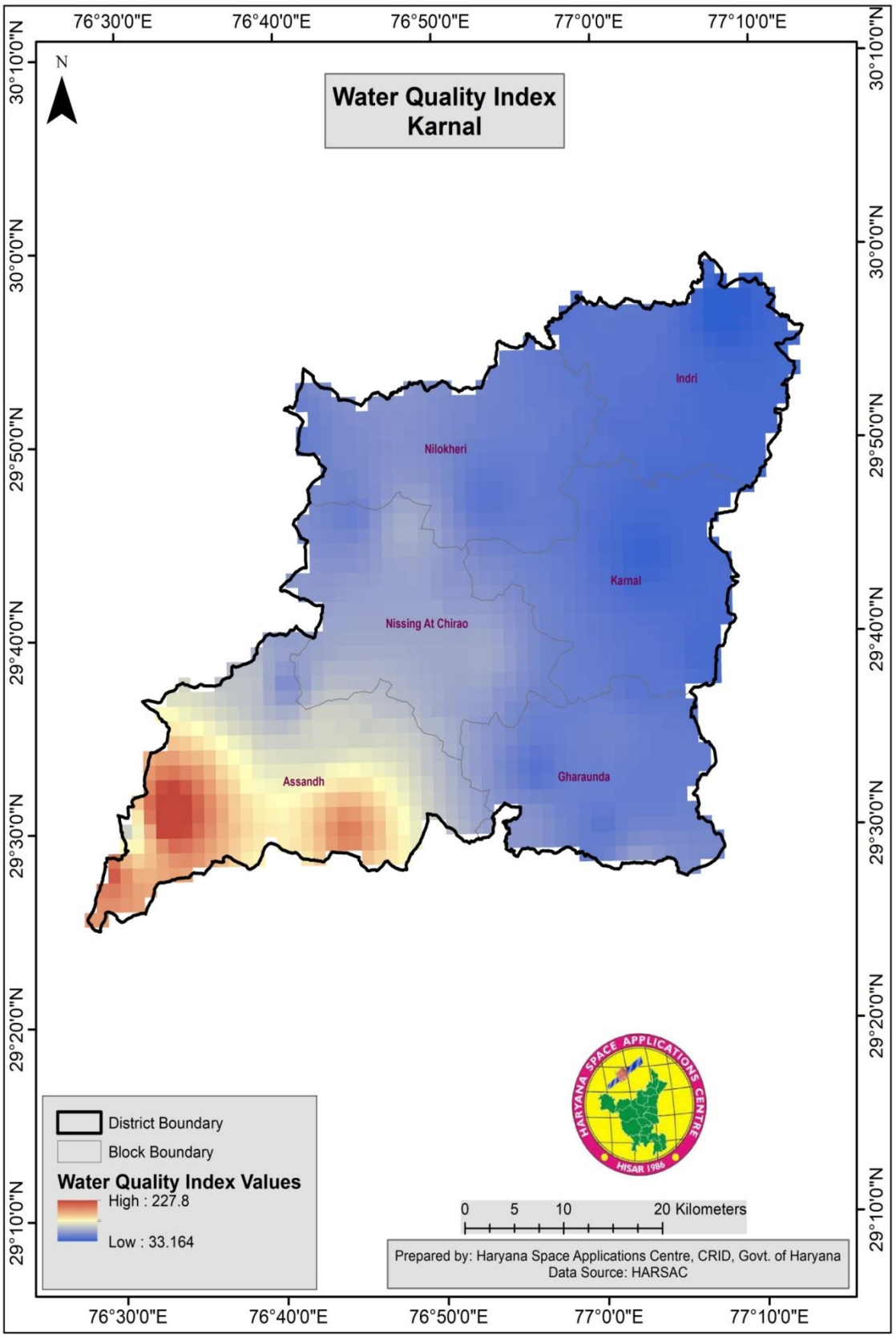


Figure 15 Water Quality Index of Karnal District

5. Aquifer System

The area falls in the Upper Yamuna Basin and the principal ground water reservoir in the area is unconsolidated alluvial deposits of Quaternary age. Ground water in near surface zone occurs under water table conditions and occurs under semi confined to confined conditions in deeper aquifers. Rain fall and seepage from the river Yamuna, canal networks and irrigation is the principal source of ground water recharge in the area.

The study of exploratory boreholes drilled in the district during the Upper Yamuna Project of Central Ground Water Board indicated presence of three tier aquifer groups up to 463 m depth below ground level.

Aquifer Group-I: The Aquifer group I is composed of different sand and clay lenses and extends from surface downwards to different depth varying down to 90m to 180m at different places and occurs all over the area. This is composed of relatively coarser sediments. This group of aquifers is underlain by a clayey horizon 10-15m thick which is regionally extensive. The average transmission of this group was calculated by the Upper Yamuna Project of CGWB to be of the order of 2200 m^2/day, lateral permeability of the order of 24m/day and average storage as 0.12.

