Report No.-01

JSA-CTR

Scientific Action Plan for Ambala

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Government of Haryana

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1 Introduction

1.1 History

Ambala has claims of being one of the Historical famous Districts of Haryana State. The District was explored during British period by A.C.Cunningham and C.Rodgers and later by B.B.Lal and many others. On the basis of various literary and archeological evidences it is possible to give an outline of culture and History of Ambala District. The earliest literacy reference to the region comprising the Ambala District in the Taittiriya Aranayaka which mentions Turghna as the bordering region towards the North of Kurukshetra. This locality identified with Shrughna Sugh also finds mention in Panini (Ancient Indian Literature). It is surmised that Ambala District to have been founded by Amba Rajput during the 14th century AD. Another version is that the name is made of Amba Wala or the mango-village judging from mango groves that existed in its immediate neighborhood. Still another version is that the district has taken its name after goddess "Bhawani Amba" whose Temple still exists in Ambala city.

The earliest inhabitants of district were a primitive people using stone tools of lower Paleolithic Age. These tools were found at various sites in the district like Tarlokpur etc. Unfortunately this district has not yielded any pre Harappan or mature Harappan site. However there has been some satisfactory evidence in kins of late Harappan. The Various evidence specially that of painted grey ware pottery support the fact that the Aryans also inhabited the region. The Ambala region was included in the Kingdom of Pandavas and their successors. The Edicts of Ashoka Chiefly Topara edicts and stupas at Singh and Chaneti associate this district with Mauryan Empire which further add to the district with Mauryan Empire adding to the importance of place. The discovering of Sunga Terracotta suggests that they held this area. Several coins of Menander have also been recovered from the area. Ambala is an Agricultural/Industrial district in the north central part of Haryana. Present day Ambala however, offers an imagery of lush fields, Wheat, Basmati, industrial landscape, educated service class, and a quiet and peaceful city.

1.2 Location

District Ambala lies on the North-Eastern edge of Haryana between 27°39'45" North latitude and 74°33'53" to 76°36'52" East longitude. It is bounded by the district Yamuna Nagar in the South-East. To its South lies Kurukshetra District, while in its west are situated Patiala and Ropar districts of Punjab and the Union Territory of Chandigarh. The Shivalik Range of Solan and Sirmaur districts of Himachal Pradesh bound the Ambala district in the North and North-East. The average altitude from the sea level is 900 feet approximately. The Location Map of Ambala district is shown in Figure 1.

