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JSA-CTR

Scientific Action Plan for Rewari

Prepared By-

Haryana Space Applications Centre (HARSAC),

Citizen Resource Information Department (CRID)

Government of Haryana

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1 Introduction

Rewari district of Haryana state lies between 27° 46'-28°28' North latitudes and 76° 15'- 76° 51' East longitudes. Total geographical area of the district is 1594 sq.km. The Rewari district is divided into three sub-divisions (tehsils) namely Bawal, Kosli and Rewari comprising five-community development blocks viz. Bawal, Jatusana, Khol, Nahar and Rewari for the purpose of administration. The district headquarters, Rewari town falls in Rewari Tehsil.

The main streams in the district are Sahibi and Krishnawati rivers. Sahibi River is an ephemeral river and rises from Mewat hills in Jaipur Alwar in Rajasthan and after gathering water from several tributaries, forms a broad stream and enters the district near Rewari after which it enters Rajasthan and then re-enters Haryana near village Jaithal. The district, except in its Eastern part is flat and sandy and absorbs all the rainwater. There are heavy floods created by Sahibi River in Haryana and Delhi. To moderate these floods a barrage been constructed near masani village and is called Masani barrage. The Krishnawati River enters in the Southern part from Mahendragarh district and nearly makes a border between Mahendragarh and Rewari district. This is a blind river and sandy soils absorb its water. The flooding water is useful for crops and contributes to ground water reservoir. There are various other small nalas also carry rainwater from the hills during monsoon season. The agriculture constitutes the main source of economy, and most of the area fit for agriculture is being cultivated. The total irrigated area of 1430 sq.km in Rewari district is irrigated by shallow and deep tube wells.

1.1 History

The History of the district Rewari is contemporary to the history of Delhi. During MAHABHARTA period there was a king named Rewat. He had a daughter whose name was Rewati. But the king used to call her Rewa lovingly. The king founded and established a city named "Rewa wadi" after the name of her daughter. Later on, Rewa got married with Balram, elder brother of Lord Krishna and the king donated the city "Rewa wadi "as dowry to her daughter. Later the city Rewa wadi became REWARI. During the rule of Mughals, a "VANIK", named Hemu of Rewari became chief of Army and Prime minister of SOOR-SAMRAJYA. On decay of this SAMRAJYA, he became ruler of Delhi and known by the name "HEM CHANDER VIKRMADITYA". He could rule for very short period and sacrificed his life on Nov. 5, 1556 in the second battle of Panipat while fighting against Mughals. During the rule of Mughal Rewari was the part of Delhi territory. In the SAVTANTRTA-SANGRAM of 1857 "Rao Tula Ram & Krishan Gopal "of Rewari fought aggressively against the British rule with the help of "Samrat Bahadur Shah Zafar" and there was a movement when they brought the British rule to an end in Rewari. But Rao Tula Ram could not succeed and he expired after some time. The land of Rewari is called “VEER-BHUMI”. Even today the people of Rewari feel proud to serve in Indian Armies. The majority of the castes, which lived in Rewari, were Morya, Guptas and Gujjars, although now the majority is of the Ahirs. All castes live with harmony. In the city the Punjabis and Guptas hold on the business.

1.2 Location

The latitude of Rewari, Haryana, India is 27°46’-28°28’ North and 76°15’- 76°51’ East. **Rewari, Haryana, India** is located at India country in the Towns place category with the GPS coordinates of 28° 10' 59.9952" N and 76° 37' 0.0084" E.

Rewari was accorded the status of a district by the Government of Haryana on November, 1, 1989. Its geographical boundaries have district Jhajjar in its north, Mahendragarh district in its west and district Gurgaon in its east & north-east directions. District Alwar of Rajasthan touches Rewari in the south-east. Prior to it, Rewari was a Sub-division and Tehsil head quarter of district Mahendragarh. Rewari is located at 82 KM milestone in the south-west direction of the national capital Delhi across the Delhi Jaipur National Highway No.8. Rewari town is situated at the height of 241.95 meters above sea level. This district is spread over 1559 Sq. km area with a total population of 6, 23,301 (1991 census). It is divided into 2 sub-divisions, Rewari and Kosli. It is further divided into 3 revenue tehsils, that is Rewari, Bawal & Kosli and 5 CD Blocks namely Rewari, Bawal, Khol, Jatusana & Nahar. The whole district consists of 412 villages and 348 Panchayats. The location map of Rewari district is shown in **Figure 1**.

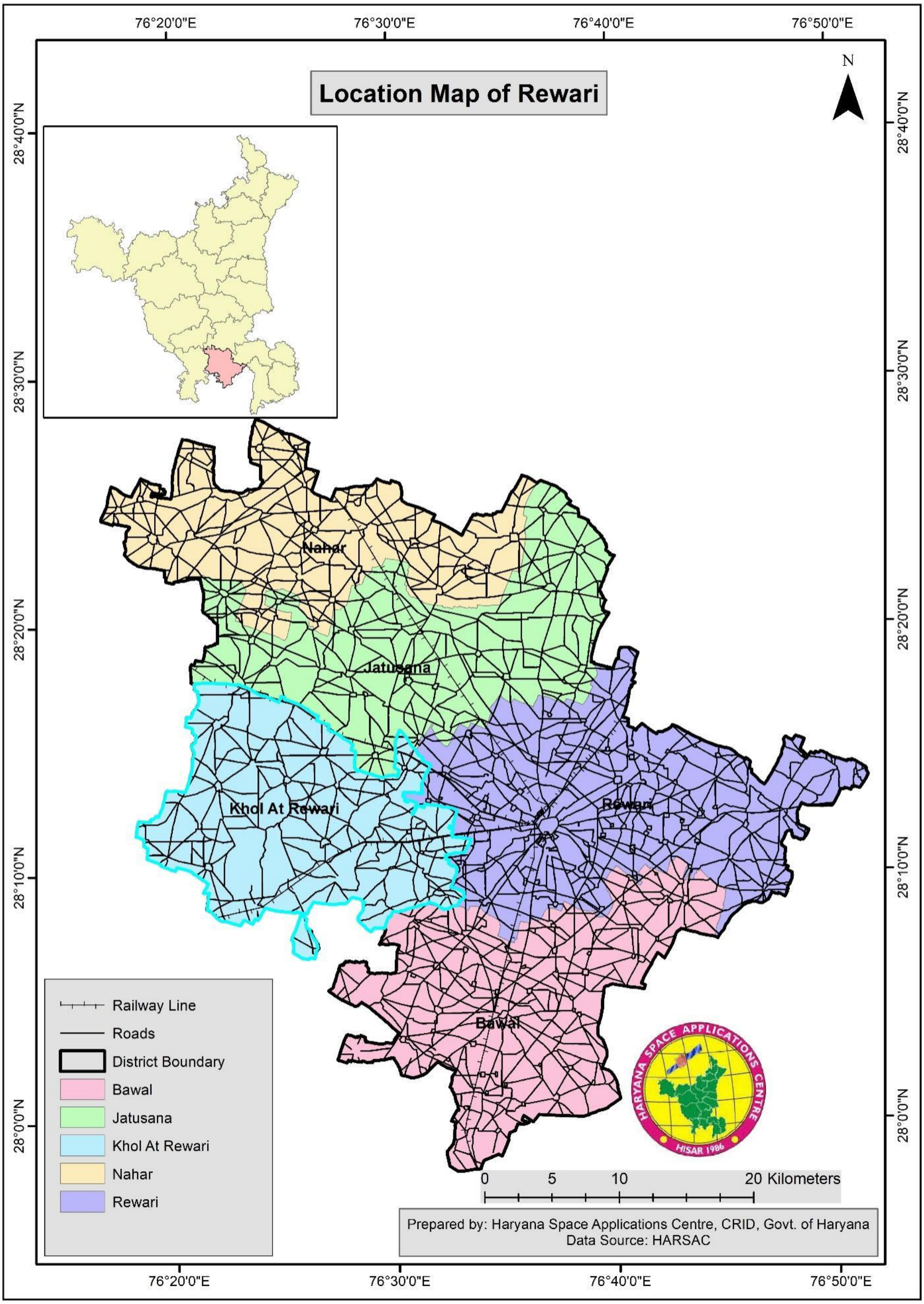


Figure 1- Location Map of Rewari District

1.3 Administrative setup

The Rewari district falls in Gurgaon Division. The district is further divided into three Sub-Divisions and five blocks, one Municipal council and two municipal committees for purpose of administration. Administratively, the Deputy Commissioner is the overall in charge of the general administration in the district and performs the duties of the District Magistrate and the District Collector. Below the Deputy Commissioner is the Additional Deputy Commissioner who assists the Deputy Commissioner in the work relating to general administration, rural development, etc. The Deputy Commissioner along with ADC, Chief Executive Officer of Zila Parishad, Superintendent of Police and other senior officers of the district looks after the development and regulatory functions in the district. To decentralize the authority in the administrative set up, the district is divided into three sub-divisions Bawal, Kosli and Rewari. Sub-divisions are not necessarily co terminus with the name of their respective tehsils. Zila Parishad and Panchayat Samitis correspond to the district and C.D. Block boundaries respectively except that they do not cover the municipal areas. The Zila Parishad elects its President and Vice-President from amongst the elected members. The term of office of members is five years. The State government as the Chief Executive Officer to the Zila Parishad deputes an officer in the senior scale of I.A.S... Various departments of the district also assist the Parishad. At the community Development Block level, each Panchayat Samiti has an elected Chairman and Vice Chairman. The Block Development and Panchayat Officer works as Executive Officer of the Panchayat Samiti. The executive authority for carrying out the provisions of the Haryana Zila Parishad and Panchayat Samitis (C.D. Blocks) Act vests in the Chief Executive Officer and the Block Development and Panchayat Officer respectively. The statutory urban local bodies are municipal councils, municipal committees, etc. The urban local bodies elect councilors from each of the ward and their term is five years. Process of governance at the lowest level is Gram Panchayat, which makes adequate arrangements for development in various fields in rural areas. The following table (**Table 1**) shows the description of administrative set up of Rewari district.

Table 1 -Major Administrative Jurisdictional Setup of Rewari District

Country	India
State	Haryana
Division	Gurgaon
Headquarters	Rewari
Tehsil	1. Rewari 2. Bawal 3. Kosli 4. Palhawas 5. Nahar
Total Area	1,594 km^2 (615 sq mi)
Total Population (2011)	900,332
Density	560/km^2 (1,500/sq mi)
Demographics (Sex Ratio)	898
Literacy	80.99%

Vidhan Sabha constituencies	1. Rewari 2. Bawal 3. Kosli
Website	http://rewari.gov.in
Location of Rewari	85 km away from Delhi.28.18°N 76.62°E
Coordinates	28.18°N 76.62°E
Total Area	35.93 km²
Elevation	245 meters (803 feet)
Sub Divisions (4)	
Tehsils (5)	• Rewari • Kosli • Bawal • Palhawas • Nahar
Sub-Tehsils (3)	• Dharuhera Dahina • Manethi
Blocks (7)	Bawal, Dahina, Dharuhera, Jatusana ,Khol At Rewari, Nahar , Rewari
Municipal Council (1)	Municipal Council, Rewari
Population (Census 2011)	900,332

Total Villages	412
Total Panchayats	348
Block Level	Panchayat Samiti (133)
District Level	Zila Parishad (18)

1.4 Climate

The climate of Rewari district can be classified as tropical steppe; Semi-arid and hot which is mainly dry with very hot summer and cold winter except during monsoon when moist air of oceanic origin penetrates into the district. There are four seasons in a year. The hot weather season starts from Mid-March to last week of the June followed by the southwest monsoon which lasts up to September. The transition period from September to October forms the post monsoon season.

The winter season starts late in November and remains up to first week of March. The normal monsoon and annual rainfall of the district is 489 mm and 553 mm, respectively, which is unevenly distributed over the area 23days. The southwest monsoon sets in from last week of June and withdraws in end of September, contributing about 88% of annual rainfall. July and August are the wettest months. Rest 12% rainfall is received during non-monsoon period in the wake of western disturbances and thunderstorms.

1.4.1 Temperature

The hot season lasts for 2.7 months, from April 15 to July 7, with an average daily high temperature above 98°F. The hottest month of the year in Rewari is June, with an average high of 102°F and low of 84°F.

The cool season lasts for 2.2 months, from December 8 to February 15, with an average daily high temperature below 75°F. The coldest month of the year in Rewari is January, with an average low of 47°F and high of 69°F.

1.4.2 Rainfall

The rainfall in the district increases from the south-west towards the northeast. About 70 per cent of the annual rainfall is received during period from July to September. The annual average rainfall received in district is 480 mm. The mean minimum and maximum temperature in the area ranges from 5.6° C to 41o C during January and May or June respectively. Average Rainfall of Rewari District is shown in **Table 2** and rainfall map is shown in **Figure 2.**

Table 2 -Average Rainfall of Rewari District

Rainfall	**Average(mm)**
SW Monsoon (June-Sep)	382.3
NE Monsoon (Oct-Dec)	21.6
Winter (Jan-March)	36.4
Summer (Apr-May)	39.3
Total	478.6

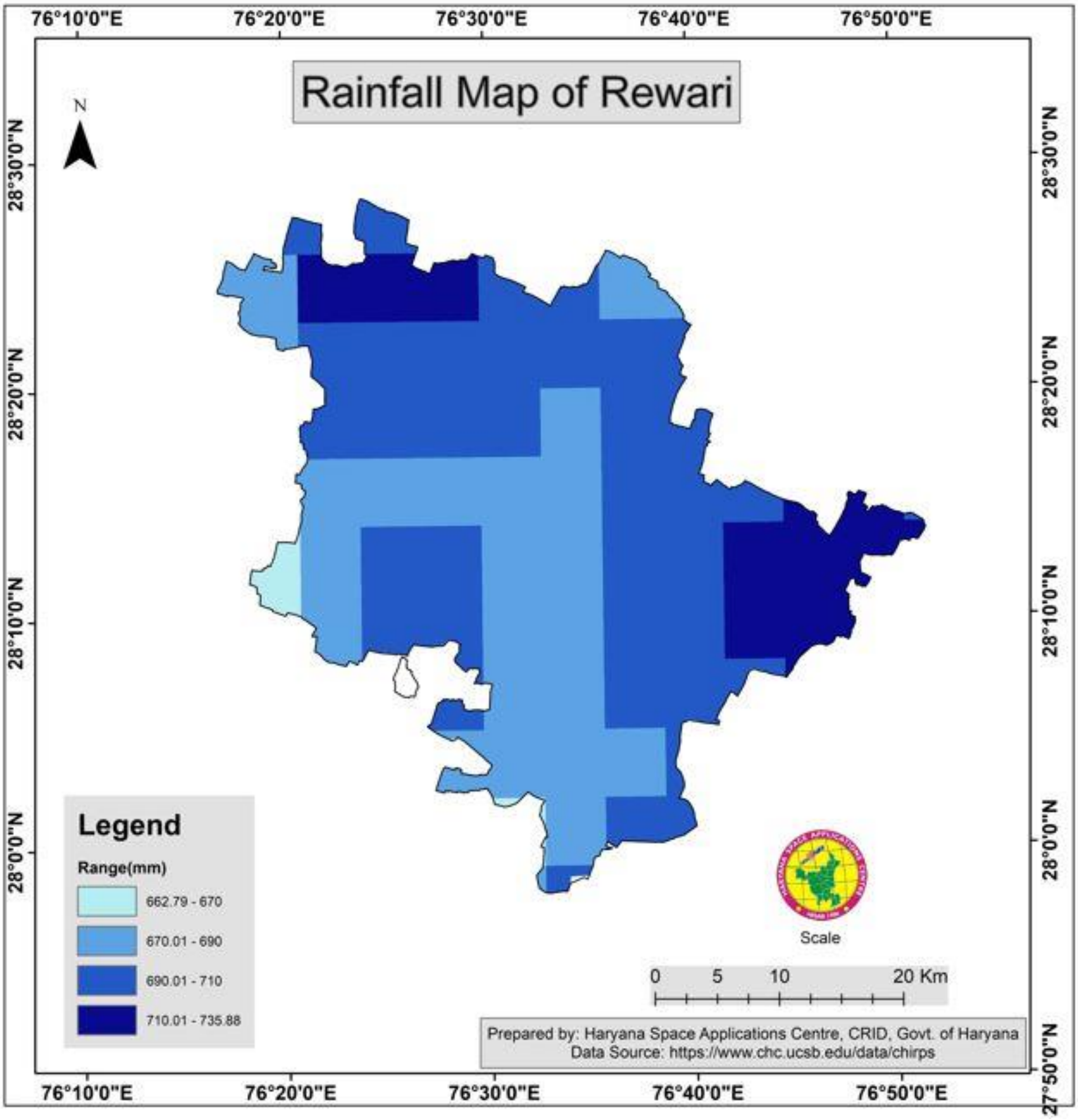


Figure 2 -Rainfall Map of Rewari District

1.5 Elevation and Topography

Rugged hilly terrain of Aravalli ranges as well as sandy dunes in the district affect the city's climate. Rewari forms a part of the National Capital Region. Rewari is located at 28.18°N 76.62°E. It has an average elevation of 245 meters (803 feet) **(Figure 3)**.

Based on the soil, physiography, bio climate, and length of growing period, the state of Haryana has been divided into 8 Agro-ecological zones (NBBS&LUP, 1989). Rewari district along with Gurgaon and Mahendragarh falls in Zone 3. The topography of the district is represented by rugged hilly terrain of Aravalli ranges.