Aquifer Group-II: This group is composed of different sand and clay lenses and lies below aquifer group-I and occurs at varying depths ranging between 115m and 195 m to 215m and 285m. The sediments of this group are less coarse and are mixed with some kankar. This group is underlain by another clayey horizon, which is considerable thick at places and appears to be regionally extensive. The average transmission of this group is 700m^2/day, the average lateral permeability is 7.2m/day and the average storage is $1x10^{-3}$.

Aquifer Group-III: The aquifer group III is composed of thin sand layers alternating with thicker clay layers and occurs at variable depths ranging between 314 m to 405m.bgl. The granular material of this group is generally finer and more so in the southerly direction. This group has an average transmission value of 525m^2/day, and average lateral permeability and average storage values of the order of 7.1m/day and $4.5x10^{-4}$ respectively.

At shallow depths the aquifer is under unconfined conditions whereas at deeper levels these are under semi confined or confined conditions. Under exploratory drilling programme Central Ground Water Board has constructed 9 deep tubewells in the district. The depths of these tubewells are in the ranges of 202m to 316m. The discharge of these well ranges from 825 to 4542 lpm for draw down varying from 4 - 20m. Depth to water level in the district ranges between 4.18 m to 21.16 m bgl in the pre monsoon period.

The depth to water level is deeper in the north-western parts and east central parts and shallow in north eastern parts and central and south-western parts. In the post monsoon period, the depth to water level

ranges between 2.68 m to 22.22 m bgl. The seasonal fluctuation in water table varies in between –2.09m to 2.73m. During the last 10 years (2002 -2011) the rate of decline of ground water is in the range of 0.02m/yr to 1.31 m/yr.

The water table elevation in the district varies between 254.14m and 213.32m above mean sea level. The elevation is higher in northern part in Indri block and gradually decreases towards south in Assandh and Gharaunda blocks. In general, the ground water flow direction is from north-east to south-west. At certain parts there is a change the direction of flow. In western parts of Assandh block the ground water flow is from east to west. The gradient of water table elevation is steeped in northern parts and gentle in southern parts. It varies from 4.27 m/km in the north to 0.47m/km in the south

6. Water Requirement/ Demand

6.1. Water Supply and Gap

Ground Water Resources estimation of the district was done in 2009 for each individual block. Perusal of the Estimates reveals overall stage of ground water development in the district is of the order of 140%. The present stage of block wise ground water development varies from 109 % (Indri) to 176 % (Assandh). The ground water development in all the blocks of the district has exceeded the available recharge and thus all the blocks have been categorized as over exploited. Net annual ground water availability of the district is 85905 ham and existing gross ground water draft for all users is 120143 ham. The blockwise ground water potential in Karnal district as per GEC-97 and number of extracted structures are given in **Table 15** and **Table 16** respectively.

Table 15 Blockwise Ground Water Resource potential in the Karnal district as per GEC-97

Block Name	Net Annual Ground Water Availability (Ham)	Existing Gross Ground Water Draft for irrigation (Ham)	Existing Gross Ground Water Draft for all uses (Ham)	Allocation domestic industrial up to next 25 years (Ham)	Net Ground Water Availability ty for future irrigation development (Ham)	Stage of Ground Water Development (%)	Category of Block
Assandh	12358	21640	21692	52	-9334	176	OVER EXPLOITED
Gharaunda	11404	14138	14339	201	-2935	126	OVER EXPLOITED
Indri	19261	20829	2096	134	-1702	109	OVER

			3				EXPLOITED
Karnal	15794	19758	20261	503	-4467	128	OVER EXPLOITED
Nilokheri	12864	20334	20540	206	-7676	160	OVER EXPLOITED
Nissang	14224	22200	22348	148	-8124	157	OVER EXPLOITED
TOTAL	**85905**	**118899**	**120143**	**1244**	**-34238**	**140**	**OVER EXPLOITED**

Water for irrigation in the district is based on both ground water and canal surface water. Ground water contributes 95 % of the total need for agriculture. Ground water is being extracted through a large number of shallow tubewells and dug cum bore holes which tap unconfined layer up to the average depth of 60-80m.

Table 16 Number of Extraction Structures Blockwise

Sl.no	Block	Shallow TW with Pump set	DIT	Ground water Draft (Ham)		
				Monsoon	Non Monsoon	Annual
1	Assandh	11956		9738	11902	21640
2	Gharaunda	9491	15	7832	9572	17404
3	Indri	11532		9393	11480	20873
4	Karnal	11765	4	9610	11745	21355
5	Nilokheri	10633	24	8823	10783	19606
6	Nissang	11066		9013	11016	20029

Entire drinking water supply to all rural as well as urban parts of the district is based on ground water only. This is basically due to the fact that the quality of ground water is fresh and potable all over and the depth to water level is within 10 to 20m in most parts. The tube wells constructed by Public Health Department, Haryana for drinking water supply are generally between 80 to 150m deep. The table shows the block-wise ground water draft for domestic use.