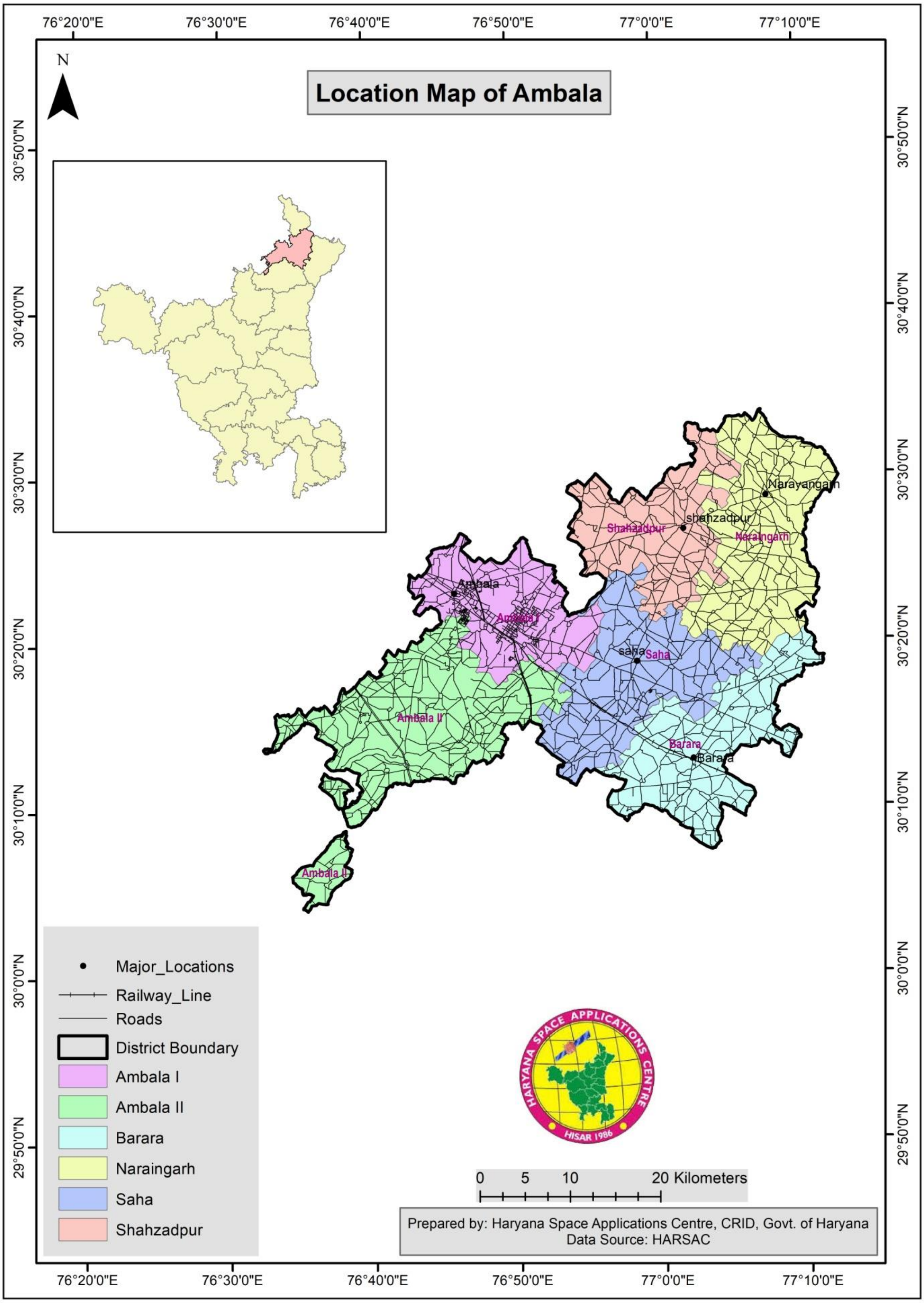


Figure 1 Location Map of Ambala

1.3 Administrative Setup

The administrative setup of the District of Ambala 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 Ambala District.

Country	India
State	Haryana
Division	Ambala
Headquarters	Gurugram
Tehsil	1. Ambala 2. Ambala Cantt 3. Saha 4. Mullana 5. Barara 6. Shazadpur 7. Naraingarh
Total Area	1258 km2
Total Population (2011)	1,128,350
Density	720/km^2
Literacy	89.31%
Vidhan Sabha constituencies	Ambala Cantt.
Website	https://ambala.gov.in
Location of Ambala	North-Eastern edge of Haryana
Coordinates	30.3752° N, 76.7821° E
Total Area	1258 km2
Elevation	264 m above the sea level

Source: https://ambala.gov.in/en.wikipedia.org/wiki

Sub Divisions (4)	Ambala, Ambala Cantt, Barara Naraingarh
Tehsils (3)	Ambala, Barara, Naraingarh
Sub-Tehsils (7)	1. Ambala 2. Ambala Cantt 3. Saha 4. Mullana 5. Barara 6. Shazadpur 7. Naraingarh
Blocks (6)	1. Ambala 2. Ambala Cantt 3. Saha 4. Barara 5. Shazadpur 6. Naraingarh
Municipal Corporation (2)	Municipal Corporation Ambala
Municipal Council (1)	Municipal Council Ambala Sadar
Municipal Committees (3)	Barara, Naraingarh
Population (Census 2011)	1,128,350
Total Villages	493
Total Panchayats	405
Village Level	Gram Panchayat
Block Level	Panchayat Samiti
District Level	Zila Parishad

Source: https://ambala.gov.in/en.wikipedia.org/wiki

1.4 Climate

1.4.1 Temperature

The climate of Ambala over most of the year is a pronounced continental in character. It is very hot in summers and markedly cold in winters. May and June can be really hot with the temperature soaring to over 48°C, while in winter it can be as low as -1°C. Ambala has a semi-arid as well as tropical climate. Being far away from the coasts and close to the Thar desert, it does not get the full share of the Monsoon current seen mostly across central and east of the country. Around 70% rainfall is received during the month of July to September and the remaining rainfall is received during December to February. Ambala is the maximum rain-hit area in Haryana with average rainfall being 47.16 inches per annum.

1.4.2 Rainfall

The normal annual rainfall of the district is 1076 mm and is unevenly distributed over the area. The average rainy days are 44. The Southwest monsoon, sets in from last week of June and withdraws in the end of September, contributing about 81% of normal annual rainfall. July and August are the wettest months. Rest 19% rainfall is received during non- monsoon period in the wake of Western disturbances and thunderstorms. Generally rainfall in the district increases from Southwest to northeast. The mean maximum temperature is 40.8° C in the month of May and June and mean minimum temperature is 6.8° C (January) of the district. The rainfall map of Ambala district is shown in Figure 2.