The region has suffered a prolonged period of aridity during the quaternary and sub-recent times and the landscape has been greatly modified by Aeolian action. The effect of fluvial cycle in developing the landform is also pronounced. The landscape of the district is peculiar. It has varied topography comprising valleys, undulating lands, sand dunes and alluvial plains. The Aravalli ranges lie in the southern and western parts of the district and thinly spread throughout the district. The region has suffered a prolonged period of aridity during the quaternary and sub-recent times and the landscape has been greatly modified by Aeolian action. The effect of fluvial cycle in developing the landform is also pronounced. The DEM, slope and contour map of Rewari district is shown in **Figure 3, 4** and **5** respectively. The catchments area of Sahibi river, which falls in Rewari district, can be divided into five distinct landscapes: **-**

a) Aravalli Hills

b) Flood Plains

c) Foot Hills

d) Aeolian Plains and Sand Dunes

e) Alluvium Deposits

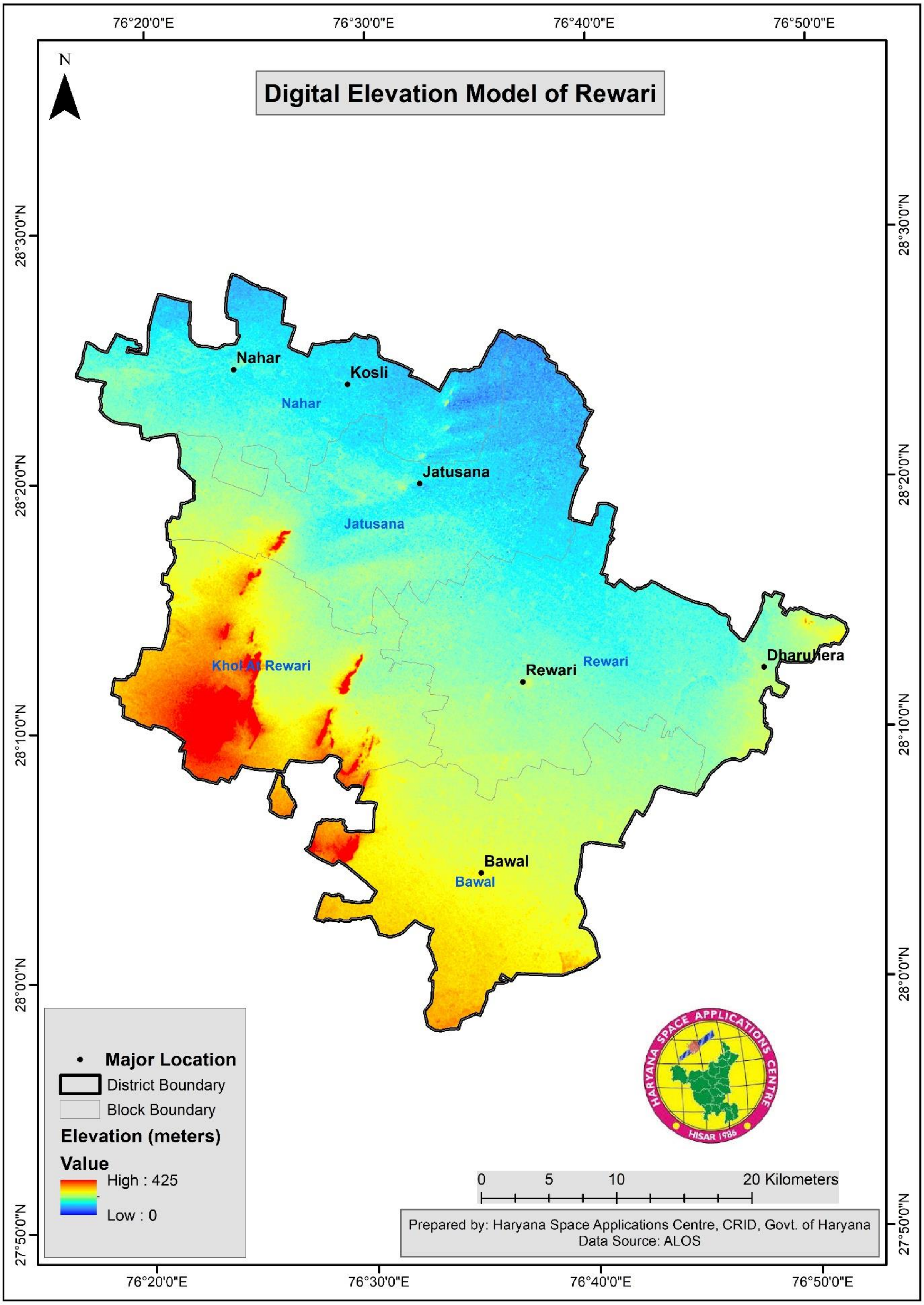


Figure 3- Digital Elevation Model of Rewari District

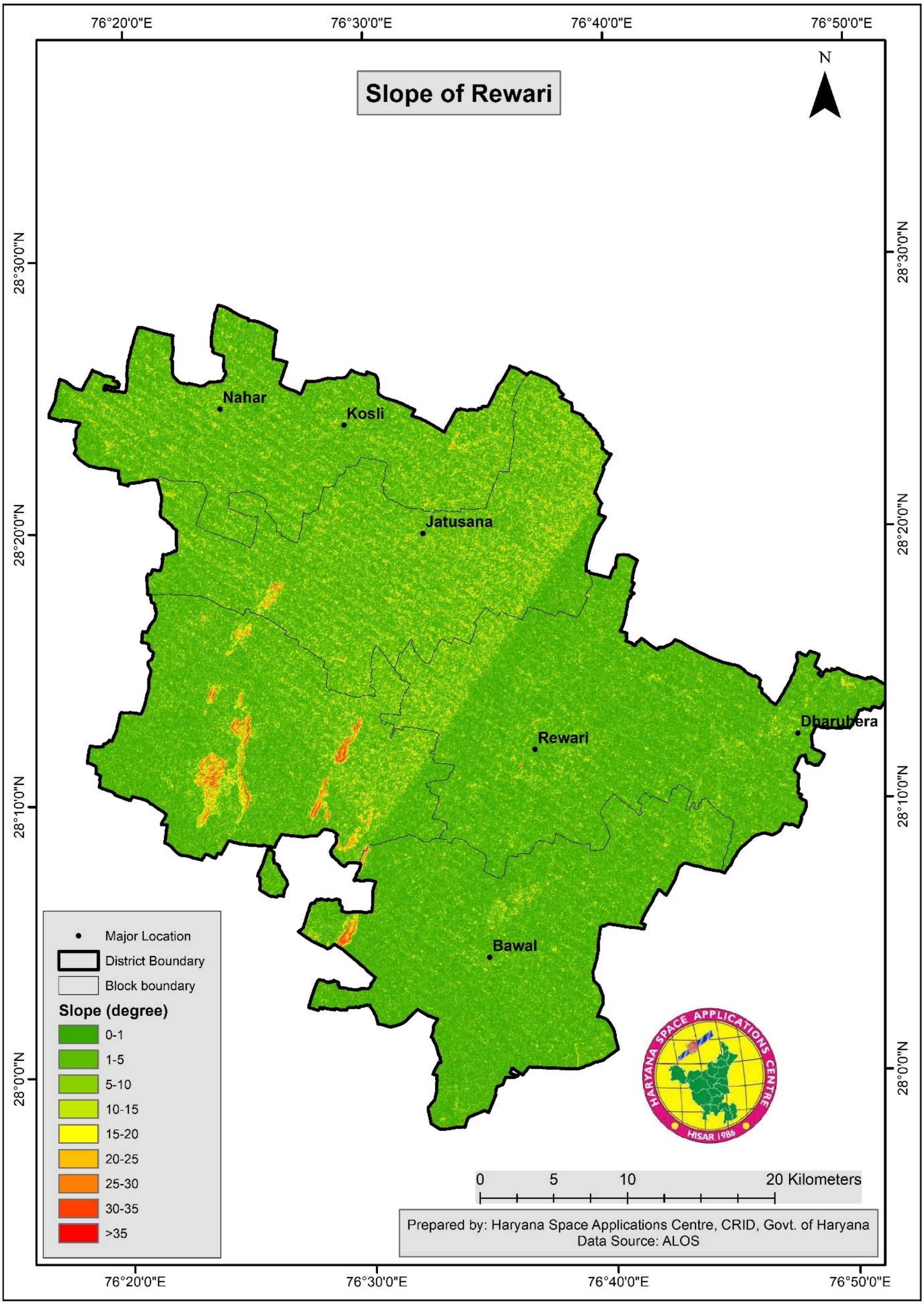


Figure 4- Slope Map of Rewari District

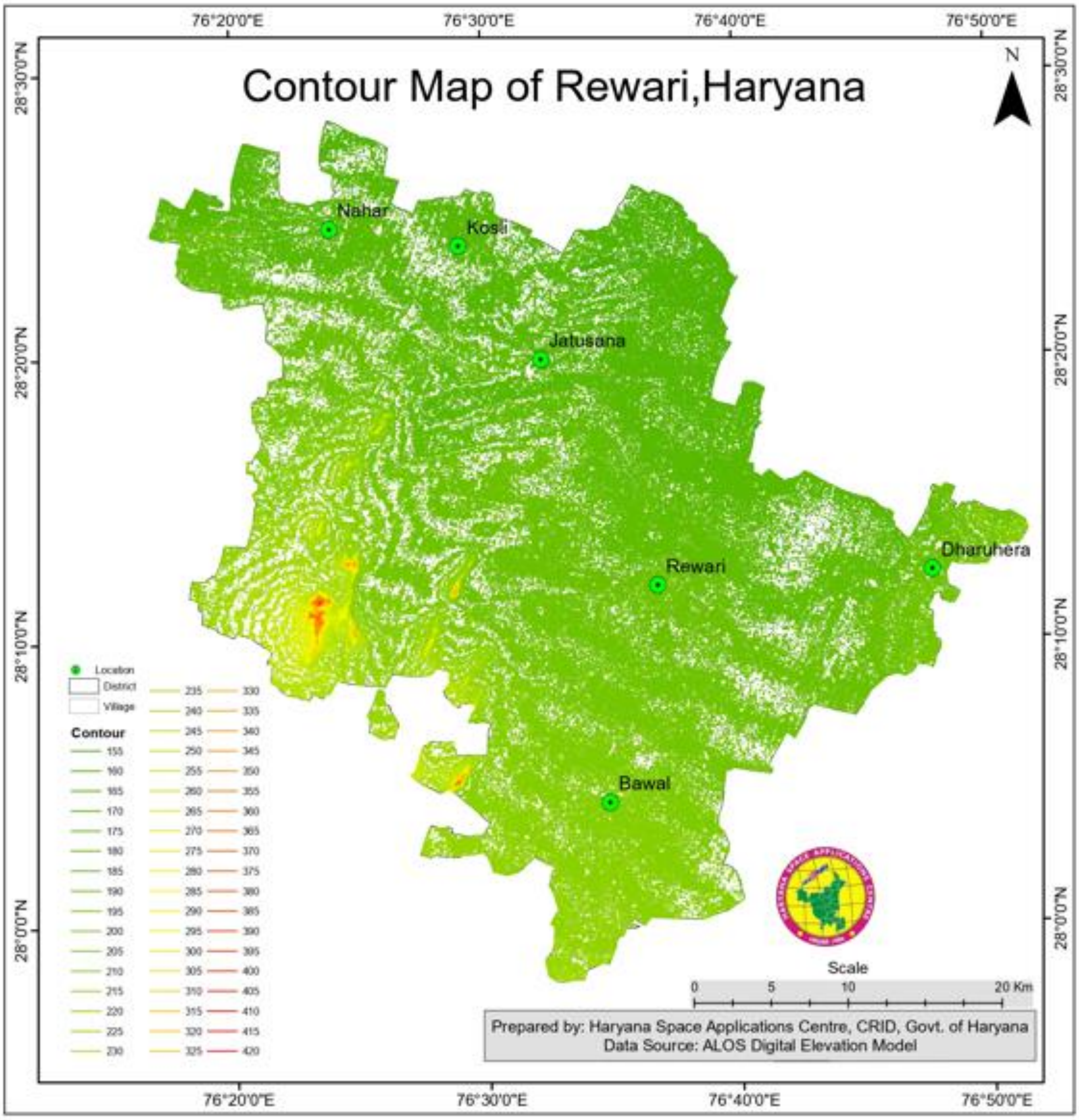


Figure 5 -Contour Map of Rewari District

1.5.1 Geology and Lithology

The district falls in the geological domain of Pre-Cambrian rocks of Aravalli Mountains. These are represented by Delhi Super Group of rocks (2500-1600 million years), which are confined to the southern part of the state of Haryana. It consists of Alwar group of rocks, which are overlain by rocks of Ajebgarh group. The Ajebgarh group of rocks is mostly developed in the form of hill ranges as well as parallel isolated hillocks in parts of Rewari. The dominant rock types of the group include shale, slate, phyllite, pelitic schist, crystalline and impure limestones, marbles, and calc-schist with intercalations of thinly bedded quartzites. The purona rocks in Rewari district belong to Ajebgarh series of Delhi system. The hills have been denuded since ages and have a height ranging from 300 m to 425 m above mean sea level.

The hills are mostly steep, bare and rocky. Aeolian plains and sand dunes have superimposed the previously existing old flood plains. Excellent quality slate is found in District Rewari. Practically, inexhaustible deposits of Quartzites found in the Aravalli ranges of the district. Huge deposits of good quality slate occurring in shades of green, black, and brown exists in the district. (Lithological Map of Rewari District is shown in figure no 6).

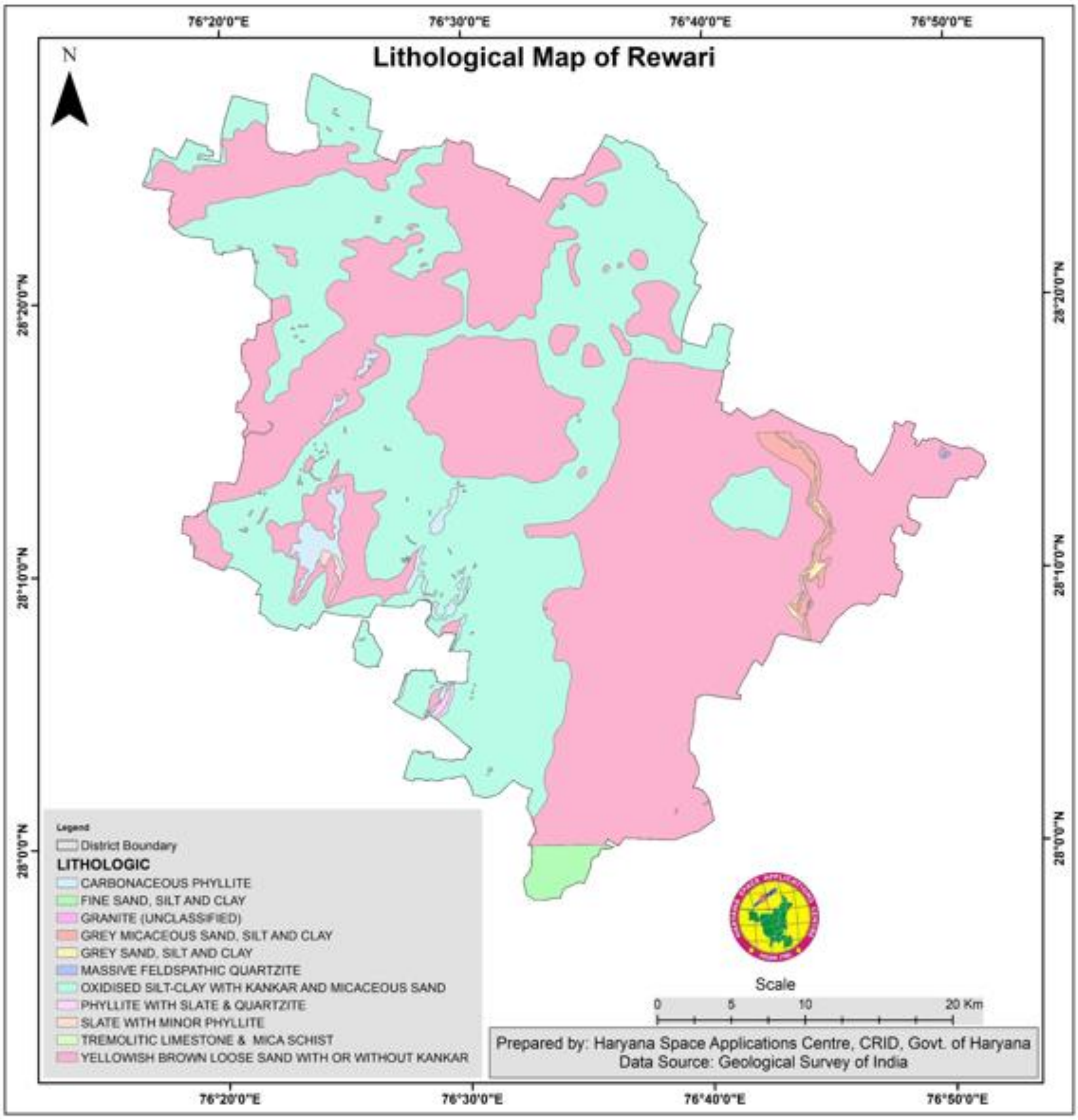


Figure 6- Lithological Map of Rewari District

1.5.2 Soil Profile

Rewari district broadly forms part of Indo-Gangetic alluvial plain of Yamuna sub-basin. It has vast alluvial and sandy tracts and is interspersed strike ridges, which are occasionally covered with blown sand. The master slope of the area is towards the north. Due to arid climate, the soils are light coloured as well as calcareous and have lime nodules in the subsurface horizon. The soils are excessively drained with slight to moderate soil erosion and have a high percolation rate. However, in fluvial low lands the soils are heavier in texture and vary from sandy loam to loam. The district of Rewari is characterized with the soils, which belong to two moisture regimes, i.e., Ustic (6.7%) and Aridic (1.4%). Dominant soils of Ustic zone are deep, excessively drained, sandy and alkaline are classified as Typic Ustipsamments and associated soils as Typic Ustochrepts. Soils of Aridic zone are sandy and alkaline and classified as Typic Torripsamments and associated soils and Typic Camborthids. The soils of the district fall under Entisols and Inceptisols orders. The surface soil texture varies from sand to fine loamy sand (**Figure 7**).