The gap in ground water recharge is highest in case of Assandh block where it has been estimated as 100.59 MCM while the same is lowest in case of Indri block where the gap is estimated to the tune of 15.19 MCM. The overall gap in ground water recharge for the district is 316.48 MCM against the total recharge of 902.43 MCM and draft of 1218.91 MCM. It indicates that the ground under stress. There is no scope for further ground water development in the district. Only measures should be taken to reduce the dependence on ground water and to enhance the ground water resources.

During the last 20 years the ground water level has declined in 80% of the area of the district and the decline is in the range of 1.0 m to 13.3 m and the rate of decline is in the range of 0.02m/yr. to 1.31 m/yr. Some of the suggestions offered by Central Ground Water Board (CGWB) in its district report are:

- No further ground water development should be considered while planning process.
- 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.
- Change in cropping pattern is recommended to reduce the heavy pumping of ground water.
- Ground water pumping from deep aquifers is recommended to reduce stress on the shallow aquifers.
- Ground water pumping for supplies should be shifted to the active flood plains all along the river Yamuna.
- The construction of roof top rainwater harvesting and artificial recharge to ground water should be made mandatory in building by laws.

6.2. Water Budget

Table 17 depicts the block wise water budget in Karnal district.

Table 17 Water Budget Block wise

Name of Block	Existing Water availability / Usage (MCM)		Total (MCM)	Water Demand (MCM)		Water Gap (MCM)	
	Surface Water	Ground Water		Present	Projected (2022)	Present	Projected (2020)
Assandh	109.675	216.92	326.595	555.97	556.67	-229.38	-230.08
Gharaunda	19.855	157.43	177.285	256.57	257.38	-79.28	-80.10
Indri	5.24	217.78	223.02	301.64	302.18	-78.62	-79.16
Karnal	41.6	211.46	253.06	438.20	440.66	-185.14	-187.60
Nilokheri	69.34	172.6	241.94	384.61	385.39	-142.67	-143.45
Nissing	37.46	242.72	280.18	364.87	365.45	-84.69	-85.27
Total	**283.17**	**1218.91**	**1502.08**	**2301.74**	**2307.63**	**-799.66**	**-805.55**

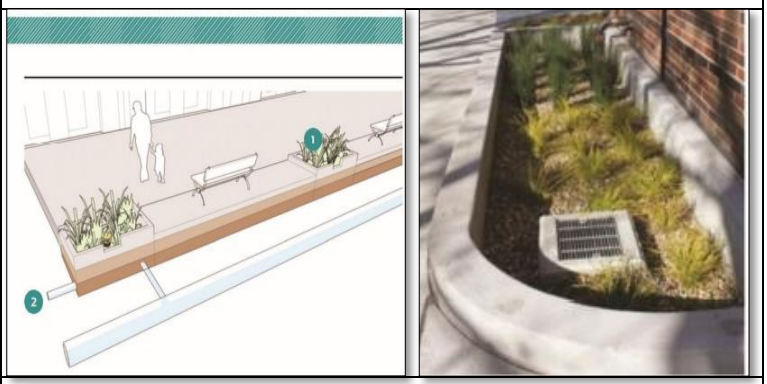
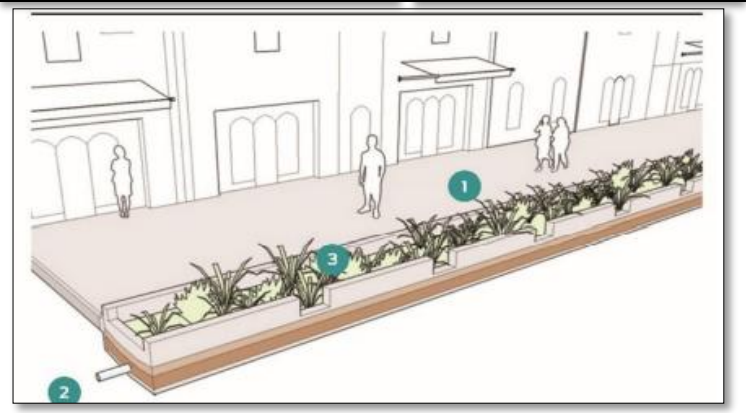
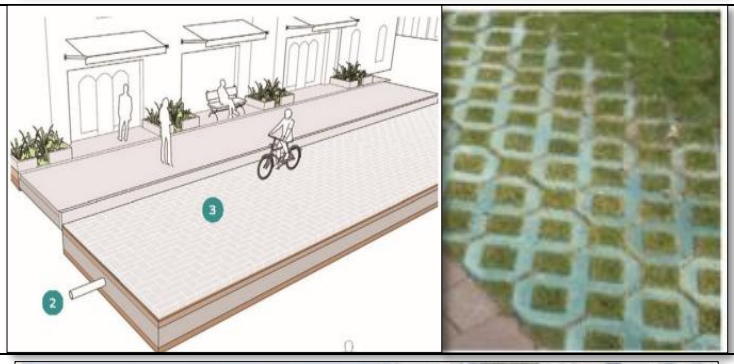
7. Strategies for Water Conservation

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 Karnal. 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 18**

Table 18 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 Karnal 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 Karnal district is shown in **Figure 15** and **Table 19** shows the proposed no of plantation targets in Karnal District.