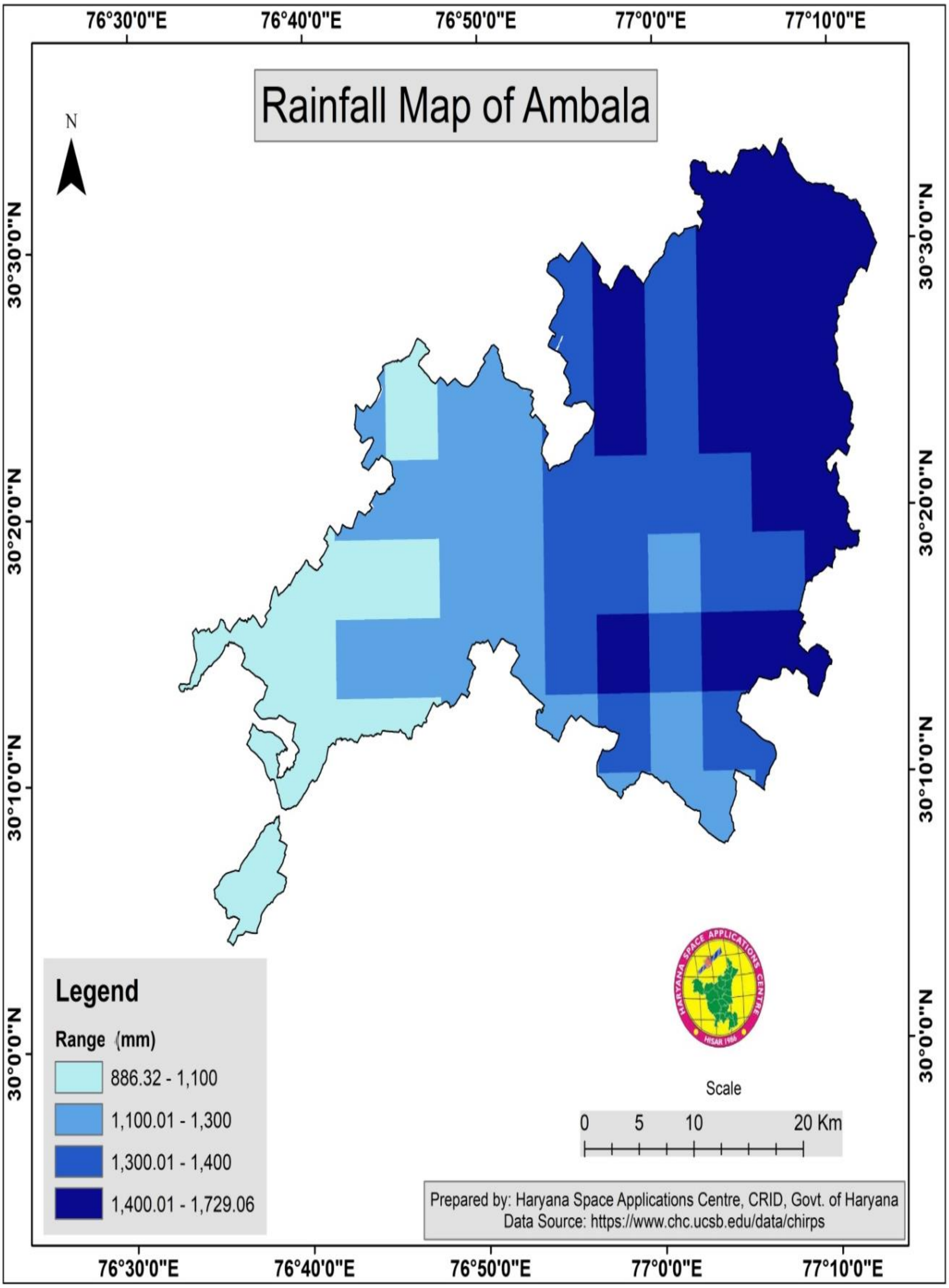


Figure 2 Rainfall Map of Ambala District

1.5 Elevation and Topography

The district area is occupied by Indo-Gangetic alluvium. There are no surface features worth to mention except that the area is traversed and drained by seasonal streams namely Tangri, Beghna and Markanda. Physio-graphically area is flat terrain. However a little part in the extreme North Eastern area of the district is occupied by Shivalik Hills and falls in the zone of "Dissected Rolling plain". The area slopes towards southwest with an average gradient of 1.5 m/km. The general elevation in the district varies between 245m to 300m above MSL. The digital elevation map of Ambala district is shown in **Figure 3**. Slope ranges from flat to >35 degree (**Figure 4**). Most of the area of Ambala is flat to less sloppy (**Figure 5**). Contours of 5 meters interval showed similar topography as in digital elevation model.