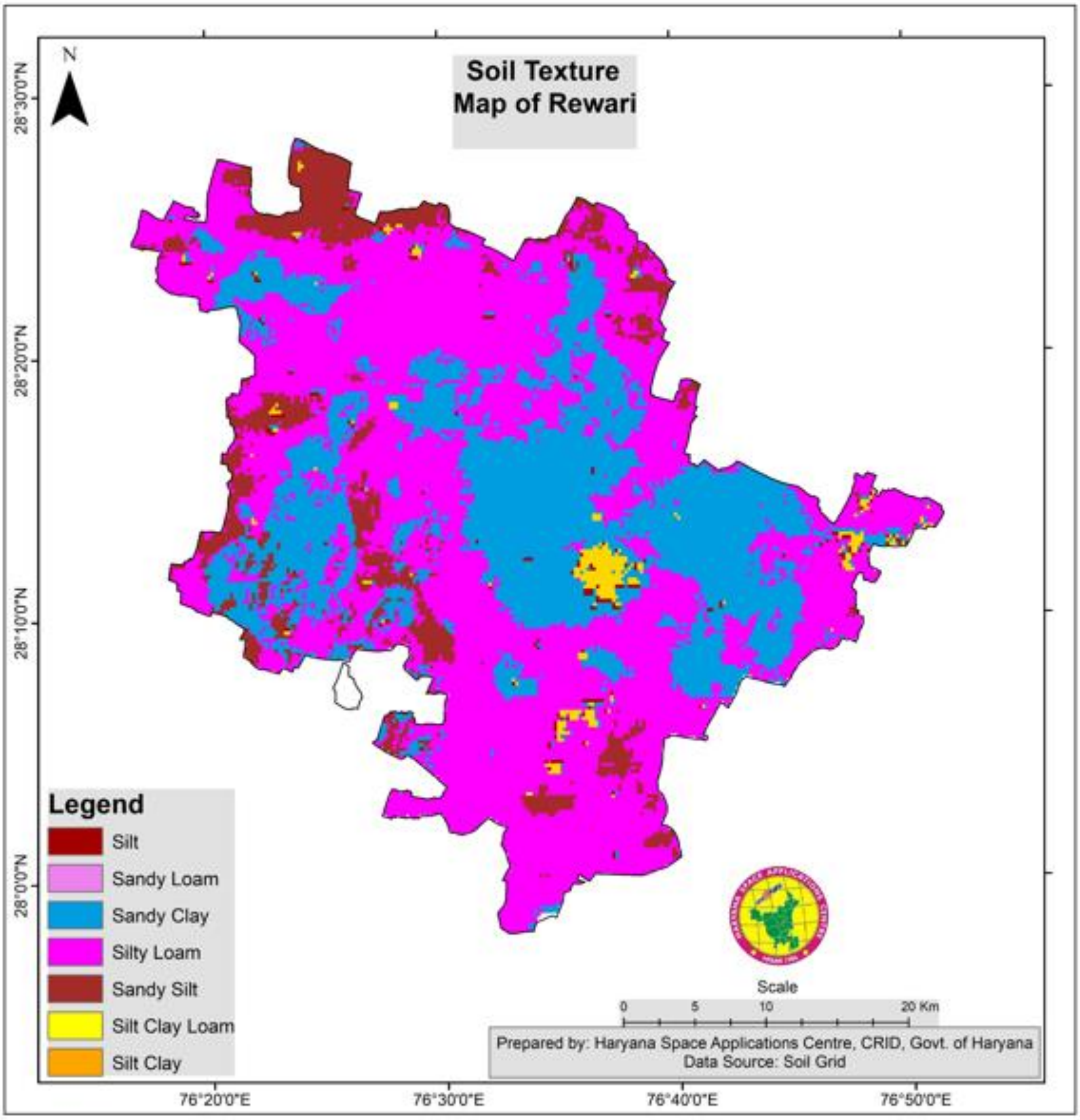


Figure 7 -Soil texture map of Rewari District

1.6 Landuse

A. Built-up Land:

These are human settlements comprising of residential areas, transport/ communication lines, industrial commercial complexes, utilities and services etc. Collectively, cities, towns and village habitation are included under this category. The built-up land category occupies 3.82% of TGA in 2005-2006 that have increased to 8.86% in 2011- 2012. The study area situated in NCR and the pace of urban development is very high. Therefore, the ever expansion of built-up lands in rural & urban areas are at the cost of natural green cover and fertile agricultural land. Statistics of land use/land cover (LU/ LC) change in Rewari district during 2005-06 to 2011-12 shown in **Table 3.**

B. Agricultural land:

Agriculture is main economic base of the area which was nearly 89.63 percent of its total geographical area under agriculture use in year 2005-2006. But the during the year 2011-2012 the share of agricultural land is declined drastically to 83.37 percent of TGA. This has happened due to that government speedily for urban, industrial and commercial development purpose and to reduce the pressure upon over crowded National Capital Delhi is acquiring agricultural land. Simultaneously a lot of uncontrolled, haphazard and unplanned urban development is also taking place along the transport network.

C. Grass/Grazing land:

These lands occur around villages on panchayat common lands and most of them are degraded conditions. These lands were spared over 2.32 percent of TGA in 2005-2006 and reduced to 1.91 percent of TGA in year 2011-2012. This reduction caused by increase in built up land and forest plantation.

D. Wastelands:

Wastelands are described as, degraded lands and are resulted from inherent/ imposed disabilities. The total area under category was 3.43 percent of TGA in 2005-2006 but it has been reduced to 3.35 percent of TGA during 2011-2012. This deviation is occurred due to wastelands were taken up for forest plantation and for urban development.

E. Water Bodies:

This class comprises area of surface water impounded in form of ponds, tanks and reservoir. These are associated with urban and rural built-up areas. The area under this category was 0.29 percent of TGA in 2005-2006 and increased to 0.41 percent in year of 2011-2012.

F. Wetland:

The wetland in the district comprised 0.00 % of the total geographical area during 2005-2006, was increased to 0.03% in the year of 2011-2012. A net increase of relative deviation was 0.00% of the total wetland area in the district.

G. Forest:

The natural forest and forest plantation covered under this category. The forest cover spread over 0.51% in year 2005- 2006 which has increased to 2.04% in the year 2011-2012 in the area. The reason for increase area under forest is forest plantation carried by government on wastelands particularly hilly undulating scrubland.

Figure 8 shows the graph of change in land use/land cover in Rewari District (2005-2006 to 2011-2012). The map of land use/land cover of Rewari District is shown in **Figure 9**. **Table 3** shows Statistics of land use/land cover (LU/ LC) change in Rewari district during 2005-06 to 2011.

Table 3 Statistics of land use/land cover (LU/ LC) change in Rewari district during 2005-06 to 2011-12. (Area in Sq.km)

Sr. No.	Categories	2005-06	2011-12	(%) of geographical area of 2005-06	(%) of geographical area of 2011-12	Change From 2005-06 to 2011-12	RD % From 2005-06 to 2011-12
1	**Built-up**	60.82	141.3	3.82	8.86	80.47	132.32
2	**Agricultural Land**	1428.74	1328.9	89.63	83.37	-99.84	-6.99
3	**Forest**	8.10	32.65	0.51	2.04	24.56	303.09
4	**Wastelands**	54.66	53.45	3.43	3.35	-1.21	-17.72
5	**Grass/Grazing**	37.01	30.45	2.32	1.91	-6.57	-2.21
6	**Waterbodies**	4.67	6.65	0.29	0.41	1.98	42.40
7	**Wetland**	0.00	0.61	0.00	0.03	0.61	0.00
TGA=1594 Sq.km							

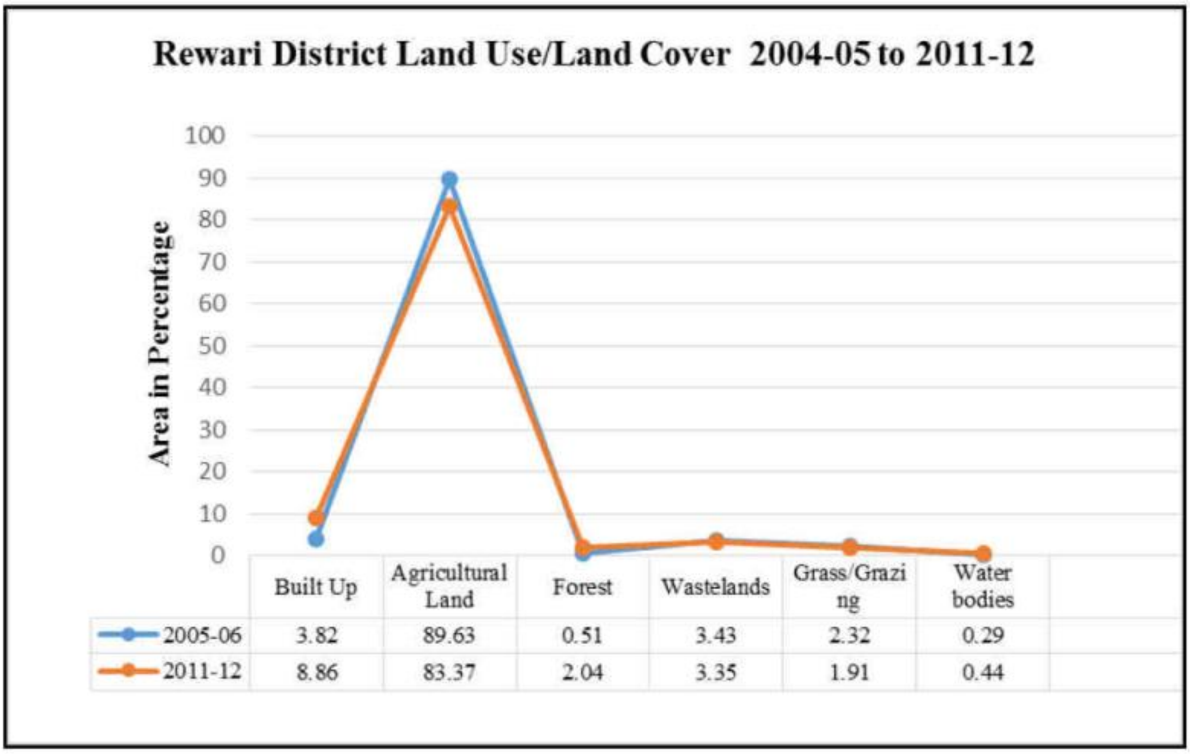


Figure 8 -Change in land use/land cover in Rewari District (2005-2006 to 2011-2012)

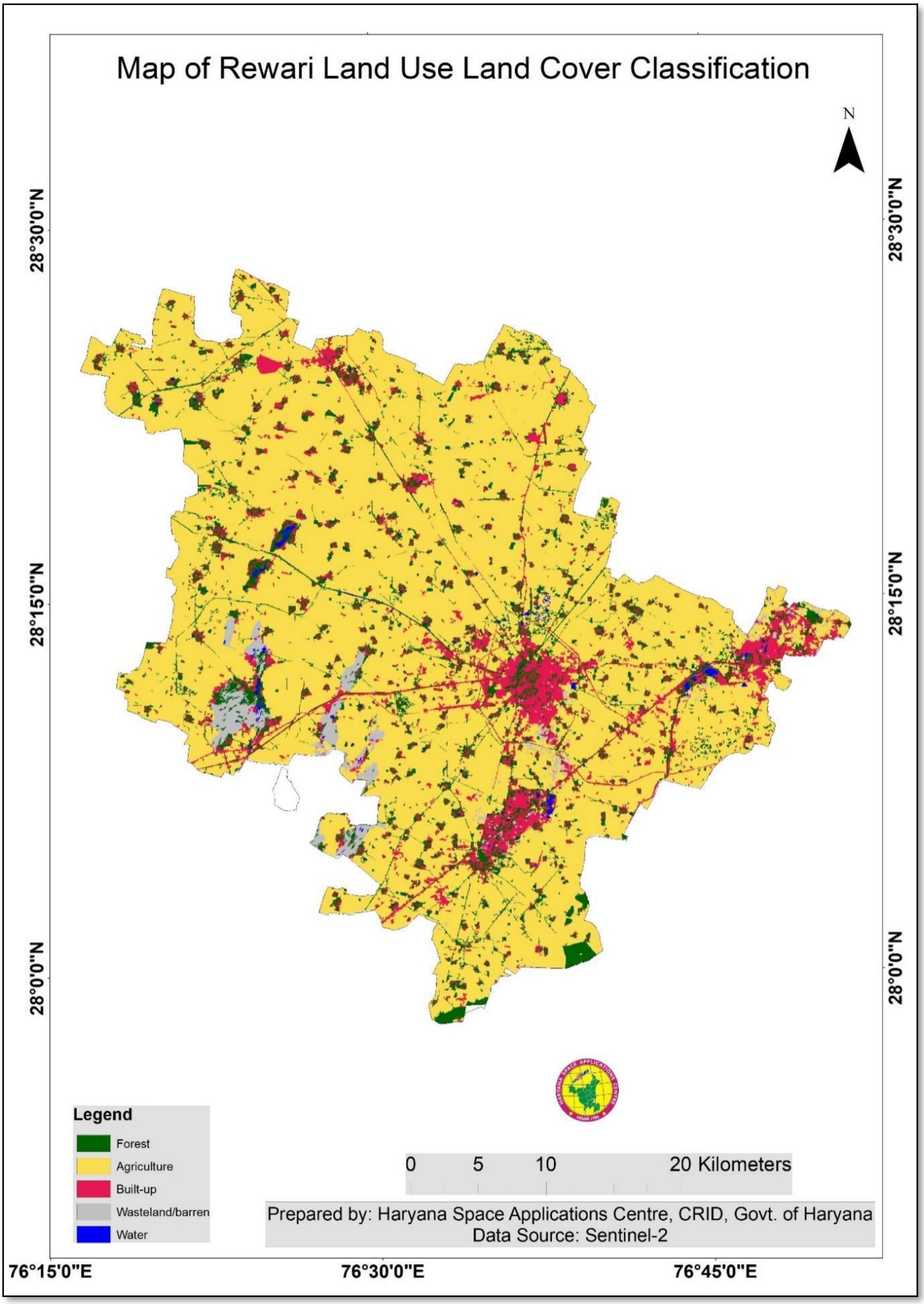


Figure 9 -Land use and Land cover of Rewari District

2 District Water Profile

2.1 Source of Water

The district is occupied by Indo-Gangetic alluvial plain of Quaternary age, and falls in Ghaggar basin. The principal ground water reservoirs in the area are unconsolidated alluvial deposits of quaternary age. Hard rocks also have some amount of ground water which circulate through joint, fractures & cracks. Over most part of the area ground water occurs under phreatic conditions, whereas in deeper water bearing zones which are overlain by impermeable clay it occurs under semi confined to locally confined conditions. The hand pumps and shallow tubewell are tapping the shallow aquifers, which are widely used for the domestic purposes. CGWB has drilled 16 exploratory borewells and 5 piezometers to delineate and determine potential aquifer zones, evaluation of the aquifer characteristics. The deepest slim hole was drilled up to the depth of 203.85 m at Chandanwas. Alluvium comprises very fine to coarse sand, gravel, silt and clay with kankar in varying proportions. The permeable granular zones comprising sand and occasionally coarse sand and gravel. Their lateral and vertical extent is limited. The borehole data reveals that clay group of formations dominate over the sand group in the district area. The discharge of deep tubewell in the area varies between 358 and 2911 lpm. The transmissivity values range from 110 to 1060 m2 /day and storability ranges from 1.14*10-3 to 4.36*10-3.

The drinking water supply is mainly through ground water in the district. Public individually as spot and convenient source of water meets the short fall in water supply to towns, cities and villages with the installation of hand pumps. The shallow tube wells tap unconfined aquifer; depth varies from 30 to 150 m. The tube wells constructed by the municipal corporation and other agencies have been constructed tapping deeper aquifer down to 200m. Most of these shallow tube wells are cavity type and either run by diesel engines or electric motors. The discharge of these shallow tube wells/cavity wells range 240 - 480 lpm.

2.1.1 Rivers

The main streams in the district are Sahibi and Krishnawati rivers. Sahibi River is an ephemeral river and rises from Mewat hills in Jaipur Alwar in Rajasthan and after gathering water from several tributaries, forms a broad stream and enters the district near Ranawi after which it enters Rajasthan and then re-enters Haryana near village Jaithal. The district, except in its Eastern part is flat and sandy and absorbs all the rain water. There are heavy floods created by Sahibi River in Haryana and Delhi. To moderate these floods a barrage has been constructed near Masani village and is called Masani barrage. The Krishnawati River enters in the Southern part from Mahendragarh district and nearly makes a border between Mahendragarh and Rewari district. This is a blind river and its water gets absorbed by sandy soils. The flooding water is useful for crops and contributes to ground water reservoir. There are various other small nalas also carry rain water from the hills during monsoon season.

2.1.2 Canals

The main canal of district is Jawahar Lal Nehru canal. It distributes into Dawana Disty, Sunmakhera Disty, Bhurthal Disty, Kakauria Disty, Jitpur Disty, Raliwas Disty, Kamalpur Disty, Rajiaka Disty, Tankari Disty and Sunjarpur Disty are irrigated the largest area in the North, middle and south part of district. The Aulant and Rampurr distributes of Mahindergarh canal also irrigated the west part of District. The Pataudi minor, Hansawa minor, Loharu minor and sherpur minor are irrigated the north part of District.