Table 19 The proposed targets for plantation in Karnal District

Block Name	Wasteland Area (acre)	Plantation at 5 feet spacing
Nissing	748.16	6517966
Nilokheri	1322.06	11517754
Karnal	1499.87	13066878
Indri	847.73	7385379
Gharaunda	1007.55	8777713
Assandh	582.04	5070728
Total	6007.41	52336418

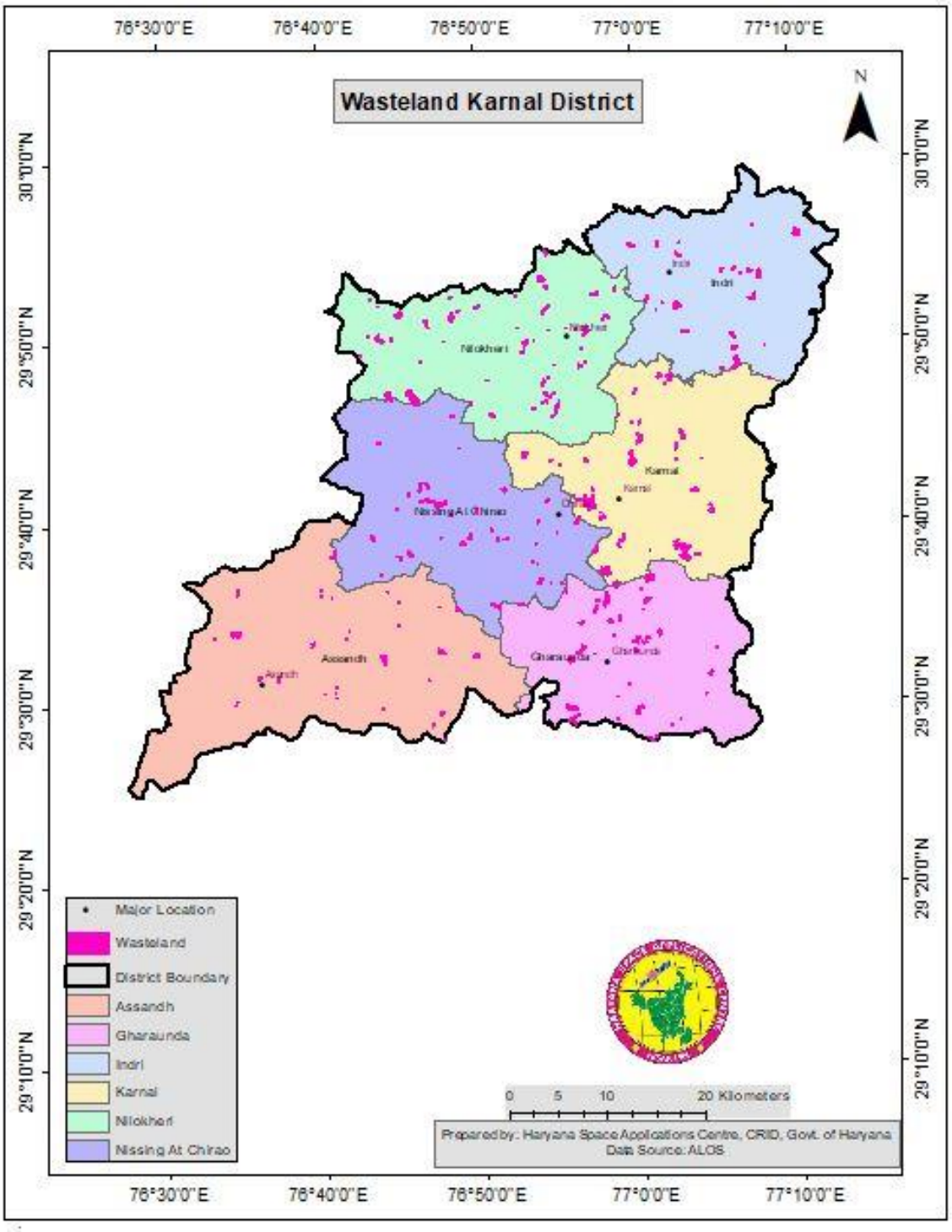


Figure 16 Blockwise Wasteland of Karnal District

7.3. Water Conservation & Artificial Recharge

There are 718 tanks and ponds in Karnal district which act both as water conservation and recharge structures. The block wise distribution of Water Conservation and Recharge Structures is given in **Table 20**.