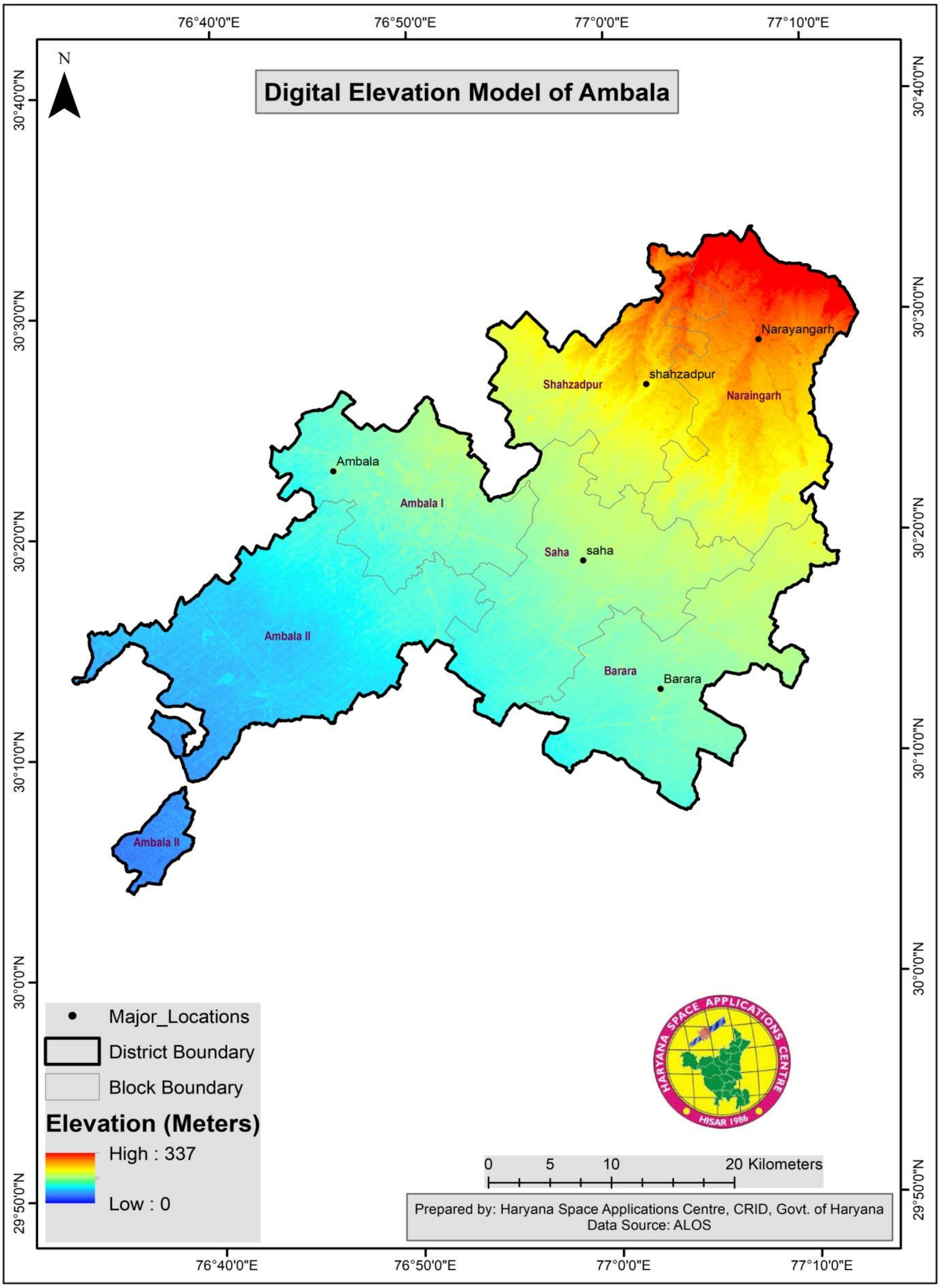


Figure 3 Digital Elevation Model of Ambala District

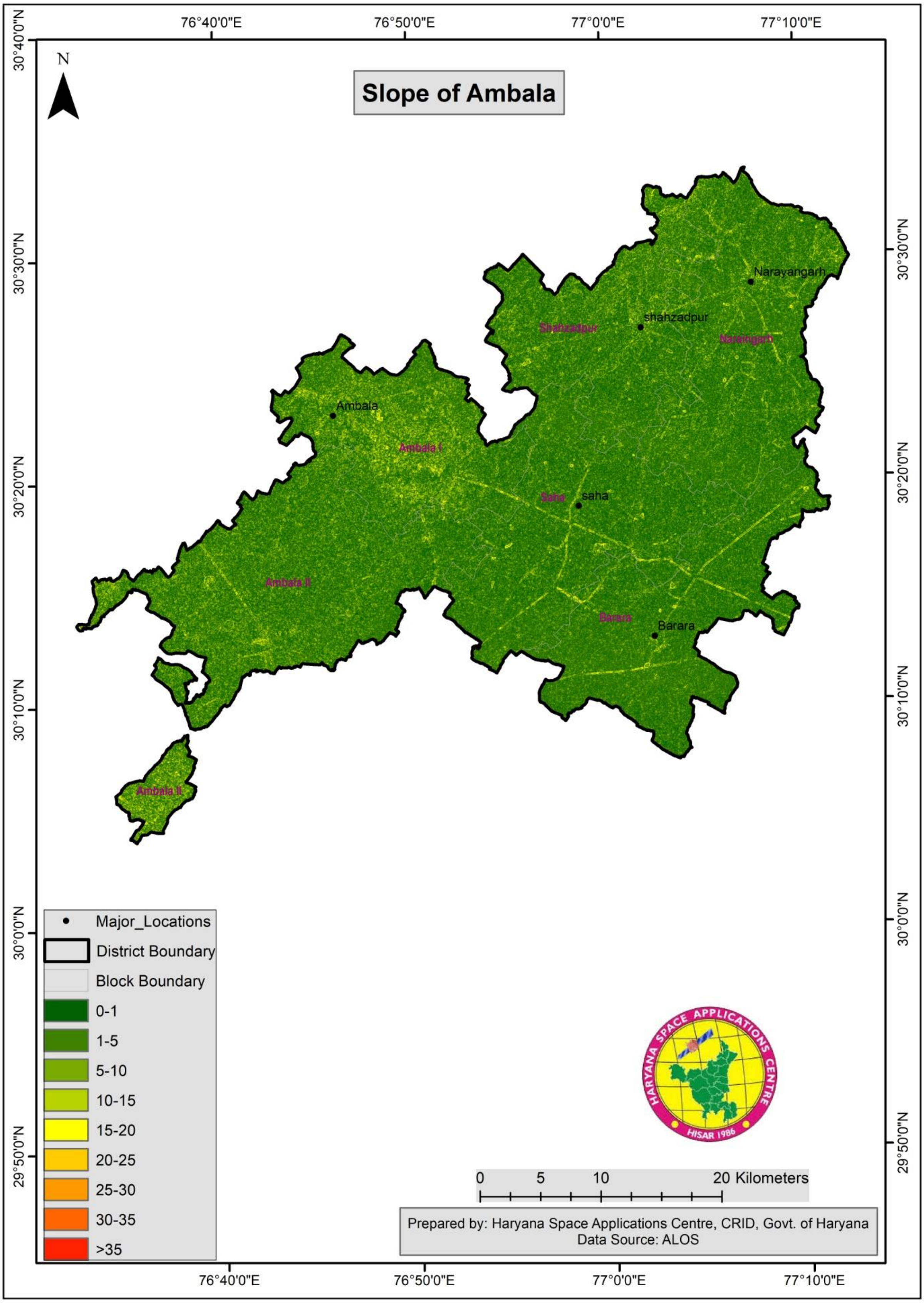


Figure 4 Slope Map of Ambala District.