2.1.3 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 features. Total no of pond in 1282 in Rewari district. The map of water bodies in Rewari district is shown in **Figure 10 & 11.**

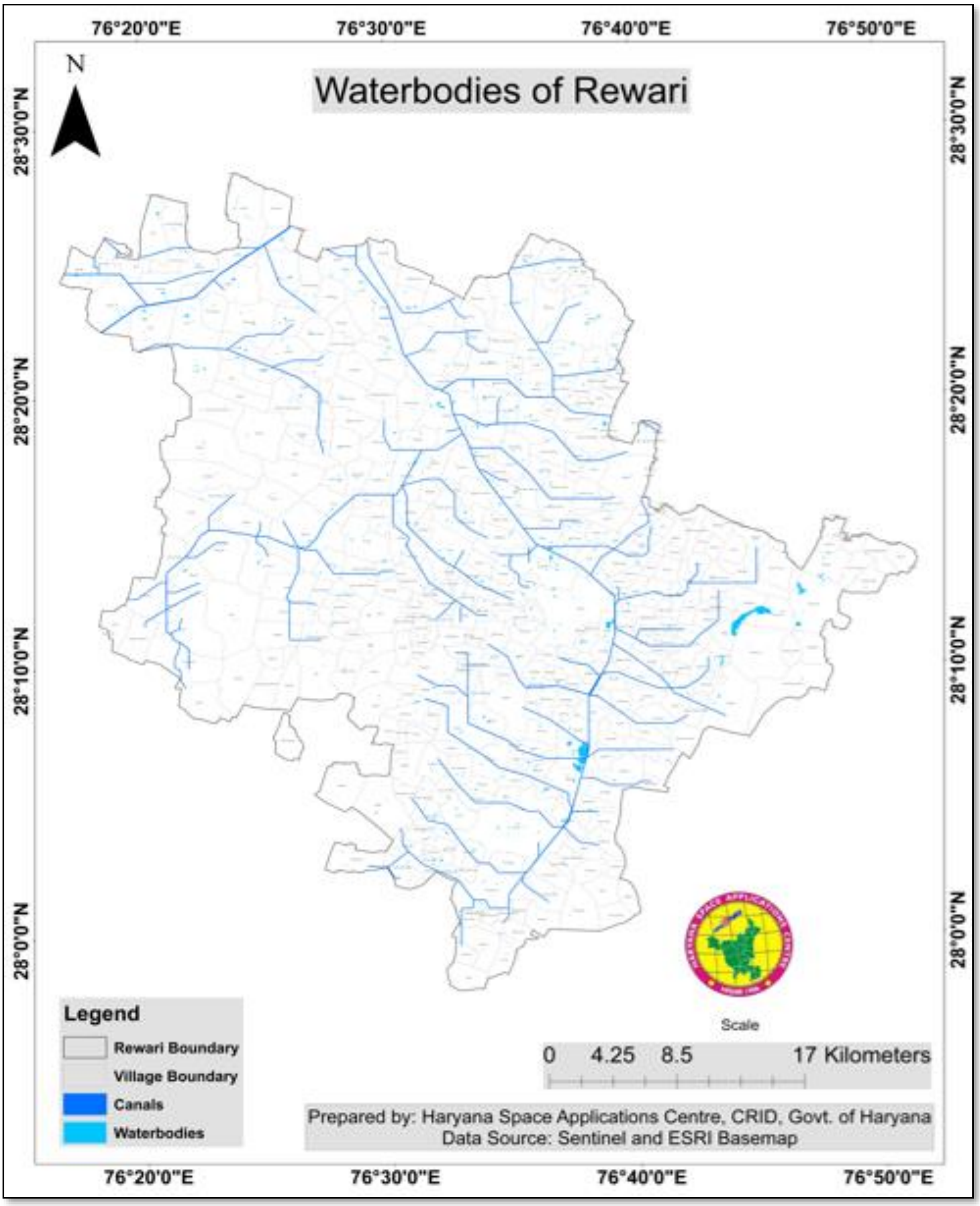


Figure 10- Water bodies of Rewari District

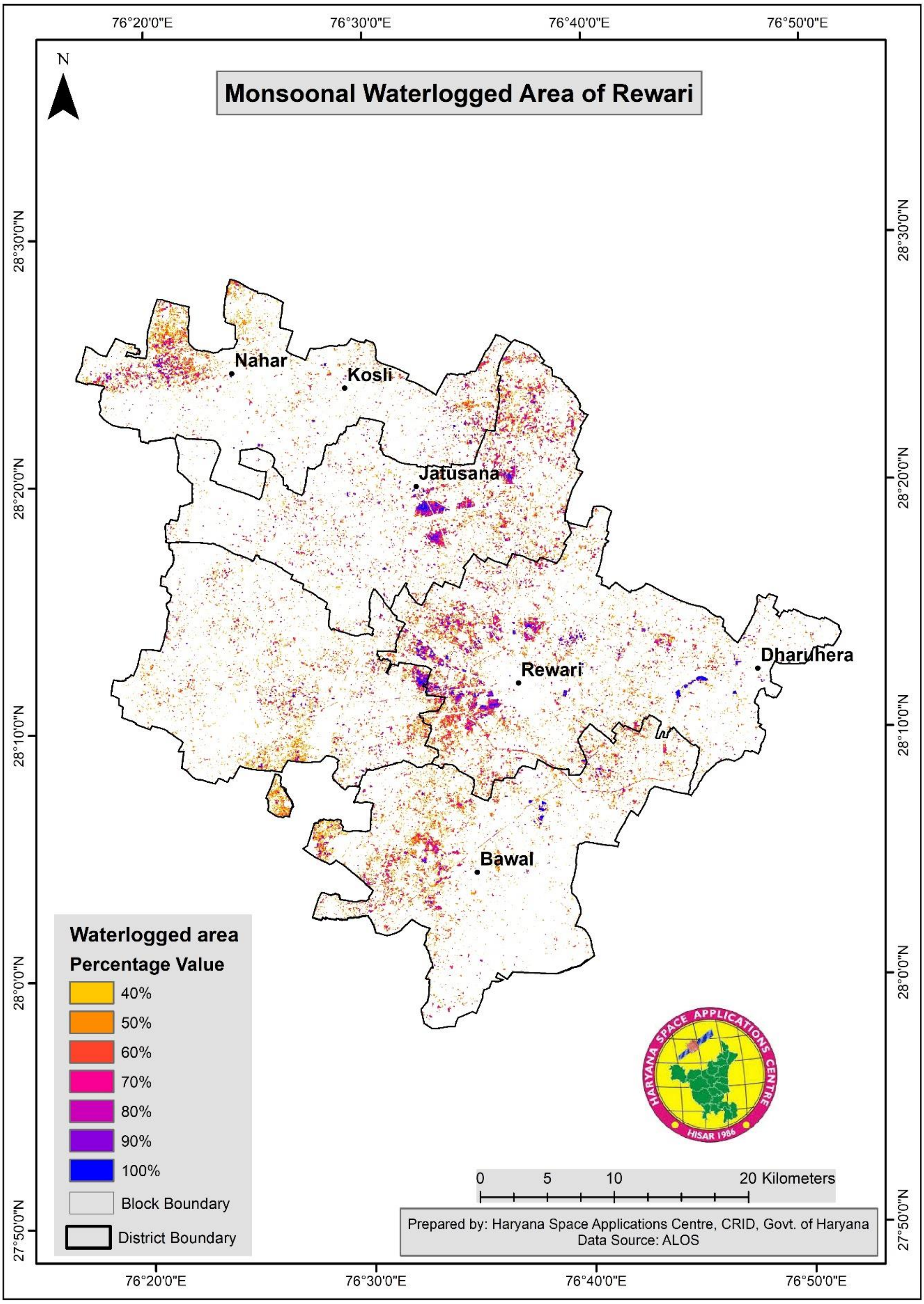


Figure 11- Monsoon Waterlogged Area Rewari District

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. The drainage of Rewari District is shown in **Figure 12** and the statistics of length of drainage of Rewari district is shown in **Table 4**.

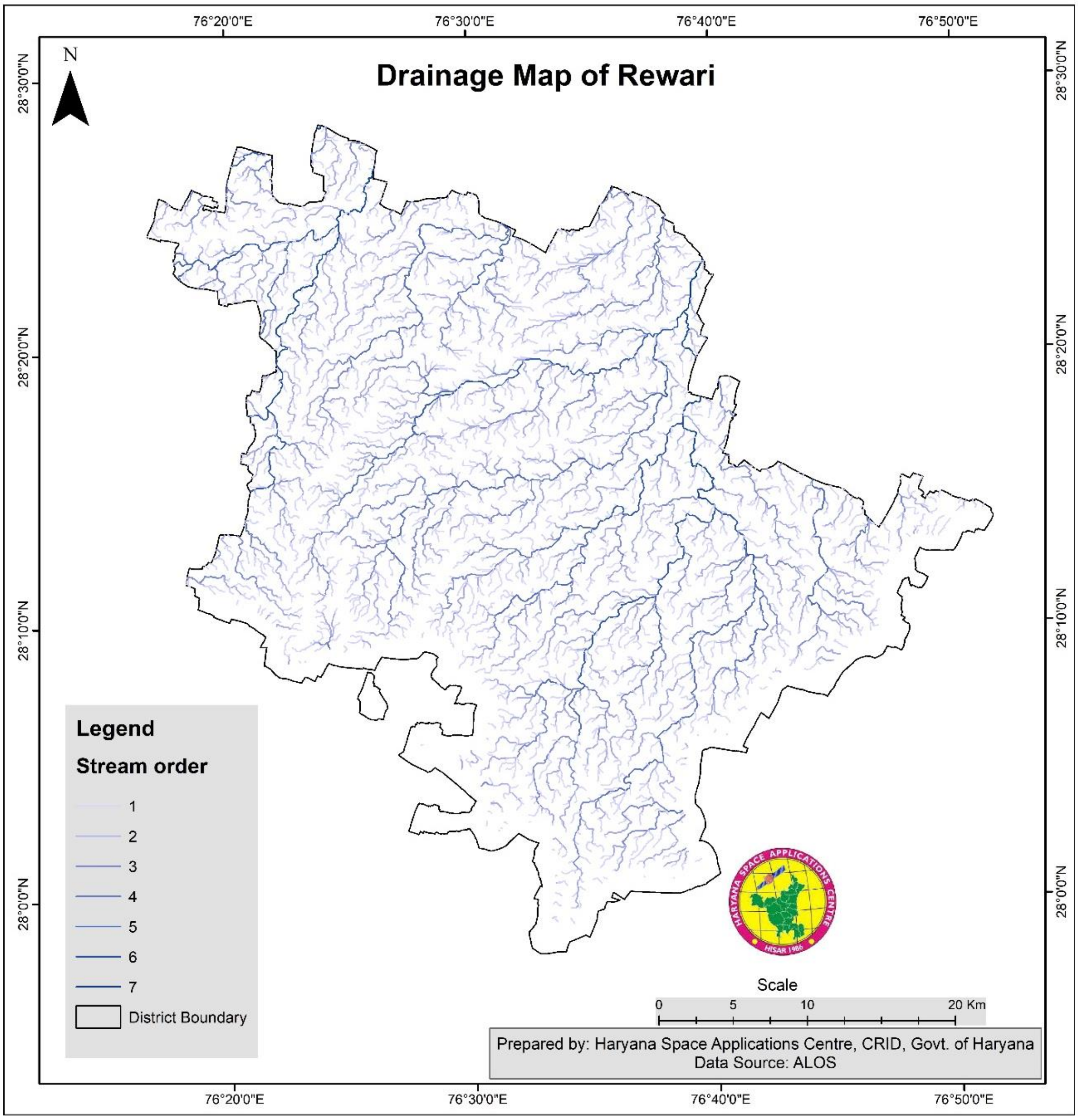


Figure 12 -Drainage map of Rewari District

Table 4 -Drainage order and total length of the drains in Rewari district

Stream Order	**Length (in meters)**
1st	1303590.16
2nd	750983.66
3rd	361724.03
4th	196480.28
5th	101023.35
6th	44680.72

2.2 Water Harvesting System

The rapid growth of rural population leads to escalation of water demand. Conservation of ground water is important because it takes years to be replenished. In areas where ground water is used, care must be taken to replenish with rainwater. A rainwater harvesting system comprises components of various stages - transporting rainwater through pipes or drains, filtration, and storage in tanks for reuse or recharge.

In general, there are three main types of rainwater harvesting systems, which include direct pump, indirect pump and indirect gravity. Mentioned below are some of the most popular rain water harvesting techniques:

1. Water butts

One of the simplest forms of rainwater harvesting is by means of water butts. This technique is extensively employed in gardens across the city. Water butts are nothing but large plastic containers that are used to collect water from the drain pipe or through natural rainfall. Water butts are mainly used in gardens for watering purposes. Purchasing a good quality water butt will last for a very long time. If you are planning on harvesting rainwater for your public garden or for a residential garden space, then such a container can greatly help you in reducing your daily water consumption. You can also pair a water butt with something like a Rain saucer, which is nothing but an upside-down umbrella. It can collect rainwater in a much efficient manner and in a much cleaner state than a gutter.

If you wish to install a rainwater harvesting system in your society or commercial space, then having a good understanding of a good complex water harvesting system can turn out to be advantageous. Harvesting such a system can assist you in your daily water requirements such as washing clothes, utensils and flushing the toilet. The two most popular water harvesting systems that you can choose from are mentioned below:

2. Gravity feed systems

The gravity feed water harvesting system is normally placed at the top a residential building. The system, as the name suggests, makes use of the power of gravity to pump water across different parts of the house. Such water harvesting systems do not require any other type of power source in the form of an electric motor or even solar power. The rainwater is usually collected off the roof of the building and is then directly fed into the filter system of the tank.

3. Pump feed system

In this type of water harvesting technique, the tank is placed at the ground level. At times, the tank is even placed under the ground, and then an electric motor pump is used to supply the collected water to the different areas of the building. You can also make use of a combined pump and gravity system that can move the conserved water at top of the building or to another tank where it can be stored before it gets distributed everywhere through pipes.

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.

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.

Mentioned below, in **Table 5** are some of the most popular rain water harvesting techniques:

Table 5 -Water Harvesting System in Rewari District

Sr.No.	Activity Name	Works Completed	Works Ongoing	Expenditure (in Lakhs)
Water Conservation and Rain Water Harvesting				
1	Check Dam		0	
2	Pond / Tank		1	
3	Trench	360	0	
4	Rooftop Water Harvesting Structure (Public)	131	6	
5	Rooftop Water Harvesting Structure (Private)	72		
6	Other Rainwater Recharge Structures (Open Well Recharge, Sand Filter for open well recharge)		0	
7	Other Water Conservation		1	

	Structures (Bench Terracing, Canal)			
Total			**8**	**1**
Renovation of Traditional and other Water Bodies / Tanks				
1	Traditional Water Bodies Restored	140	21	
Total		**140**	**21**	**36**
Reuse and Recharge Structures				
1	Soak Pit	3626	0	
2	Stabilization Pond	0	0	
3	Other Reuse / Recharge Structure	26	7	
Total		**3652**	**7**	**0**
Watershed Development				
1	Gully Plug	0	0	
2	Percolation Tank		0	
3	Staggered Trenches	77	0	
4	Other Watershed Construction Activities	51	9	
Total			**9**	**16**
Intensive Afforestation				
1	Intensive Afforestation-Nurseries	1930	3	
2	Intensive Afforestation-Plantation		56	
Total			**59**	**33**
Awareness Programs by KVK				
1	Farmer's training programs by KVKs on Water Use Efficiency and Appropriate Crops	1		
2	Distribution of one packet of vegetable seeds and saplings of five nutritious plants to farmers			

3	Awareness Programs/ Kisan Mela on the theme Valuing Water	851		
Total		**852**		
		Waste Water Treatment		
1	Use of Treated Waste Water	24		
Total		**24**		

Rooftop rainwater harvesting in Rewari District is shown in **Figure no 13**.

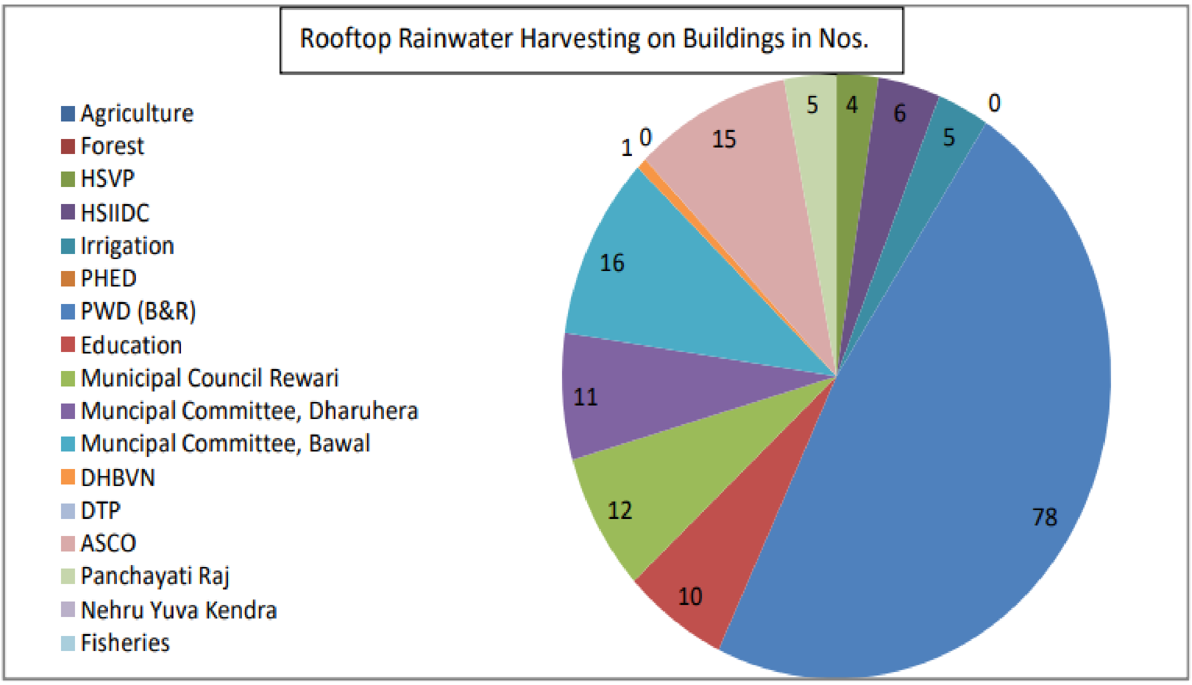


Figure 13 Rooftop Rainwater Harvesting on Building in Numbers

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 Rewari District for rain water harvesting is shown in **Table 6** at rural and urban area. The map of water conservation activity in Rewari at rural and urban level is shown in **Figure 14**.