Table 20 Blockwise distribution of Water Conservation and Recharge Structures

Block Name	No. of tanks/ ponds	Average water spread area (ha)		No. of days water is available		Recharge in Ham during	
		Monsoon	Non-Monsoon	Monsoon	Non-Monsoon	Monsoon	Non-Monsoon
Assandh	126	183	183	121	149	14.46	17.67
Gharaunda	95	83	83	95	115	14.66	18.36
Indri	122	93	93	108	132	11.35	13.74
Karnal	131	85	85	120	150	28.96	35.40
Nilokheri	132	149	149	135	165	31.89	39.26
Nissang	112	146	146	135	165	28.38	34.69
TOTAL	**718**	**739**	**739**	**714**	**876**	**129.70**	**159.12**

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 970's. The led 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 centers or 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 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

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 exists outside the city center and rural areas where open drainage systems still exit. Over the past three decades, the city limits of Karnal 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 21**) shows a list of generic conditions that are most often found in Karnal according to the type of treatment considerations and other main constraints such as land availability and population, given that finances are a constant.

Table 21 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

7.5. 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 16** shows the various stakeholders involved in IEC Activities.

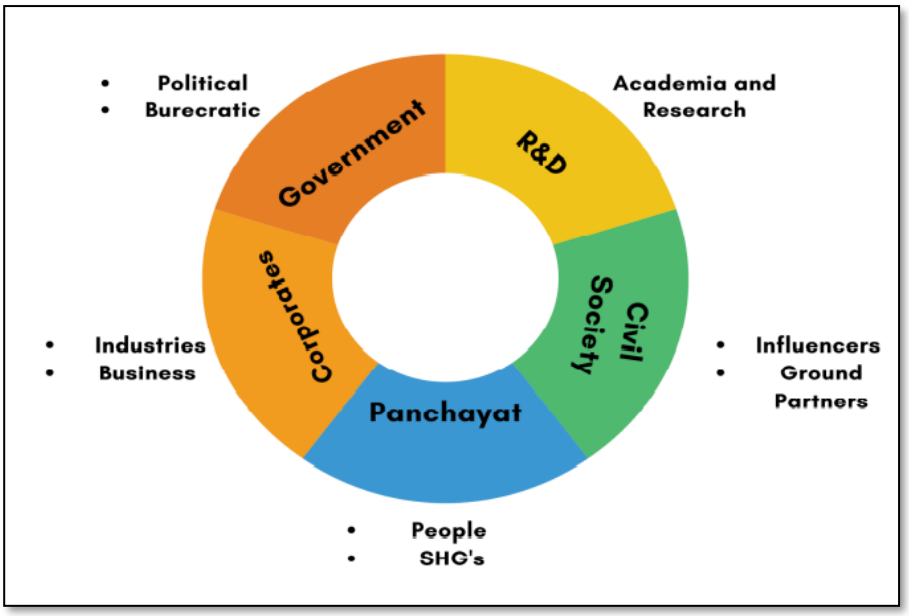


Figure 17 The Various Stakeholders of IEC Activities

Table 22 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

Making it a People's Campaign:

IEC plan has been prepared to generate awareness amongst the stakeholders for achieving the objectives of the Jal Shakti Abhiyan it is essential to use all type of communication mediums such as Inter Personnel Communication (IPC), Print media, electronic media, outdoor media and folk media. Extensive publicity and designing and printing of IEC material will be undertaken to disseminate the designated communication issues. IEC activities will be taken up in the action plan are telecast and broadcast of issues through electronic media, publication of public appeals in print and extensive use of social media. In addition to this, orientation workshops, trainings, designing and printing of IEC material will be distributed at appropriate locations including schools, colleges and other institutes. The major focus has been given to the grass root level interpersonal activities. The interpersonal communication will help in clearing the doubts of audience and take instant action. The advantage of this medium is that the messages can be communicated to the target audience who are not adequately educated.

Water Conservation Awareness Programme are presently being executed by Nehru Yuva Kendra Karnal; Pilot Project is catching the rain which was inaugurated at District level on 31.12.2020. Various Stakeholders were made aware of Water Conservation need & Techniques, Workshops has been organized on Village/Block/District Level by Nehru Yuva Kendra Karnal. Government organizations, schools, colleges & other institutes of concern are also made part of the awareness programme from time to time. Glimpse of programs organized are shown below: -

राष्ट्रीय युवा स्वयंसेवकों व संदर्भ व्यक्तियों द्वारा गॉव के सरपंच, पंचायत सदस्यों, युवा मंडलों के अध्यक्ष एवं सदस्यों और गॉव के युवाओं को जल संरक्षण एवं उसके महत्व के बारे में जानकारी दी गई।

जन स्वास्थ्य विभाग की जिला सलाहकार श्रीमती नेहा परासर ने नेहरू युवा केन्द्र द्वारा बी डी पी ओं हॉल, कुंजपुरा में आयोजित कैच द रेन कार्यकम में भाग ले रहे युवाओ को जल बचाओ और जल के पुर्नउपयोग के महत्व के बारे में जागरूक किया। जिसमें ब्लॉक समन्वयक, पचांयत सदस्य और युवा मंडलो के लगभग 80 युवाओ ने भाग लिया।