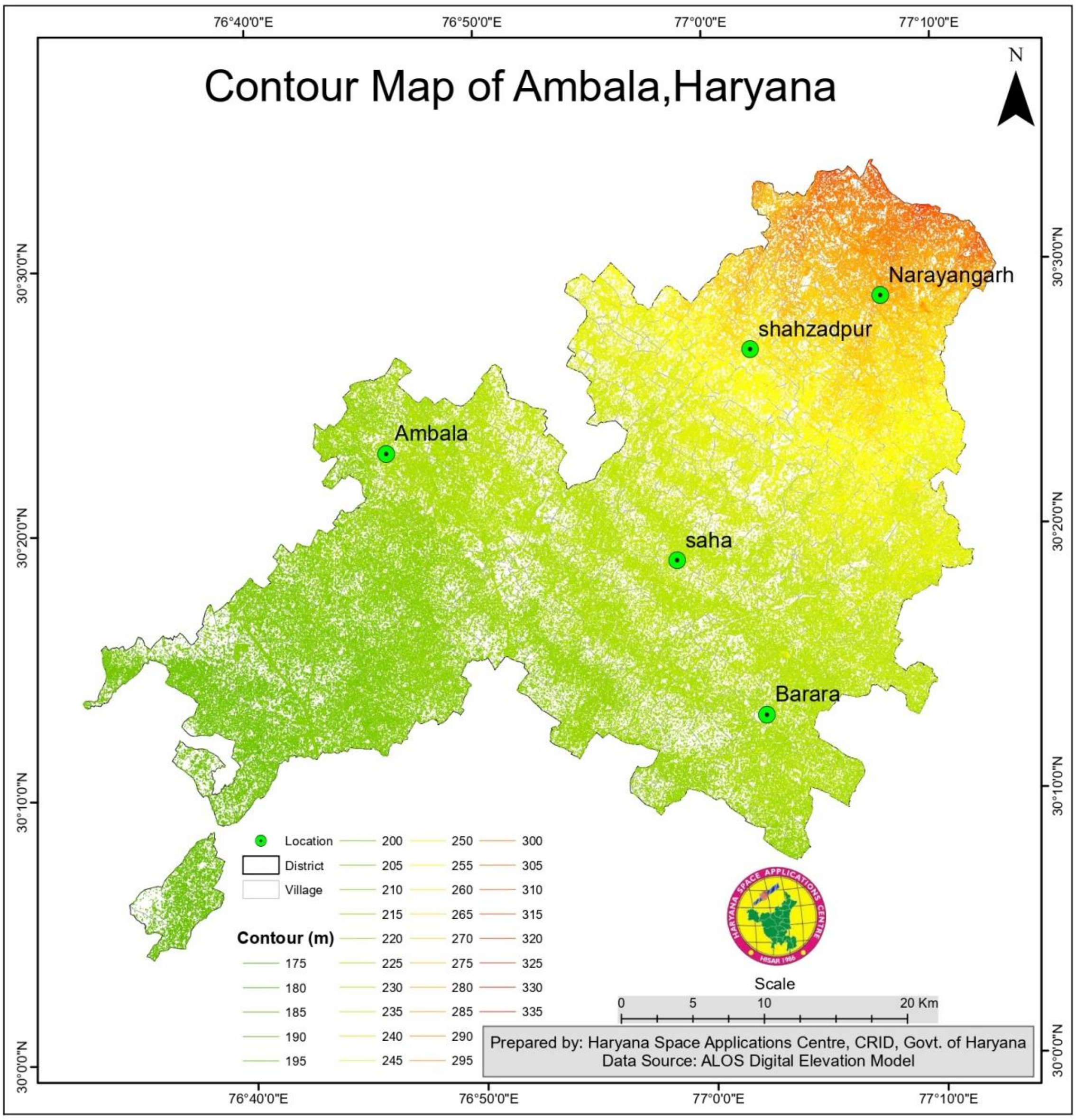


Figure 5 Contour Map of Ambala District

1.5.1 Geology and Lithology

The district is occupied by Indo-Gangetic alluvial plain of Quaternary age. Major part of Ambala district is formed of alluvium of recent period. As far as geological formations ilrc concerneu, the Shiwalik Murree Series (Dagshai, Kasuali and Dharamsala Bcds/Sirmaur Serics) and JUlogh group/Vaikrita group/Central Gneiuss (equivalcnts of Salkhala~) arc found in the region. The Lithology map of Ambala district is shown in **Figure 6**.