Table 6- Water Harvesting technique in Rural area and Urban area

In Rural Area		
Sr. No.	Block Name	Total Activity
1	Bawal	325
2	Jatusana	289
3	Khol At Rewari	229
4	Nahar	256
5	Rewari	388
In Urban Area		
1	Rewari	188

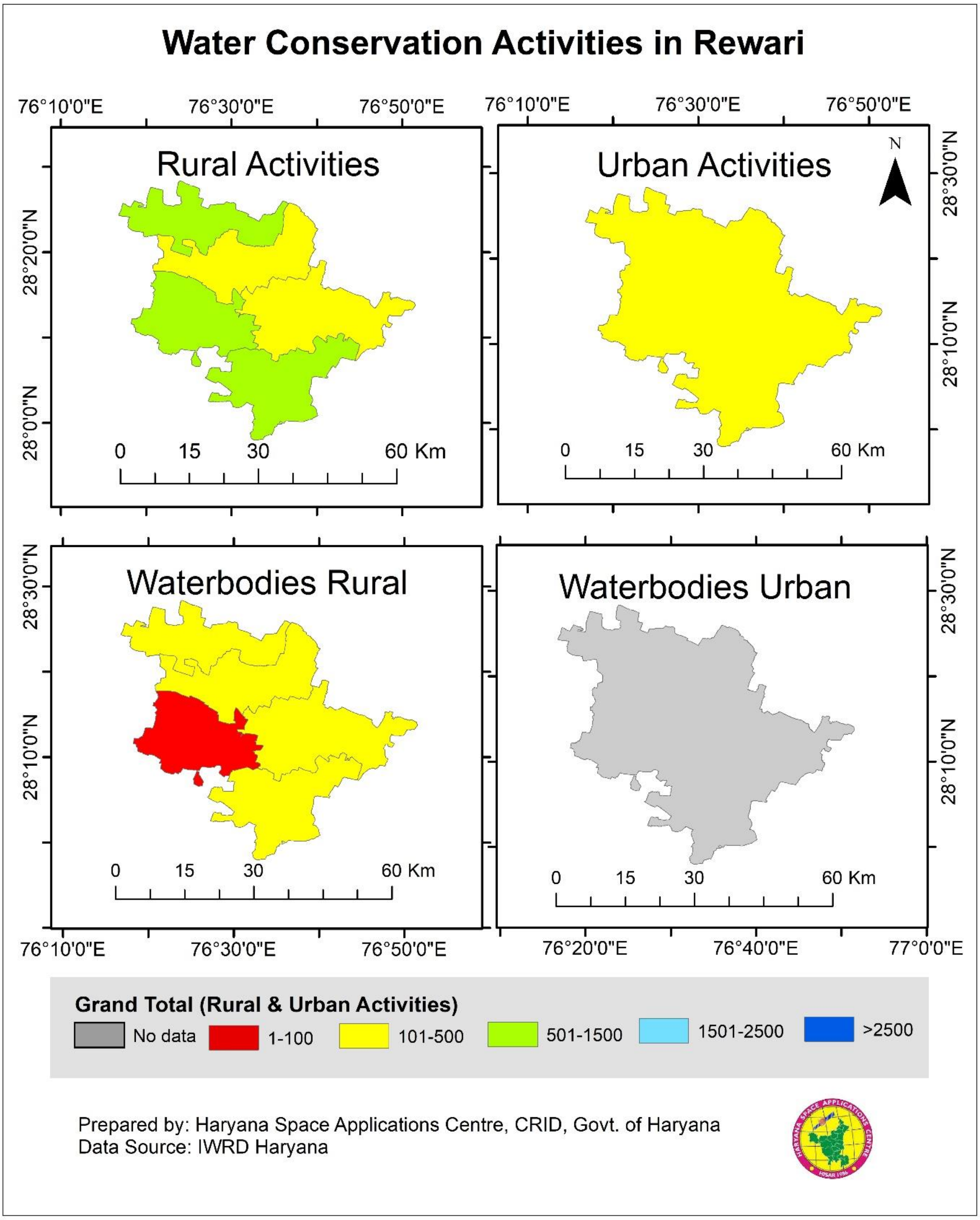


Figure 14- Water Conservation Activity in Rewari District

2.2.3 Sewerage Treatment Plant

Sewage from every residential colony, hotel, or corporate office collected in the sewage collection system. Sai Aqua fresh is a well-known Delhi, India based manufacturing company that caters to the needs of clients who are looking for the best Sewage Wastewater Treatment Plant Suppliers in Rewari**.** The purpose of a sewage treatment plant is to thoroughly treat wastewater. The sewerage treatment plant map is shown in **Figure 15**. In the Rewari District total 6 treatment plant are installed having total capacity of approx. 46 MLD.

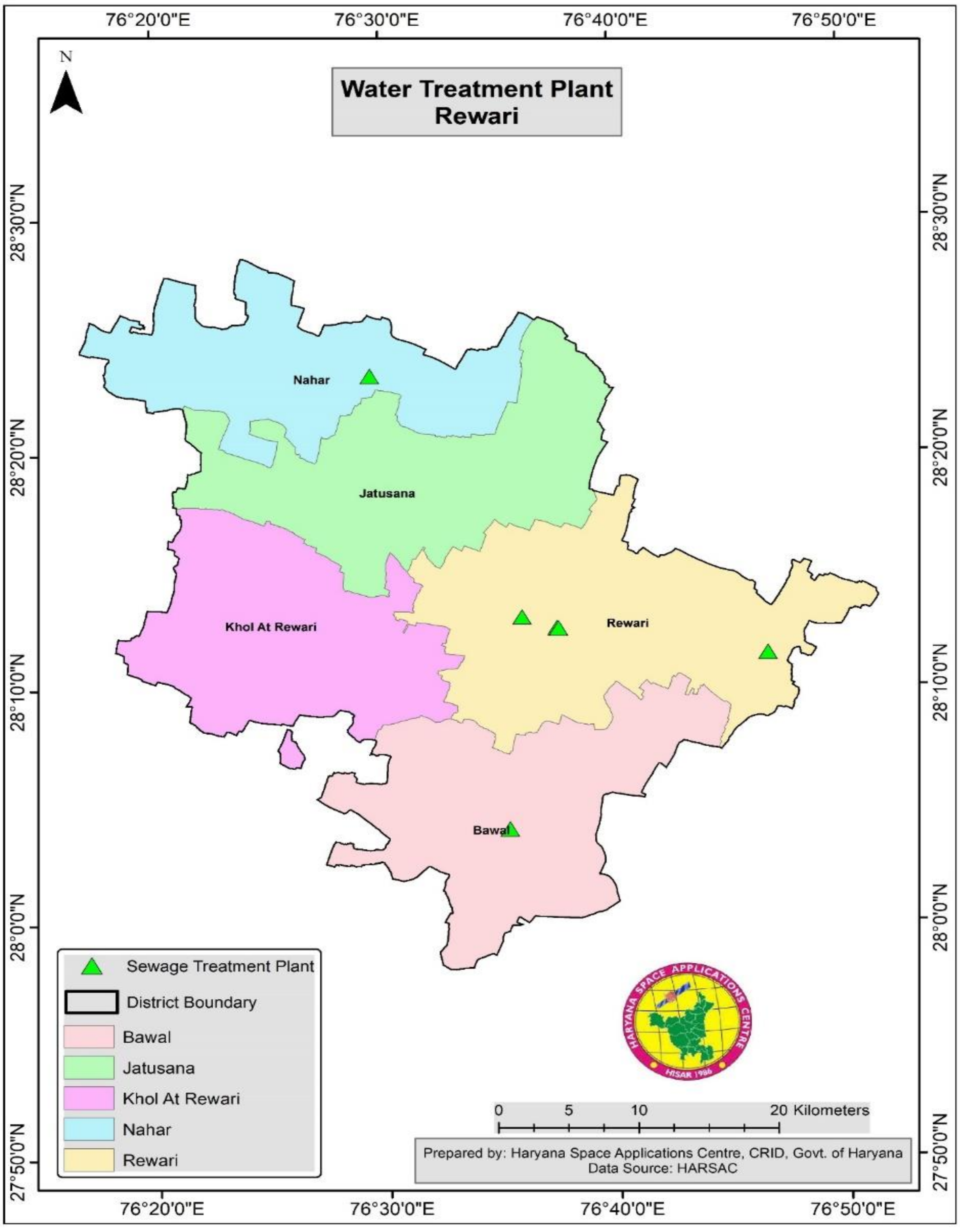


Figure 15- Water Treatment Plant in Rewari District

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. Requirement of water for agriculture has been estimated on district basis. Details of agricultural demand are calculated on the basis of average water usage of 0.068 cusecs for 4046856 sqm of agricultural land. Also, the total estimate of irrigation water demand as per Regional Plan 2021 has been adopted. Based on the above data, the irrigation water demand for 2011 and 2021 has been computed in **Table 7** below:

Table 7- Total Irrigation Water Demand, 2011 & 2021

Districts in Haryana Sub Region	Irrigable Area Acres		Irrigation Water Demand (BCM per annum)	
	2011	2021	2011	2021
Rewari	322,750	371,163	0.692	0.796

3.1 Gravitational Irrigation

Requirement of water for agriculture has been estimated on district basis. Details of agricultural demand are calculated on the basis of average water usage of 0.068 cusecs for 4046856 sq. m of agricultural land.

Drip irrigation system delivers water to the crop using a network of mainlines, sub-mains and lateral lines with emission points spaced along their lengths. Each dripper/emitter, orifice supplies a measured, precisely controlled uniform application of water, nutrients, and other required growth substances directly into the root zone of the plant.

4 Water Availability

The main streams in the district are Sahibi and Krishnawati rivers. Sahibi River is an ephemeral river and rises from Mewat hills in Jaipur Alwar in Rajasthan and after gathering water from several tributaries, forms a broad stream and enters the district near Ranawi after which it enters Rajasthan and then re-enters Haryana near village Jarthal. The district, except in its Eastern part is flat and sandy and absorbs all the rain water. There are heavy floods created by Sahibi River in Haryana and Delhi. To moderate these floods a barrage has been constructed near masani village and is called Masani barrage. The Krishnawati River enters in the Southern part from Mahendragarh district and nearly makes a border between Mahendragarh and Rewari district. This is a blind river and its water gets absorbed by sandy soils. The flooding water is useful for crops and contributes to ground water reservoir. There are various other small nalas also carry rain water from the hills during monsoon season. The agriculture constitutes the main source of economy, and most of the area fit for agriculture is being cultivated. The total irrigated area of 1430 sq.km in Rewari district is irrigated by shallow and deep tube wells.

Central Ground Water Board (CGWB) has carried out ground water exploration and various Hydro geological studies in the district. So far, 16 exploratory wells and 5 Piezometers have been drilled in the district.

The flood in Sahibi River caused heavy damages in the years 1957, 1964 and 1977. Accordingly, the work of Masani Barrage at NH-8 was started in February, 1979. But due to construction of various check dams on Sahibi River by State of Rajasthan in the meantime, the work of Masani Barrage was stopped in the year 1986 without installation of gates on the weir. Since, the late 1980s the basin of Masani Barrage remained dry except during the monsoon season of 1995 when flood water passed through it and in 1996 the water storage was created with walls in the bays at a level of 242.20 meters on crest level of barrage 240.00 meter.

In the year 2010 Lal Bahadur Shastri Recharge Channel was planned by puncturing the left embankment which act as a connecting channel to escape surplus water of JLN Canal to be stored in barrage for recharging. Since the year 2012 water has been escaped to the recharge channel during monsoon season and when the circumstances have arisen during power failure of pump houses or abrupt heavy rainfall. But for the first time in the year 2017, it was specifically planned as a policy matter to tap the potential of extra water available during monsoons and supply to Masani Barrage continuously like other canals run for irrigation purposes. Hence, the Masani Barrage was fed continuously for 66 days with 25007611 cu m water for recharging the dry basin of barrage benefiting mainly 09 adjoining villages namely Jarthal, Niganiawas, Nikhri, Rasgan, Kharkhera, Raliawas, Bhatsana, Dunjarwas & Dharuhera where ground water table has shown rise in level ranging from 1.524 meter to 7.62 meter. In this year 2018 too, continuous supply is being delivered to Masani Barrage for 104 days and 35107360 cu m water stands delivered which is nearly 40% more as compare to last year.

This recharge drive has benefited about 21,500 inhabitants of the above villages directly. Canal to Pond Recharge 184 Village Ponds were filled and maintained full with regular supplies during the monsoon period 2021.

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 Rewari districts of Haryana sub-region is shown in **Table no 8** and Total domestic water demand from 2011 to 2021 in **Table 9**.

Table 8 -Direct Source Water Availability at present

Sub-Region/City/Town	Surface Water Availability (BCM per annum)	Ground Water Availability (BCM per annum)	Remarks/Total
Rewari	0.51	0.088	No further GW can be used
Dharuhera		0.058	
Bawal		0.079	
Nahar		0.041	
Sub-Total	0.51	0.266	0.776

Table 9- Total Domestic Water Demand, 2011 & 2021

Sub-Region/City/Town	**Population**		**Domestic Demand (MLD)**		**Domestic Demand (BCM per annum)**	
	2011	**2021**	**2011**	**2021**	**2011**	**2021**
Rewari	284,750	521,099	57.23	104.74	0.0209	0.0382
Dharuhera	106,731	217,023	10.78	21.92	0.0039	0.0080
Bawal	65,493	115,800	7.92	14.01	0.0029	0.0051
Rural	611,000	596,880	43.38	42.38	0.0158	0.0155

4.2 Ground Water Availability

Groundwater has come up as a remarkable resource of water supply. Its more and more need in agriculture, industries and domestic sectors makes it as an asset of vital concern. Yearly renewable groundwater resources of the district have been observed to be about 715 million cubic meters, while the yearly groundwater extraction has been to the tune of 965 million cubic meters, thereby leaving a deficit of 250 million cubic meters. This large deficit in groundwater resources of the district can be attributed to over-utilization of the resource in four blocks out of five. These indicate towards the design of speedy Ground water management plans in the district such as artificial Recharge on large scale through rain water harvesting, regulation on development of groundwater in over-exploited and risky areas, development of groundwater sanctuaries, power tariff on withdrawal of groundwater, judicious use of water etc. These measures will certainly bridge the gap between groundwater availability (**Figure 16**) and demand in the district.

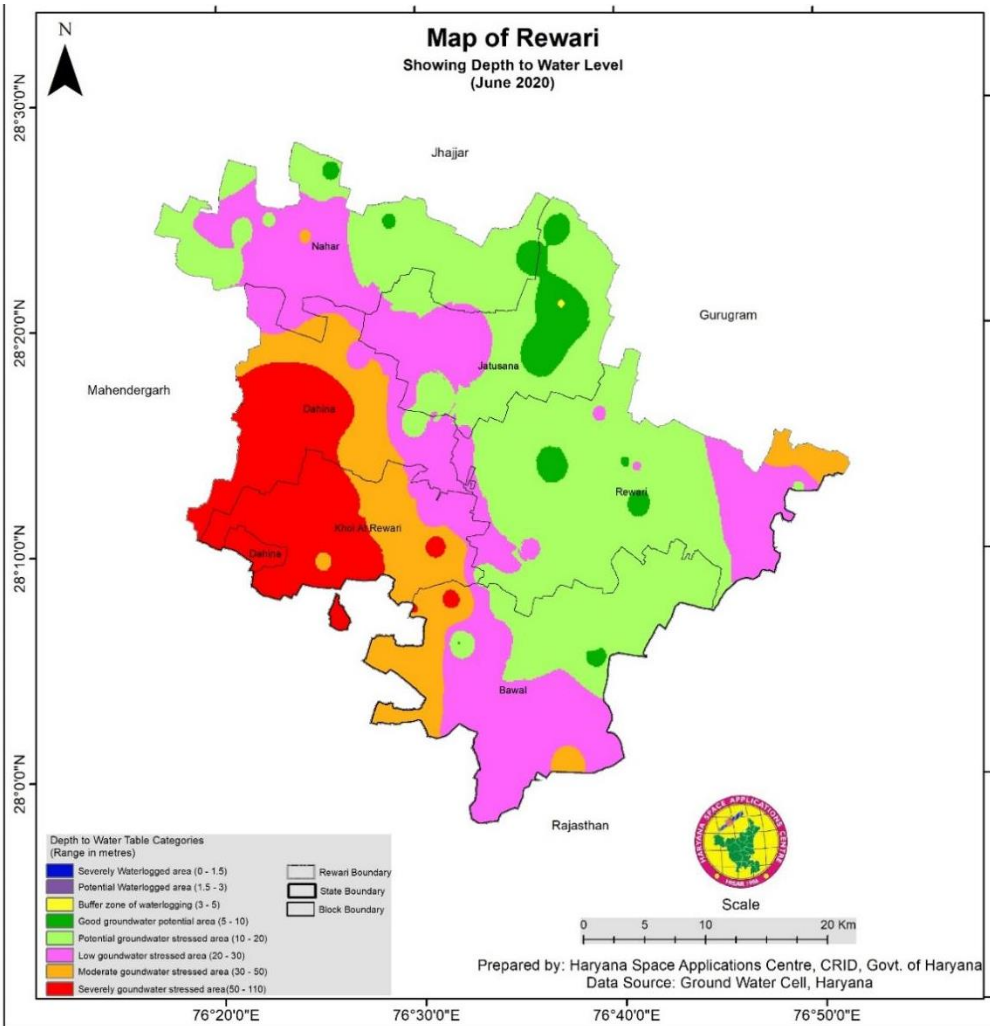


Figure 16- Groundwater Availability Map of Rewari District

4.2.1 Ground Water Quality

CGWB has carried out studies for chemical quality of ground water in the area. The ground water of the district is alkaline in nature. Ground water is highly mineralized, alkaline and soft to hard in nature. The electrical conductivity varies from 836µmhos cm at 25ºC to 13210 µmhos/ cm at 25ºC. The highest value is observed in sample collected from tubewell located in northeastern part of the city. The southern part of the Rewari city has highly saline groundwater and EC is more than 2000 µmhos/cm at 25ºC. It indicates that shallow groundwater is not suitable for drinking purposes due to constituents more than permissible limits. Among the trace elements, Iron have been found above the permissible limits.