नेहरू युवा केन्द्र करनाल युवा कार्यकम और खेल मंत्रालय भारत सरकार द्वारा करनाल के तत्वावधान में जिला युवा अधिकारी रेनू सिलग के निर्देशानुसार जल बचाओ रेली कार्यकम का आयोजन किया गया। कार्यकम में महिलाओ द्वारा साफ –सफाई की गई और रेली निकालकर गांव के लोगो को जागरूक किया गया।

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 17**). The block wise area proposed for rainwater harvesting under most suitable sites is shown in **Table 23.** For the process of calculating suitable site a fixed weightage is needed to be applies on the above-mentioned criteria (**Table 24)**.

Table 23 Block wise area under very good suitable site proposed for rain water harvesting

Block Name	Area (Very Good suitability area in Sq meter)
Nissing	216011846.1
Karnal	236989629
Nilokheri	252305885.9
Indri	277160714.3
Gharaunda	144221925.5
Assandh	304781986.2

Table 24 Assigned Weight for Criteria Parameters

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

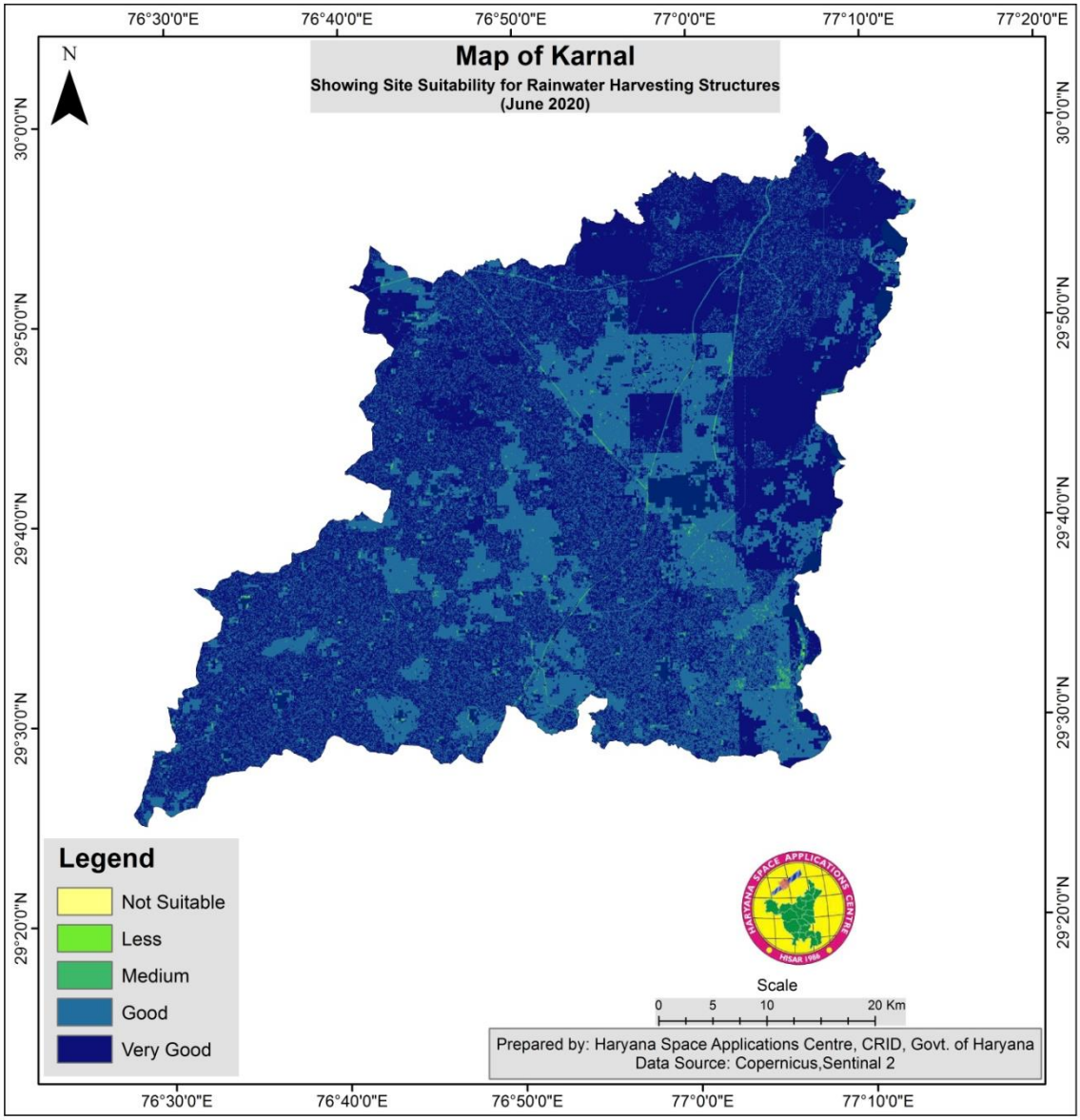


Figure 18 Site Suitability Map of Rainfall Harvesting Structure in the Year 2020

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 18** shows the proposed suitable site based on multi criteria. Block wise proposed suitable sites based on multi- criteria is shown in **Table 25**.