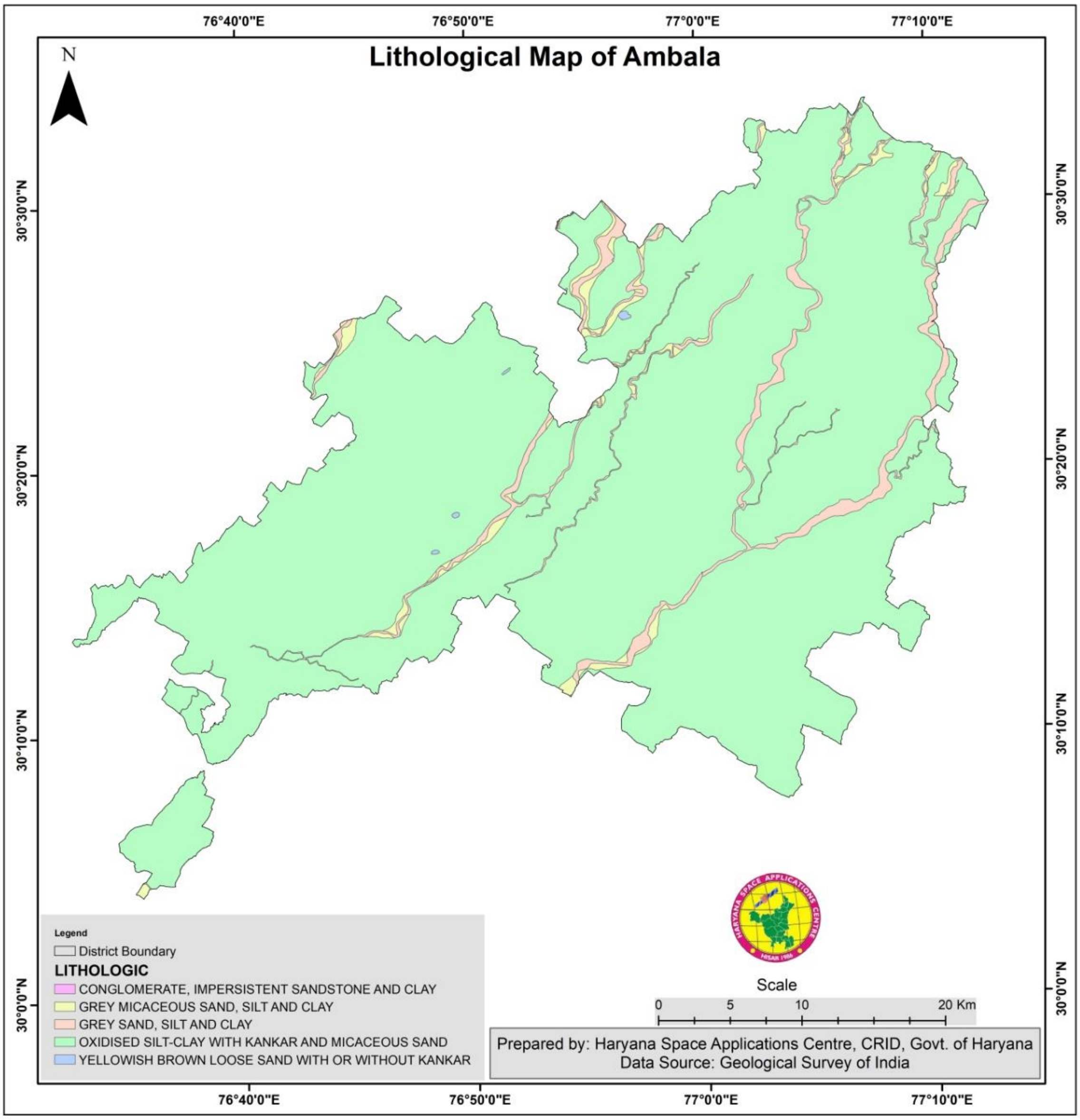


Figure 6 The Lithology map of Ambala district

1.5.2 Soil Profile

Soils in the district are mainly light loam (Seoti), piedmont (Ghar and Kandi), Siwalik (Pahar), silty clay (Naily and Chhachhra-Dakar), etc. Naraingarh plain has silty clay soils mixed with sand, Ambala plain has coarse loam soils and the Ghaggar plain has silty clay soils. River borne soils are very productive. The soils are non-calcareous and sandy loam on the surface, and loam to clayey loam at depth and placed under the classification of soil as Udorthents.The soil health of the district is of medium fertility. As per the soil health indices, majority of the soil are low in available nitrogen, phosphorus, organic carbon and medium in available potash. Due to intensive cultivation micronutrient status of the soils are also depleting and reports of deficiency of iron, manganese and zinc have been reported. It can be observed from figure below that maximum area lies under sandy loam soil and constitutes about 78.61% of the totally different soil classes in the district, which also results in soil erosion in respect of sheet erosion and wind erosion. The general profile of soil map of Ambala is shown in **Figure 7**.

Table 2 Soil classification in the district.

Soil Type	
Major Soil Classes	**Area(ha)**
Sandy Loam Soil	158000
Loamy Sand Soil	43000