(i) Groundwater quality for domestic purpose: The quality of water is alkaline in nature. EC is found more than permissible limits at Gangaichaj (3650µs). Balawas (5740µs) and Guriani (3040µs). Nitrate is as high as 62mg/l in Gangai, 54mg/l in Balawas and 172mg/l in Bawal. Fluoride is above permissible limits at Kosli (2.13mg/l), Bahu (2.26 mg/l), Gangaichaj (1.60mg/l), Karanwas (1.99mg/l) and Masani (2.18mg/l). The groundwater is occurring in shallow aquifers is moderately saline Apart from above, other areas have potable quality of groundwater.

(ii) The suitability of groundwater for irrigation purposes is good on soil with adequate permeability and for growing semi tolerant variety of crops. However, groundwater at Balawas area falls under C4S4 class & is not fit for irrigation and can cause salinity and sodium hazards.

In total, 143 groundwater samples from running tube wells from the block were analyzed during 2013-2014 for ionic concentration of CO_3^{2-}, HCO_3^-, Cl^-, SO_4^{2-}, NO_3^-, F^-, Ca^{2+}, Mg^{2+}, Na^+, K^+. Subsequently, electrical conductivity (EC), sodium absorption ratio (SAR) and residual sodium carbonate (RSC) were also calculated. According to AICRP classification, 39, 18, 10, 17, 3, 9 and 4 % waters in Rewari block were found to be in good, marginal saline, saline, high SAR saline, marginal alkali, alkali and highly alkali, respectively. Whereas according to Manchanda classification, 41, 19, 10, 13 and 17 % waters of Rewari block were classified under good, marginal, saline, sodic and saline sodic categories, respectively. The highest ECe in Rewari block was observed in village Chandanwas (6.29 dSm^{-1}) and lowest was found in village Janti (1.30 dSm^{-1}). Residual sodium carbonate (RSC) and sodium absorption ratio (SAR) varied from nil to 9.65 me l^{-1}, 1.14to 19.45 $(mmol - 1)^{1/2}$. Spatial variable maps of EC, SAR, RSC and water quality of groundwater used for irrigation in the block were prepared through GIS to study spatial variability. Water quality index of Rewari District is shown in **Figure 17** and block wise water quality index value is shown in **Table 10.**

Table 10 -Block wise average water quality index value in Rewari District

Block Name	Average Water Quality Index Value
Bawal	152.9
Jatusana	197.3
Khol At Rewari	137.0
Nahar	178.6
Rewari	167.5

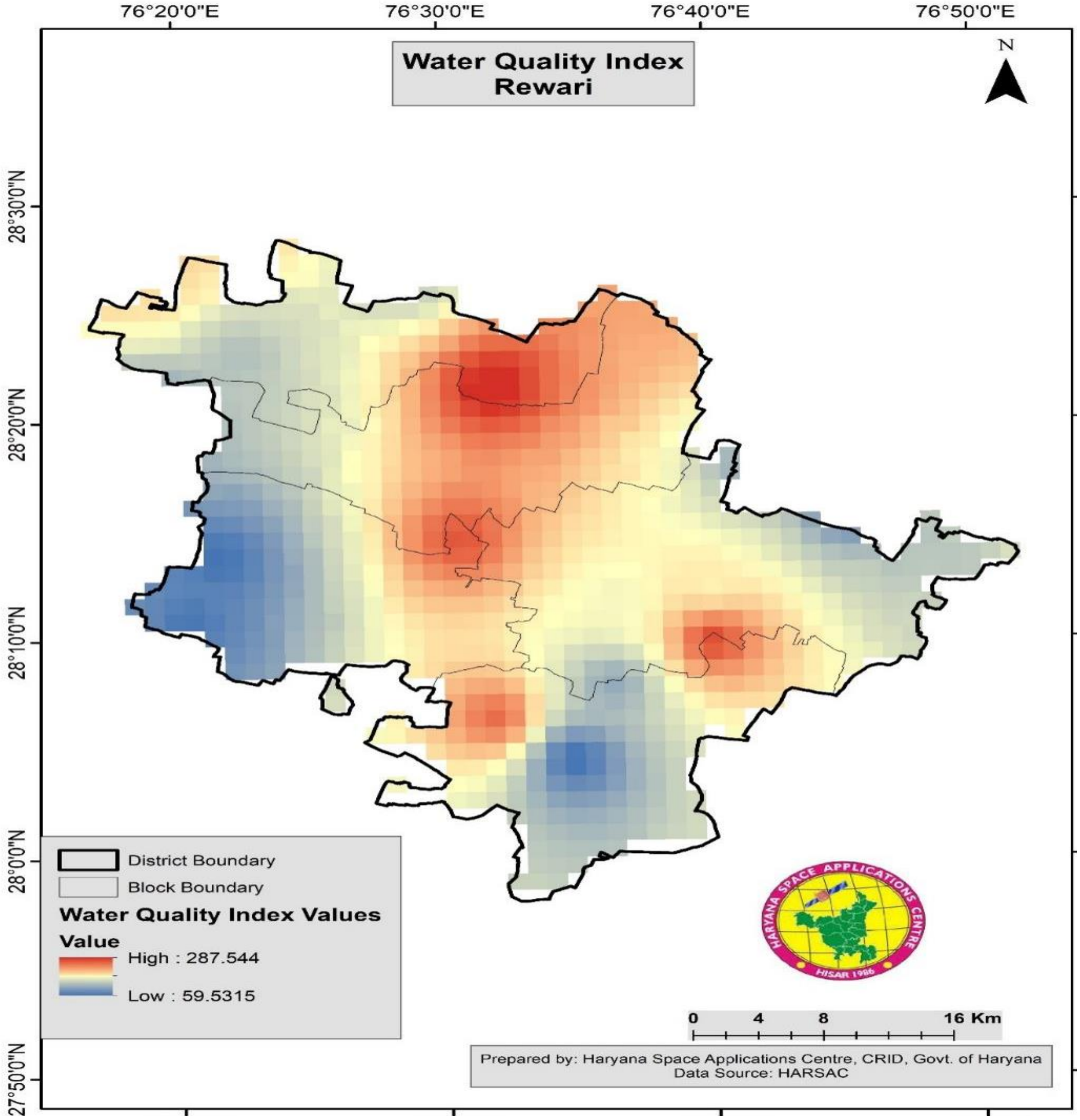


Figure 17- Water quality index of Rewari District

5 Water Requirement/ Demand

Background Water is an important resource for meeting the water requirements for irrigation, domestic and industrial uses. In the Sub-Region the ground water is extensively used for irrigation and domestic purpose. Due to tremendous increase in the requirement of ground water for agriculture, industries and by newly developed urban areas, the water levels have shown a continuous declining trend in a number of districts. On the contrary, the excessive use of canal water for agricultural purpose coupled with unfavorable geological conditions, lack of natural surface drainage.

Rural Settlements

A minimum of 70 lpcd including a supply of 30 lpcd for cattle, for independent connections: a minimum of 100 lpcd; for spot sources: a minimum of 40 lpcd which can supplement the piped supply: stand posts in rural areas: 40 lpcd; urban villages: similar to the town with which it is surrounded. Besides this, following aspects may have to be kept in view:

- The bulk requirement of institutional establishments of 20-% separately with proper justification.

- Firefighting requirement to be added to this as per norms in the CPHEEO Water Supply Manual.

- Unaccounted for water (UFW) to be limited to 15%.

- The stage of ground water development ranges between 88% (Nahar) to 170% (Khol). The net ground water resource of Rewari district have been estimated to be 260.65 MCM and the gross ground water draft of the district is 313.91 mcm leaving behind a shortfall of (-)54.68 MCM. The stage of ground water development in the district is 120%. **Table 11** shows the ground water resources of Rewari district.

Table 11 -Ground Water Resources of Rewari District, Haryana State

Assessment Unit /Block	Net Annual Ground Water Availability (MCM)	Existing Gross Ground water Draft for irrigation (MCM)	Existing Gross Ground Water Draft for all uses (MCM)	Allocation for next 25 Years for Domestic and Industrial uses (MCM)	Net ground Water availability for future irrigation development (MCM)	Stage of groundwater development %
Bawal	0.7564	0.7864	0.7934	0.0106	-0.0406	105
Jatusana	0.5145	0.5763	57.89	0.0040	-0.0659	113
Khol	0.2754	0.4608	46.79	0.0109	-0.1963	170
Nahar	0.4741	0.4150	41.67	0.0026	0.0566	88
Rewari	0.5860	0.8706	66.23	0.0179	-0.3024	151
Total	2.6065	3.1090	3.1391	0.0460	-0.5468	Over Exploited

5.1 Status of Ground Water Development

The drinking water supply is mainly through ground water in the district. Public individually as spot and convenient source of water meets the short fall in water supply to towns, cities and villages with the installation of hand pumps. The shallow tube wells tap unconfined aquifer, depth varies from 30 to 120m. The tube wells constructed by the municipal corporation and other agencies have been constructed tapping deeper aquifer down to 200 m. The shallow tube wells irrigate about 1130 sq.km. Area in the district. The discharge of these shallow tube wells/cavity wells range 240 – 480 lpm. The present stage of block wise ground water development varies from 88% (Nahar) to 170% (Khol). Out of five blocks, four fall in Over Exploited and one in Semi critical category. In Semi critical block i.e., Nahar, there is scope for ground water development but with caution, but there is no scope of largescale ground water resource development in the over exploited blocks. However, the shallow ground water can be exploited with caution through shallow tube wells (Cavity Type). PVC pipes are commonly used for constructing these tube wells.

The drinking water supply is mainly through ground water in the district. Public individually as spot and convenient source of water meets the short fall in water supply to towns, cities and villages with the installation of hand pumps. The shallow tube wells tap unconfined aquifer, depth varies from 30 to 150 m. The tube wells constructed by the municipal corporation, and other agencies have been constructed tapping deeper aquifer down to 200m. Most of these shallow tube wells are cavity type and either run by diesel engines or electric motors. The discharge of these shallow tube wells/cavity wells range 240 - 480 lpm. Ground Water Resources of Rewari District, Haryana State is shown in **Table 10**.

5.2 Water Supply and Gap

The present stage of block wise ground water development varies from 50% (Bawal) to 194% (Khol). Out of five blocks, four fall in Over Exploited and one in Semi critical category. In Critical block i.e., Jatusana, there is scope for ground water development but with caution. Shallow ground water can be exploited with caution through shallow tube wells (Cavity Type). PVC pipes are commonly used for constructing these tube wells.

The major problem in respect of ground water in the district is decline in the water level. It is apprehended that the declining ground water trend can further aggravate with installation of more tube wells. High fluoride (F) content, more than the permissible limit of 1.5 mg/l, in shallow ground water is observed a few places in the district, thus making the water harmful (unfit) for human consumption. High values of nitrates, more than the prescribed limit of 45 mg/l is also observed in shallow ground water at few places in the area.

5.2.1 Shortages in Domestic & Industrial Supply

The Rewari district summary of the drinking + industrial water shortages for the years 2011 and 2021 based on present source water availability are given in the following **Table 11**.

Table 12 Area wise shortages of drinking, industrial water in HSR

District	Present Source Water Availability BCM/Yr.	Livestock demand	Drinking +Industrial Demand BCM/Yr.		Irrigation demand BCM/Yr.		Deficit (-) /Surplus (+) BCM/Yr.	
		20th Livestock	2011	2021	2011	2021	2011	2021
Rewari District	0.776	0.00492585	0.0716	0.1348	0.692	0.796	0.0124	-0.1597

5.3 Water Budget

Block-wise disparity in groundwater availability and demand has been presented in **Fig. 18**. Negative signs in the figure indicate the water deficit whereas positive signs indicate water surplus for draft. A deficit of about 382.49 mcm water has been observed during the Rabi season, whereas a surplus of about 133.16 mcm water has been experienced during the Kharif season. The availability of surplus water during Kharif season is attributed to short duration crops of Jowar and Bajra. The average groundwater development during the study period in Rewari district has been observed as 135%. These findings advocate that further development of the resource is not possible by installing tube wells. Each and every block of the district is over-exploited excluding the Bawal block. It has been ranked as grey block with respect to the development of groundwater. This ranking of Bawal block is credited to better net yearly recharge and reasonably low withdrawal of groundwater. The groundwater resources assessment of Rewari district portrays the average standing of groundwater exploitation condition. However, there could be disparities in the standing of the groundwater regime within the district, which needs micro level investigations before any long-term groundwater management plan is launched in the susceptible areas.

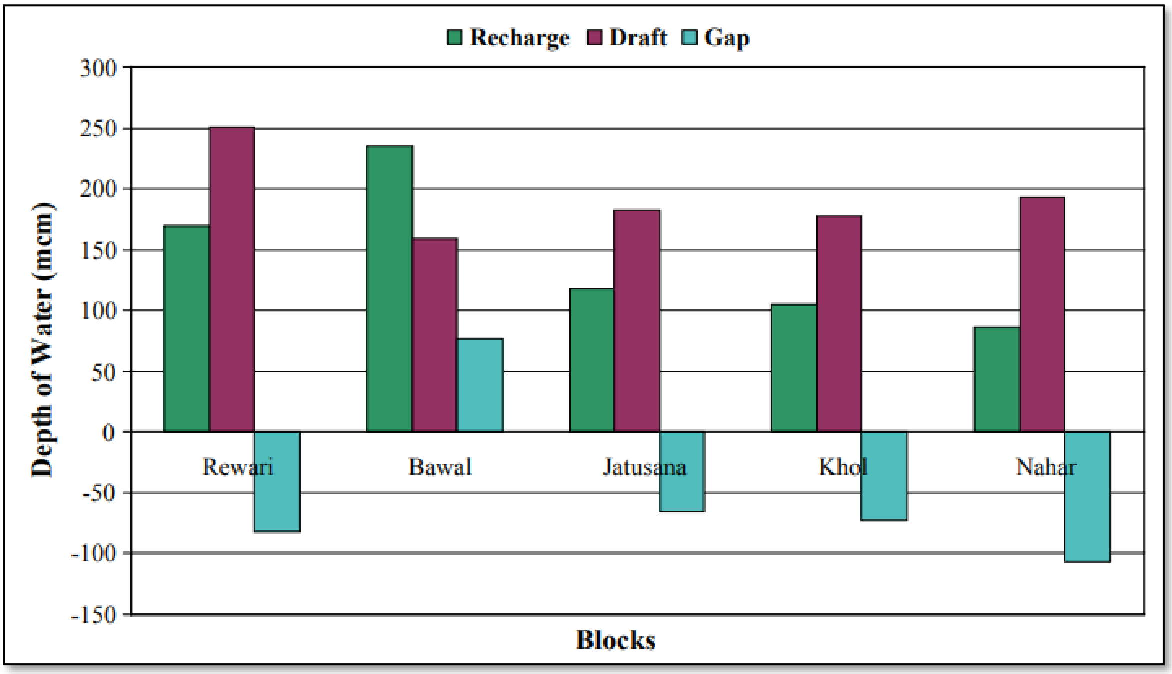


Figure 18- Block-wise variation in supply and demand of groundwater in Rewari district of Haryana

6 Strategies for Water Conservation

It is evident from the groundwater development trends of the Rewari district that it has over-exploited its groundwater resources. Moreover, on account of quick changes both in population composition and pattern of land use in the district, the groundwater resources will deplete further. Heavy duty submersible pumps have been installed haphazardly without rendering any thought to the capacity of aquifers. If precautionary measures have not been put into practice to justify the demand with groundwater accessibility, the district will be devoid of groundwater in near future. Additionally, sustainable development of groundwater resources in the district has not been taken up as yet on behalf of the policy makers as the issue merits. Therefore, an urgent and appropriate groundwater resource development and management plan for the district is urgently required to eliminate the prevailing imbalances of water resources. Implementation of following conservation and management practices will certainly help in augmentation of depleting groundwater resources of the district. Unhampered implementation of following conservation and management practices will certainly help in augmentation of depleting groundwater resources of the district.

1. The dug wells traditionally used for the monitoring the water levels area is either dried or abandoned. It is recommended to install shallow piezometers in the blocks.

2. To arrest declining trend of groundwater levels, water level should be monitored through good network of hydrograph stations uniformly distributed to represent horizontal and vertical extent of aquifer scenario.

3. High Fluoride and Nitrate areas need to be mapped and the public be educated about its harmful effect on human body. Small defluorination plants can be used and mixing of water can be practiced.

4. PVC pipe assembly may be used in case of shallow tube wells.

5. Registration of all groundwater abstraction structures are to be done and for the construction of any new tube well, prior permission should be sought.

6. Mass awareness programme should be organized to educate the people regarding consequences of mining of ground water and need for its effective/economic use.

7. Conjunctive use of canal and groundwater use should be practiced for irrigation so that stress on ground water can be reduced and saline water can also be utilized.

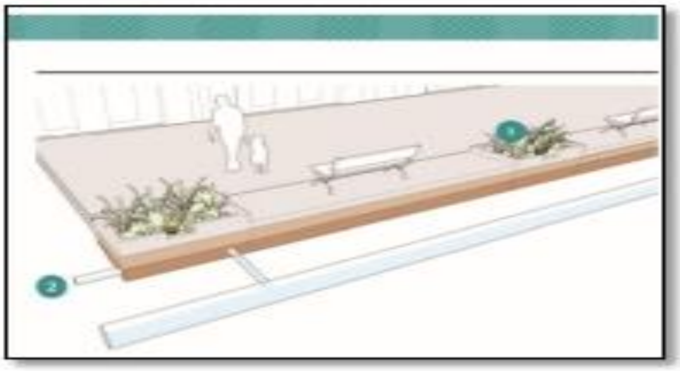
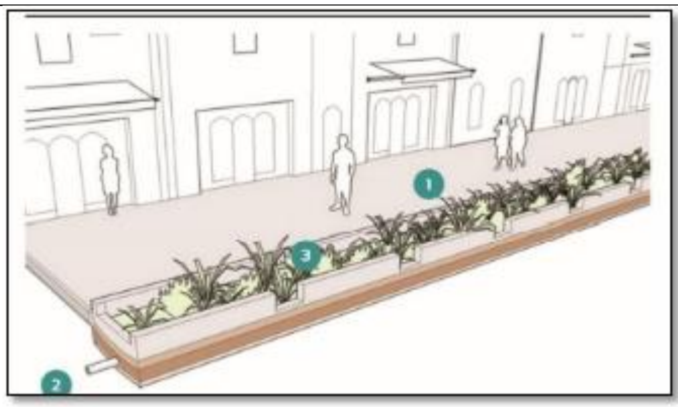
8. Farmers are to be educated about change in cropping pattern in the area from paddy to low water consuming crops.