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

1. 1 Mini percolation Tanks
2. 1 Pakka check Dams
3. 2 Micro Irrigation tanks

Table 25 Block wise proposed suitable sites based on multi-criteria

Sl. No.	Block Name	Mini percolation Tank	Percolation Tank	Pakka Check Dam	Annicut	Micro Irrigation Tank
1	Nissing	1	0	1	0	2
2	Nilokheri	0	0	0	0	0
3	Karnal	0	0	0	0	0
4	Indri	0	0	0	0	0
5	Gharaunda	0	0	0	0	0
6	Assandh	0	0	0	0	0

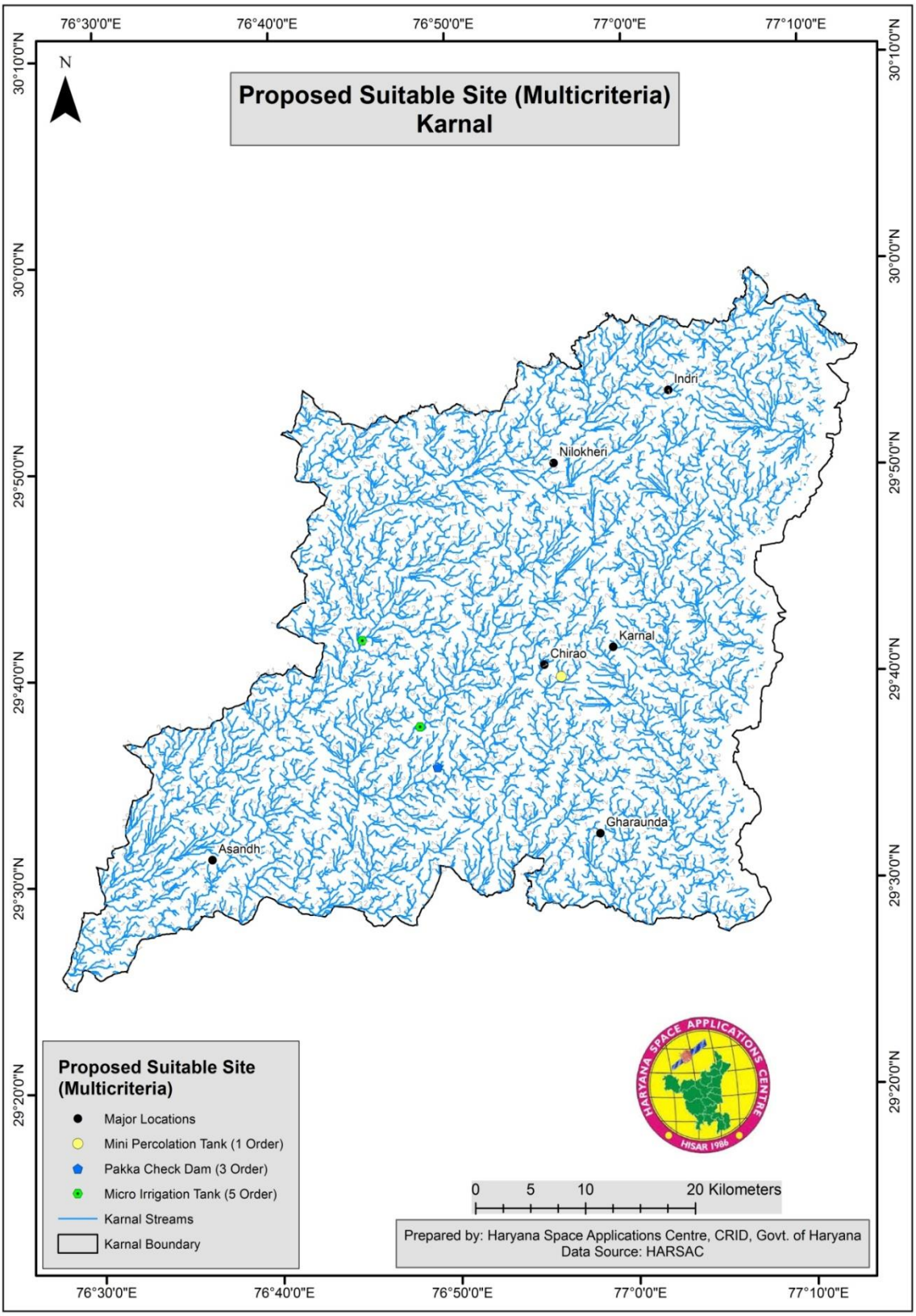


Figure 19 Proposed Suitable Sites based on Multicriteria in Karnal District

8.3. Based on Drainage

The drainages that are created from satellite imagery can be used as base for the water harvesting structure **(Figure 19).**