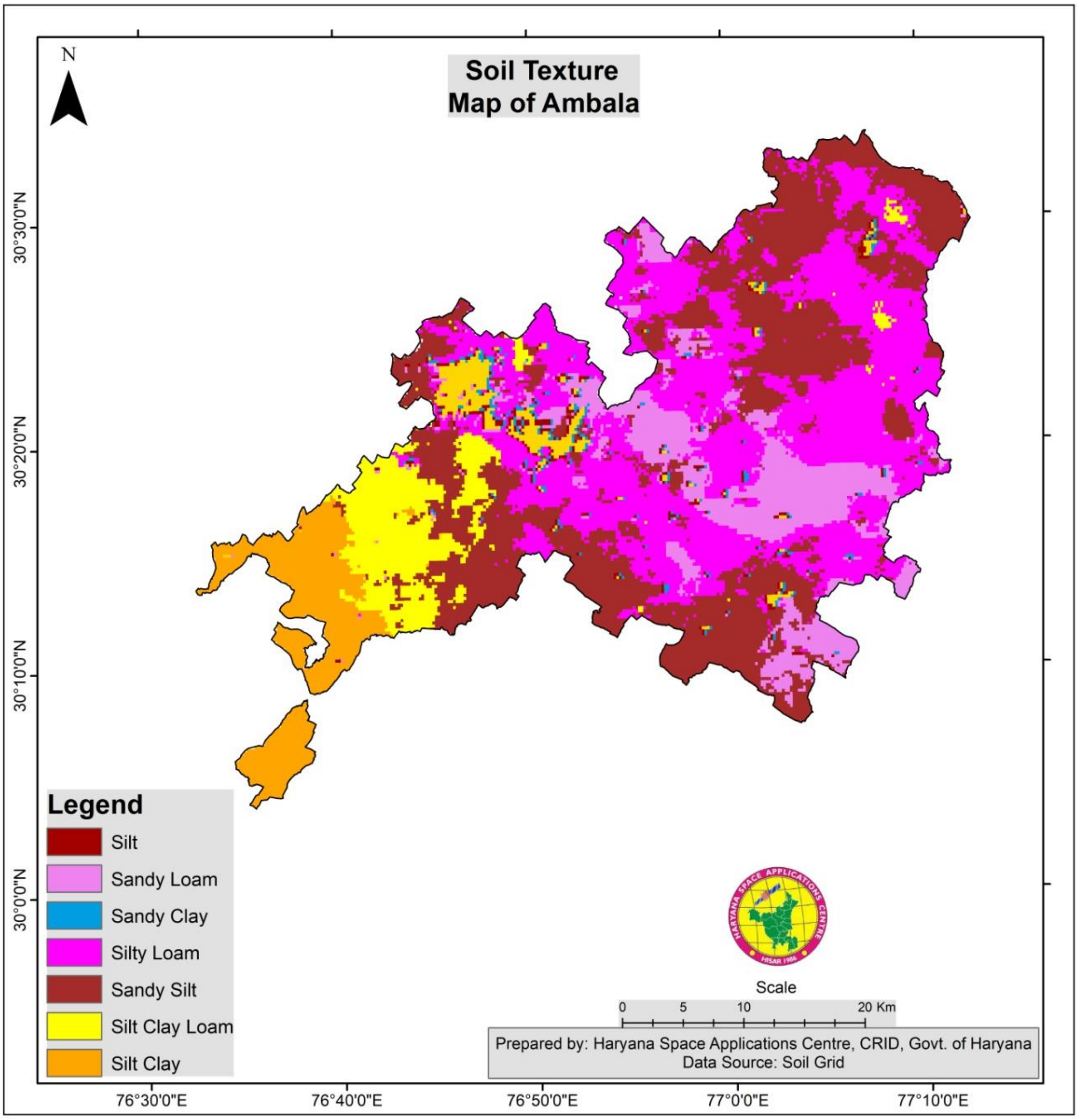


Figure 7 Soil texture map of Ambala District

1.6 Landuse

Agriculture is the mainstay of the economy of the district Ambala. practically the entire area suitable for cultivation is under the plough. Status of land-utilization in the district is summarized in **Table 3.** Land- use of the district clearly show that most of the land is put under cultivation while the forest cover, permanent pastures and grasslands are present but covers a very negligible area. The total area under forest cover in the district is 1100 ha, while 200 ha is under wasteland. The total area under other uses in the district is 800 ha which includes various commercial and non-commercial uses. The land use land cover map of Ambala District is shown in **Figure 9.**