9. Water efficient irrigation practices should be followed by farmers to reduce burden on irrigation water.

6.1 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 Ambala. 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 much scarce in terms of frequency. Table 13 shows the method of water recharge strategies in urban area.

Table 13 -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	**Storm water Tree**	

6.2 Plantation

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 Ambala 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. Wasteland map of Rewari District is shown in **Figure 19** & **Table 14**.

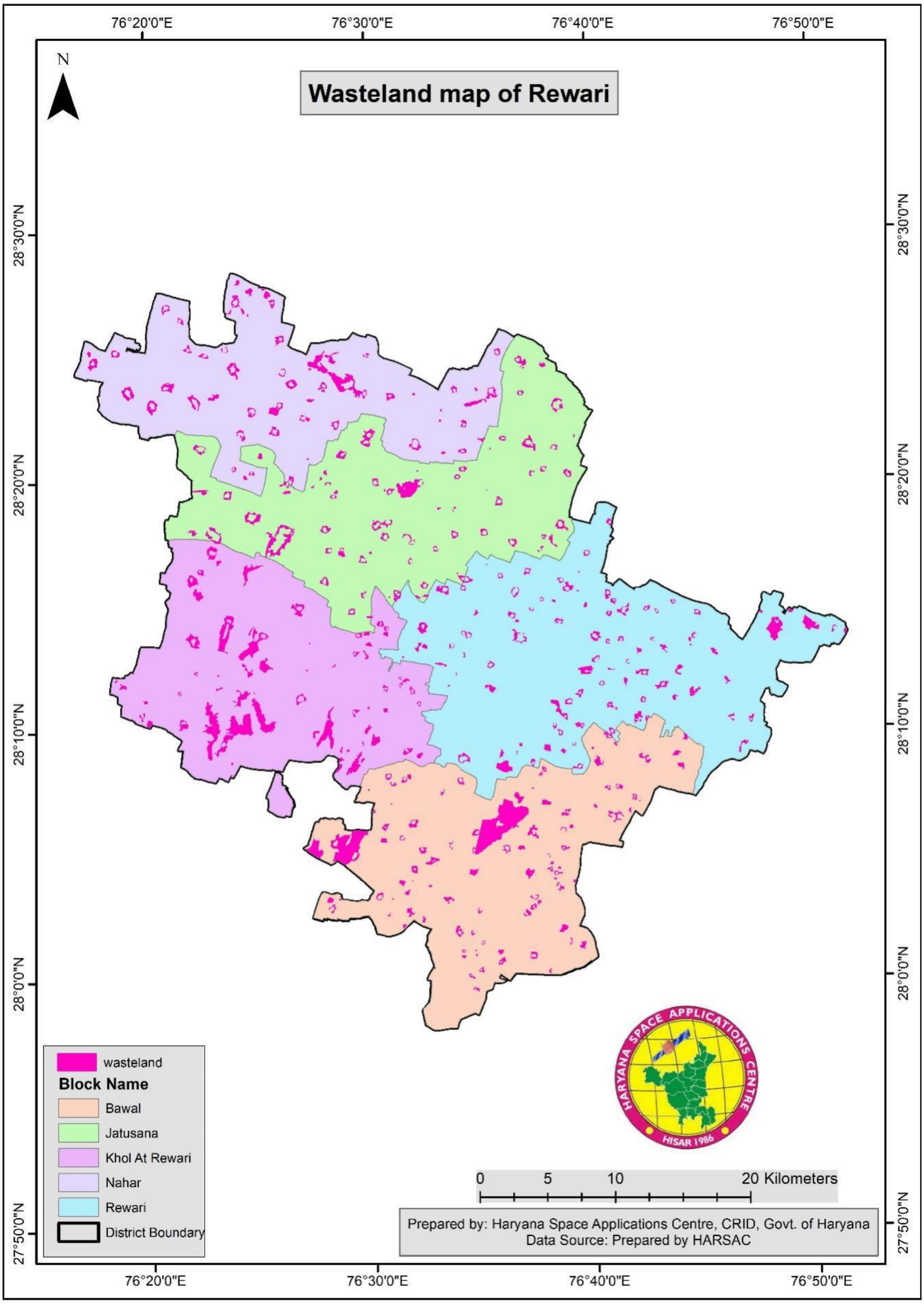


Figure 19- Wasteland map of Rewari District

Table 14- Wasteland map of Rewari District

Block Name	Wasteland Area (acres)	Plantation (potential) at 5 feet spacing
Bawal	5100.5	8885071
Jatusana	3314.8	5774382
Khol At Rewari	4816.5	8390343
Nahar	2959.8	5155972
Rewari	3532.1	6152918
Total	**19723.7**	**34,358,685**

6.3 Water Conservation and Artificial Recharge

The whole district except Nahar is suitable for ground water recharge by means of Recharge trench with injection Wells.

Groundwater Recharge from Rainfall –

Rainfall contributes towards surface runoff, groundwater recharge, deep percolation and other losses in Rewari district. The rainfall pattern in the district is erratic and non-uniformly distributed. The predominant rainy season (monsoon) in the district extends from July to September. The usual yearly rainfall in the district is 553 mm and about 85% of yearly rainfall results during monsoon season. The remaining yearly rainfall pours as winter or thunderstorm rain during pre and post-monsoon season. The rainfall statistics employed for recharge assessments have been gathered from five meteorological stations located at various block headquarters in the district. The lowest normal yearly rainfall has been recorded at Khol (298 mm) whereas highest yearly rainfall has been recorded at Rewari (619 mm) (Table 2). For the computation of rainfall recharge, 50% of the total rainfall has been taken as effective rainfall. The amount of rainfall recharge has been computed by multiplying the 50% amount of rainfall (m) with the area (m) of the respective blocks (Mathur and Jain 1981; Gaur 2001) shown in **Figure 18**.

6.2.2 Groundwater Recharge by Percolation from Water Conservation Structures

The district has a rich heritage of various water conservation structures such as tanks, ponds, percolation tanks, embankments, water harvesting structures which have been constructed by the residents in ancient times. Although, many of these structures are out of use due to faulty upkeep. However, water collected in these structures in rainy season contributes to the groundwater through infiltrations. All over, a record of 780 such structures have been compiled and greatest number of them have been found in Khol, Rewari and Bawal blocks of the district. Gross storage from these structures has been calculated by multiplying the number of water conservation structures with their storage capacity. Out of the total gross storage 75% storage has been taken as Kharif recharge, while remaining 25% has been taken as Rabi recharge (Omvir Singh and Rekha Sharma et. al). Groundwater recharge patterns in Rewari district of Haryana (mcm) is shown in **Figure 20** & **Figure 21**. Ground water recharge patterns have been shown in **Table 15**.

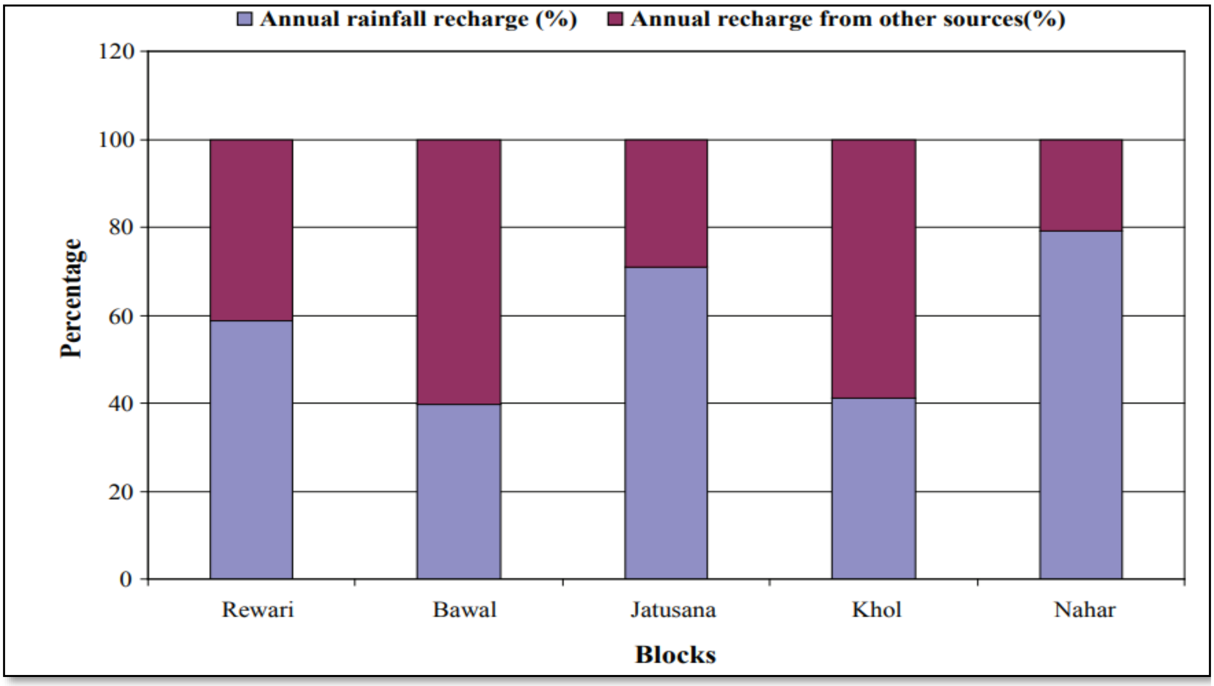


Figure 20- Share of groundwater recharge through various sources in Rewari district of Haryana

Table 15 Groundwater recharge patterns in Rewari district of Haryana (mcm)

Block	Recharged during Kharif season(monsoon)					Recharged during rabi season(non-monsoon)					Annual recharge (sum total of 1–10)
	Rainfall	Return flow from irrigation	Canals seepage	Fluctuation in water table	Water conservation structures	Rainfall	Return flow from irrigation	Canal seepage	Fluctuation in water table	Water conservation structures	
	1	2	3	4	5	6	7	8	9	10	11
Rewari	88.94	0.52	23.89	11.94	2.76	10.82	2.41	23.38	3.98	0.92	169.57
Bawal	83.84	0.47	63.86	7.64	2.13	9.18	2.12	62.50	2.55	0.71	235.01
Jatusana	75.54	0.51	6.63	12.49	1.17	8.08	2.53	6.49	4.16	0.39	117.98
Khol	37.78	0.58	32.07	−7.81	4.37	5.38	2.34	31.39	−2.60	1.46	104.95
Nahar	61.11	1.10	2.30	7.11	0.51	7.16	2.21	2.25	2.37	0.17	86.29
Total	347.20	3.18	128.75	31.37	10.94	40.63	11.62	126.01	10.46	3.65	713.80

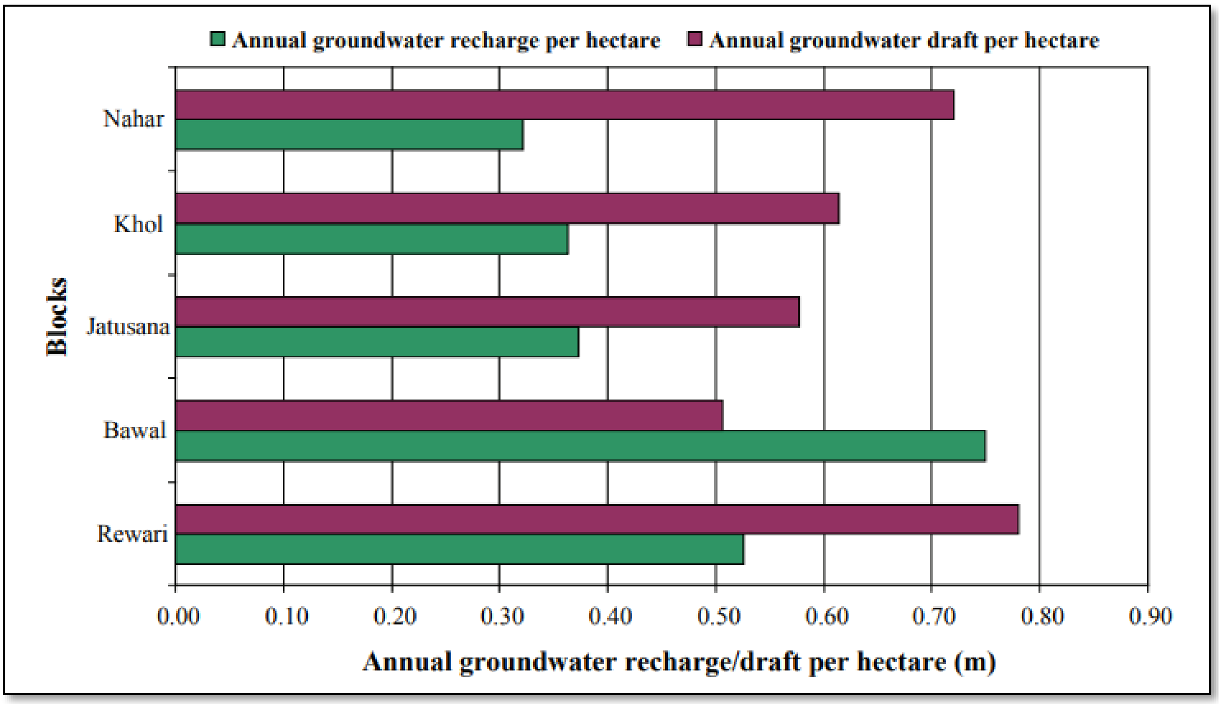


Figure 21- Block-wise yearly groundwater recharge per hectare vs. yearly groundwater withdrawal per hectare in Rewari district of Haryana

6.4 Surface water management

6.4.1 Pond restoration and rejuvenation

Rainwater detention and artificial renewal of groundwater has been welcomed worldwide as remedial and practical measures for increasing groundwater availability and for capturing the falling trends of groundwater levels. Water supply in Rewari district, where rainfall is irregular and restricted within 2–3 months of the year can be increased by improved water detention and artificial renewal structures. Rainwater detention and artificial repletion of rainfall can enhance surface water resources, thereby resulting an increase in the quantity of groundwater resources (Sikdar et al. 1994). These technological interventions have shown excellent results regarding an increment in the availability of groundwater resources. Not only this, these interventions have checked the falling rate of groundwater levels and moderation of surplus runoff. The application of these techniques will further improve soil moisture, recharge of aquifers and irrigation potential of the district. Implementation of these techniques in the state of Haryana have shown an increment in the levels of groundwater to the tune of 0.25–0.70 m (Jha 2007). Moreover, construction of small water reservoirs (percolation tanks and shallow tanks) at suitable locations will increase the availability of surface water resources in the district, resulting an enrichment in groundwater reserves at the lower reaches.

Judicious Use of Water - Judicious use of water refers to the multipurpose use of waters in an integrated way, so that returns may be more than the gross output, whenever an individual opening is applied one by one. To increase the availability of groundwater resources in the district, several schemes with respect to judicious use of water should include, for example (1) enhancement of canal water by siphoning the groundwater through lifting tube wells along the canal systems (2) storage of rain water in open water bodies for usage in combination with canal and groundwater (3) application of good quality groundwater in rotation with canal water and vice-versa. By adopting conjunctive use water techniques maximum returns can be achieved without degrading the water resources of the region.

Treatment of Waste Water - There is a great potential for reuse and recycling of waste water from domestic and industrial sectors of the district. It has been observed that thousand liters of sewerage water is produced every day in different towns. An additional potential of water will be available for reuse if the generated waste water is treated and recycled. Adoption of this practice will thereby reduce the pressure on aquifers.

Pricing and Higher Power Tariff on Withdrawal of Groundwater - Since water is available without any financial liabilities in the district. Therefore, undue advantage of non-pricing of water is being taken by the effluent farmers and societies. Pricing of groundwater to commensurate, with demand can play a very important role in increasing water use efficacy in the district. Furthermore, rate of groundwater withdrawal is also intimately related to the power tariff. A major part of electricity delivered to the agriculture sector is used to pump groundwater for irrigation. Presently, power is supplied to rural areas at highly subsidized rates rather than based on actual power consumption. The highly subsidized rate, combined with efficient and reliable power supplies encourages the indiscriminate withdrawal of groundwater and sale of water in informal water markets. The higher tariff rates of energy would work as a limit for farmers to cultivate water demanding crops. Higher energy tariff rates will perform like an environmental tax, which the agriculturalists of the district have to reimburse for groundwater extraction. Moreover, separate feeders for domestic and agricultural sector will check the further exploitation of groundwater resource. This experience has paid good dividends in the effective controlling of the electricity consumption and thereby reducing groundwater withdrawal in Gujrat (Jha 2007).

Development of Groundwater Sanctuaries - Environmentally least affected landform in the Rewari district is Aravalli hills. Blessed with equitable biota these hills are well-known for their green belts. Moreover, these hills are also the potential recharge zones for aquifers. Therefore, these hills need to be protected as groundwater sanctuaries in the district.

6.4.2 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 center and rural areas where open drainage systems still exist. Over the past three decades, the city limits of Rewari 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.