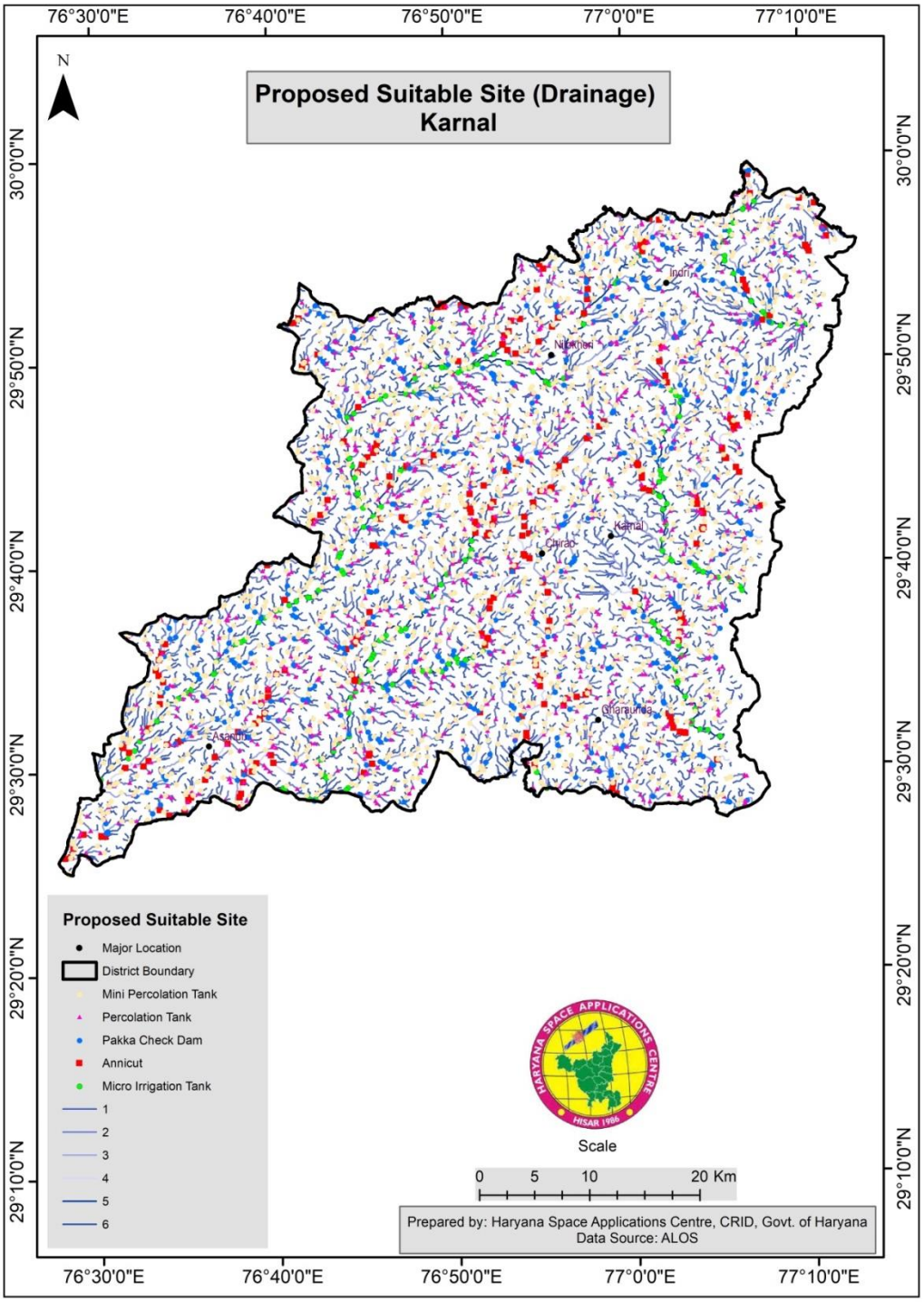


Figure 20 Proposed suitable sites based on drainage in Karnal District

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 19** shows the proposed suitable sites based on drainage structure in Karnal district. The proposed harvesting structures in Karnal based on drainage are given in **Table 26.**

Table 26 Proposed harvesting structures in Karnal based on drainage

Sl. No.	Block Name	Mini percolation Tank	Percolation Tank	Pakka Check Dam	Annicut	Micro Irrigation Tank
1	Nissing	290	188	86	58	44
2	Nilokheri	256	203	96	41	43
3	Karnal	202	151	81	48	26
4	Indri	194	152	83	25	30
5	Gharaunda	201	137	95	37	24
6	Assandh	371	253	137	73	37
	Total	1514	1084	578	282	204

9. Conclusion

Due to rapid urbanization, the Karnal 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.

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