6.5 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. The following image shows the various stakeholders involved in IEC Activities is shown in **Figure 22**

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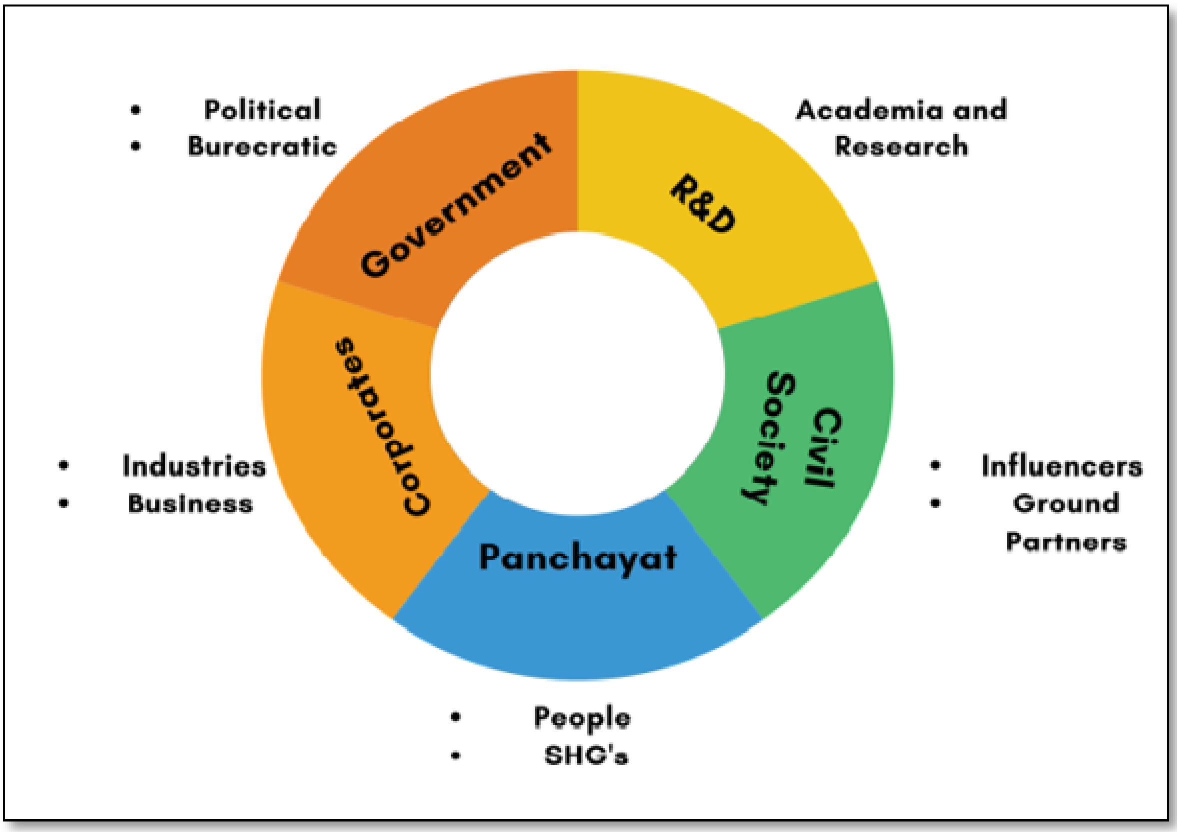

Figure 22 -The above figure shows the various stakeholders of IEC Activities

7 Proposed Activity

7.1 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 23**). The block wise area proposed for rainwater harvesting under most suitable sites is shown in **Table 16.** For the process of calculating suitable site a fixed weightage is needed to be applies on the above-mentioned criteria (**Table 17).**

Table 16- Block wise area under very good suitable site proposed for rainwater harvesting

Block Name	**Area (Very Good suitability area in Sq. meter)**
Bawal	141960684.1
Jatusana	163645343.4
Nahar	140060814.5
Rewari	221693074.7
Khol At Rewari	95505602.91
Total	762865519.7

Table 17- Assigned Weight for criteria parameters

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

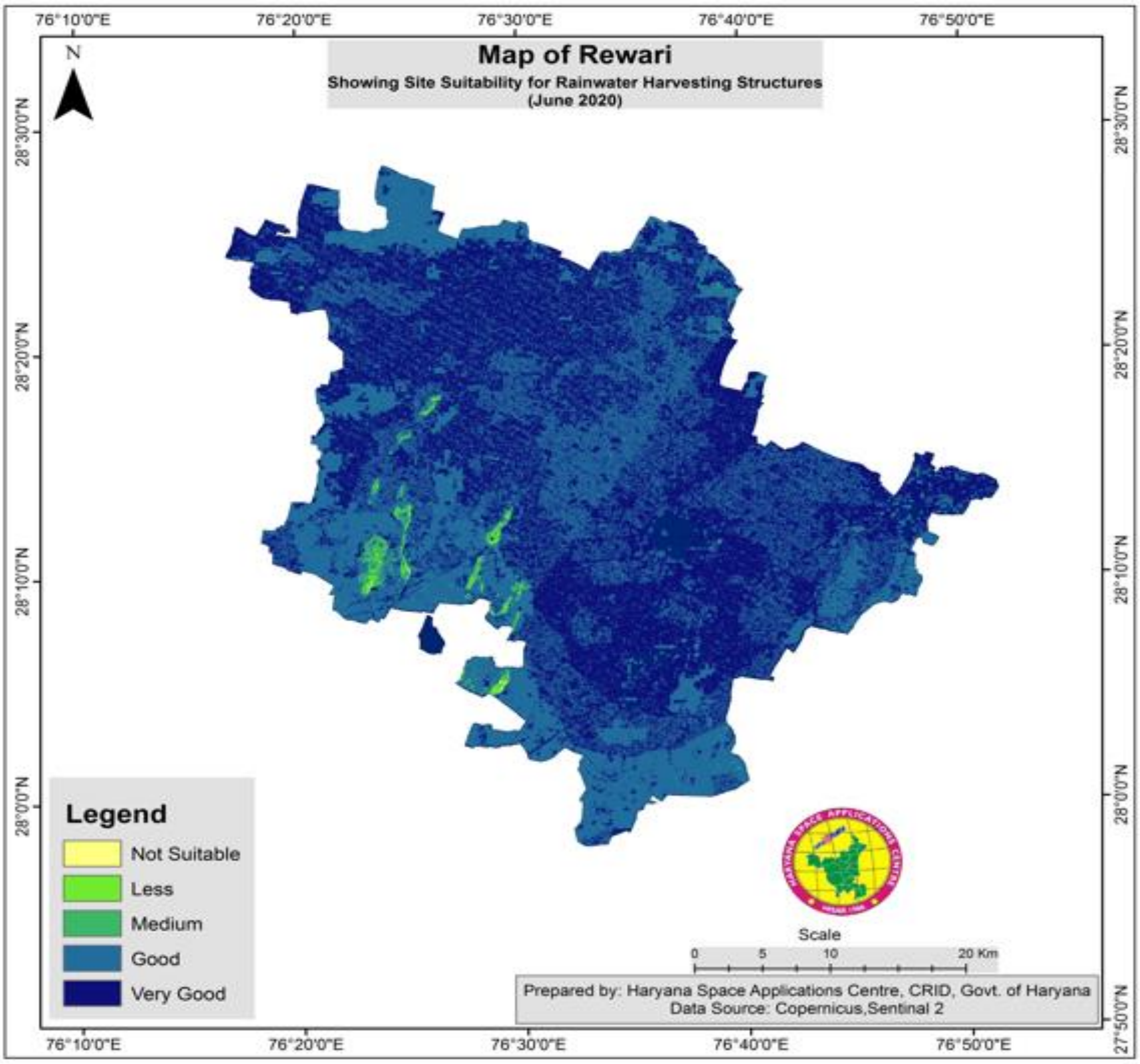

Figure 23- Site Suitability Map for Rainfall Harvesting Structure in the Year 2020

7.2 Proposed Suitable Site based on 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 24** shows the proposed suitable site based on multi criteria. Block wise proposed suitable sites based on multi-criteria is shown in **Table 18**.

Table 18- Block wise proposed suitable sites based on multi-criteria

Sr. No.	Block Name	Mini percolation Tank	Percolation Tank	Pakka Check Dam	Annicut	Micro Irrigation Tank
1	Bawal	-	-	-	-	-
2	Jatusana	-	-	-	-	-
3	Nahar	-	-	-	-	-
4	Rewari	-	-	-	-	-
5	Khol At Rewari	-	1	-	-	-

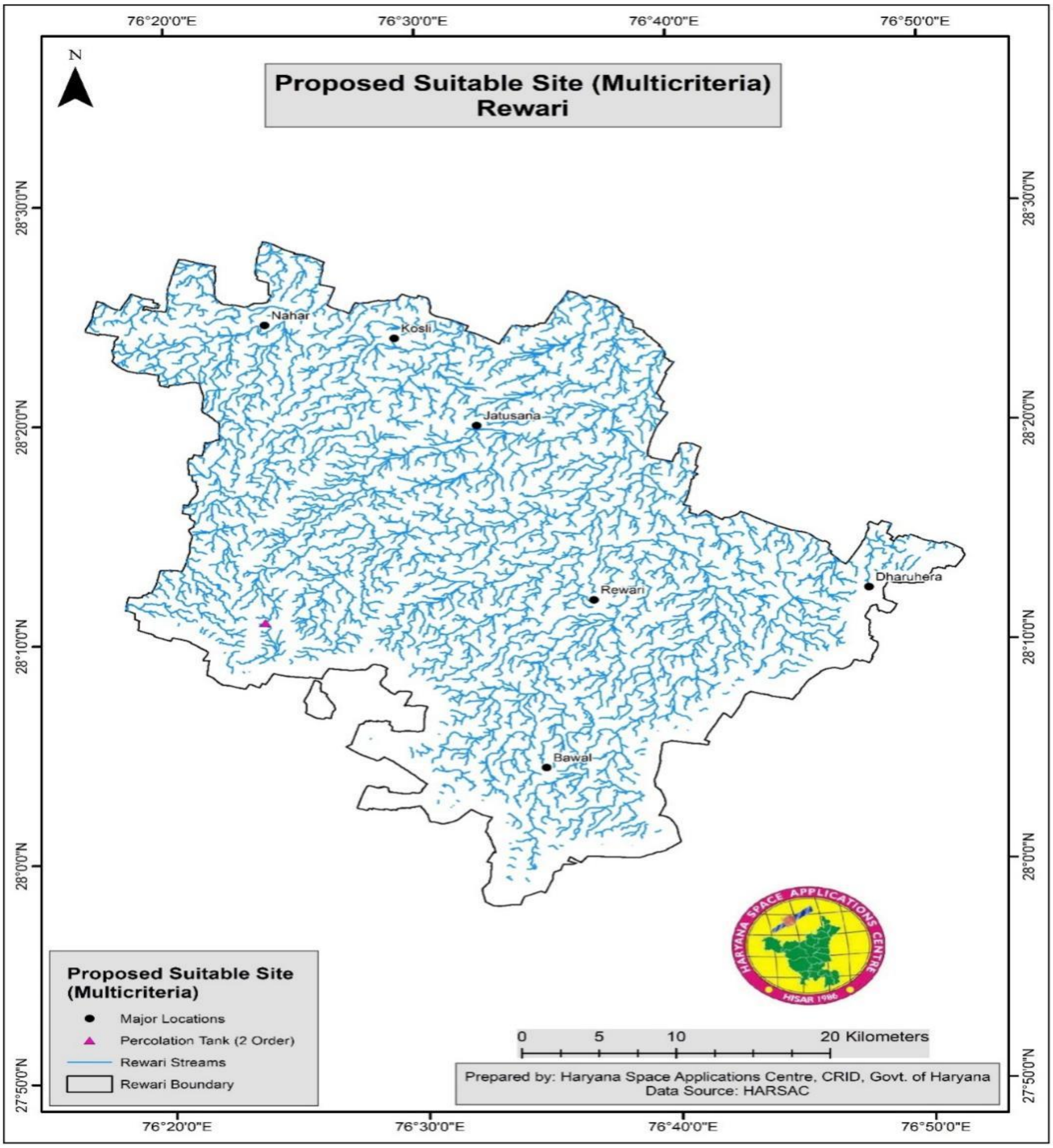

Figure 24 -Proposed suitable sites based on Multicriteria in Gurugram District

7.3 Proposed Suitable Site based on Drainage

The drainages that are created from satellite imagery can be used as base for the water harvesting structure. 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, 2nd Order Stream, pakka check Dams 3rd Order Stream, Micro Irrigation tanks 4th Order can be built. **Figure 25** shows the proposed suitable sites based on drainage structure in Rewari district. Proposed harvesting structures in Rewari based on drainage **Table 19.**

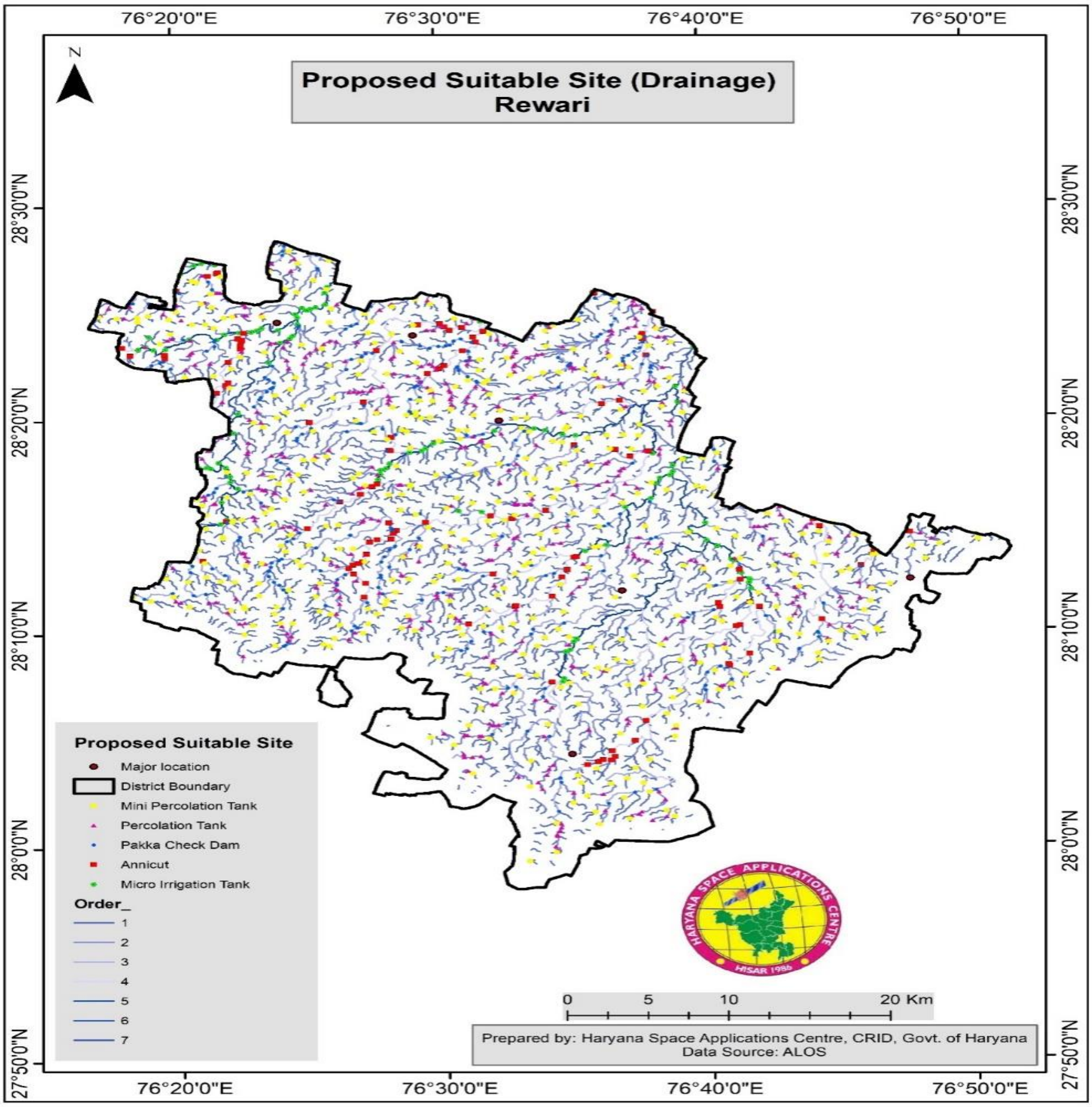

Figure 25- Proposed suitable sites based on drainage in Gurugram District

Table 19- Proposed harvesting structures in Rewari based on drainage

Sr. No.	Block Name	Mini percolation Tank	Percolation Tank	Pakka Check Dam	Annicut	Micro Irrigation Tank
1	**Bawal**	59	62	24	12	2
2	**Jatusana**	104	114	58	26	32
3	**Nahar**	79	99	85	30	35
4	**Rewari**	103	82	39	22	20
5	**Khol At Rewari**	99	84	83	21	7
	Total	**444**	**441**	**289**	**111**	**96**

Conclusion

There is water scarcity in lean season and water logging 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/water bodies, canals, natural drains, and drains based on slope are helpful in taking decisions on the construction of new structures for water harvesting. Block-wise estimates are given in the report while village level information is available at https://onemapggm.gmda.gov.in/portal/apps/webappviewer/index.html?id=dba1be50c558408cb6b06c27d337bdb4.

Heavy duty submersible pumps have been installed haphazardly without rendering any thought to the capacity of aquifers. If precautionary measures have not been put into practice to justify the demand with groundwater accessibility, then the district will be devoid of groundwater in near future. Additionally, sustainable development of groundwater resources in the district has not been taken up as yet on behalf of the policy makers as the issue merits. Denying the farmers with their ownership rights to groundwater, imposing an environmental tax on its extraction, separation of agricultural and domestic feeders for supplying power in villages, location specific recharge structures to replenish fast depleting water resource would provide the district with a buffer. A regular evaluation of groundwater assets should be prime concern of water resource managers and policy makers. Aravalli hills, which is working as a revival zone in the district need to be ensured as groundwater sanctuaries. Moreover, check dams need to be raised at the outlet of streams and hydro geologically sensitive areas to harvest the rainwater. Improved irrigation practices (sprinkler and drips) should be mimicked in order to minimize pressure on water resources. Indigenous village ponds need to be brought back into practice with community endeavor to guarantee the renewal of groundwater resources. Better water management at the individual level is the need of hour. Cropping pattern in the district should be replaced with low water consumption crops. Remarkably, mass consciousness and deployment of individuals with respect to different dimensions of groundwater management is the greatest prerequisite in the district. Finally, we must keep in our mind that the Nature can satisfy human need but not the greed.

………………………………………………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