Table 3 Land use pattern of the district

Blocks	Total Geographical Area(Ha)	Area under Agriculture (Ha)				Area under Forest (Ha)	Area under wasteland (Ha)	Area under other uses(Ha)
		Gross Cropped Area(1)	Net Sown Area (2)	Area Sown more than once(1-2)	Cropping Intensity (%)			
Ambala-I	42000	60100	28600	31500	210	100	0	200
Ambala-II	16700	17300	7700	9600	225	0	0	0
Barara	25000	38600	20100	18500	192	100	100	200
Naraingarh	24400	28100	16400	11700	171	400	0	200
Saha	22200	32700	17700	15000	185	100	100	100
Shahzadpur	23400	28700	15500	13200	185	400	0	100
Total	**153700**	**205500**	**106000**	**99500**		**1100**	**200**	**800**

Source: Agriculture Contingency Plan District: AMBALA

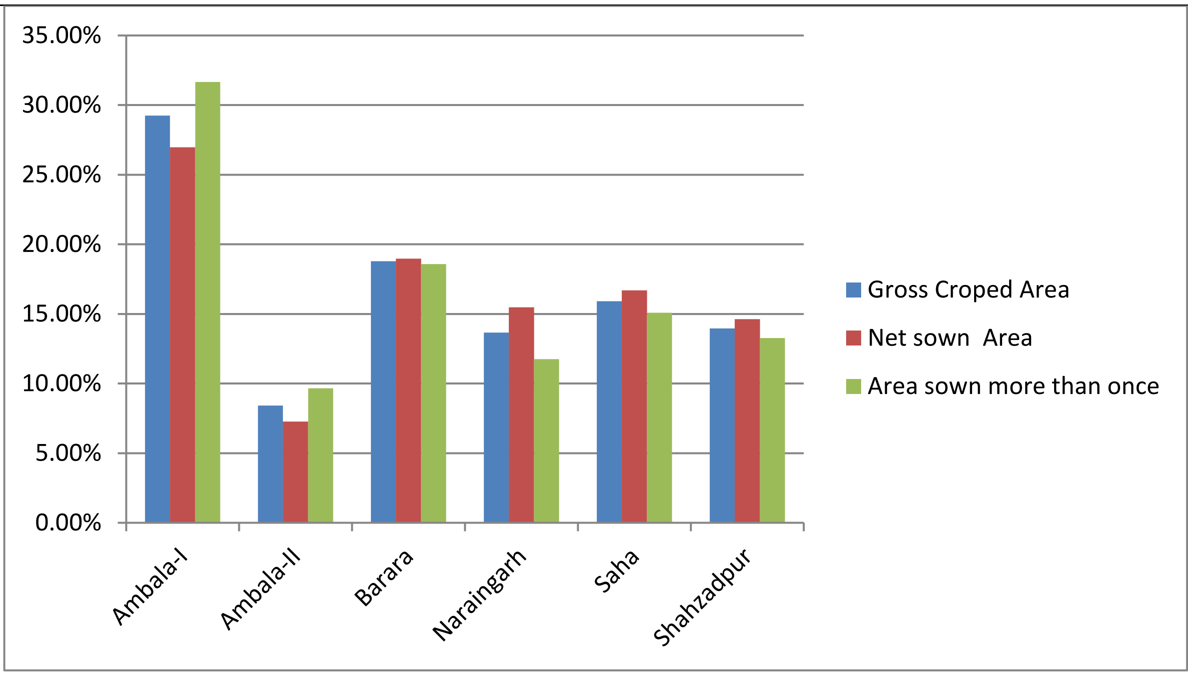


Figure 8 Block Wise Crop production

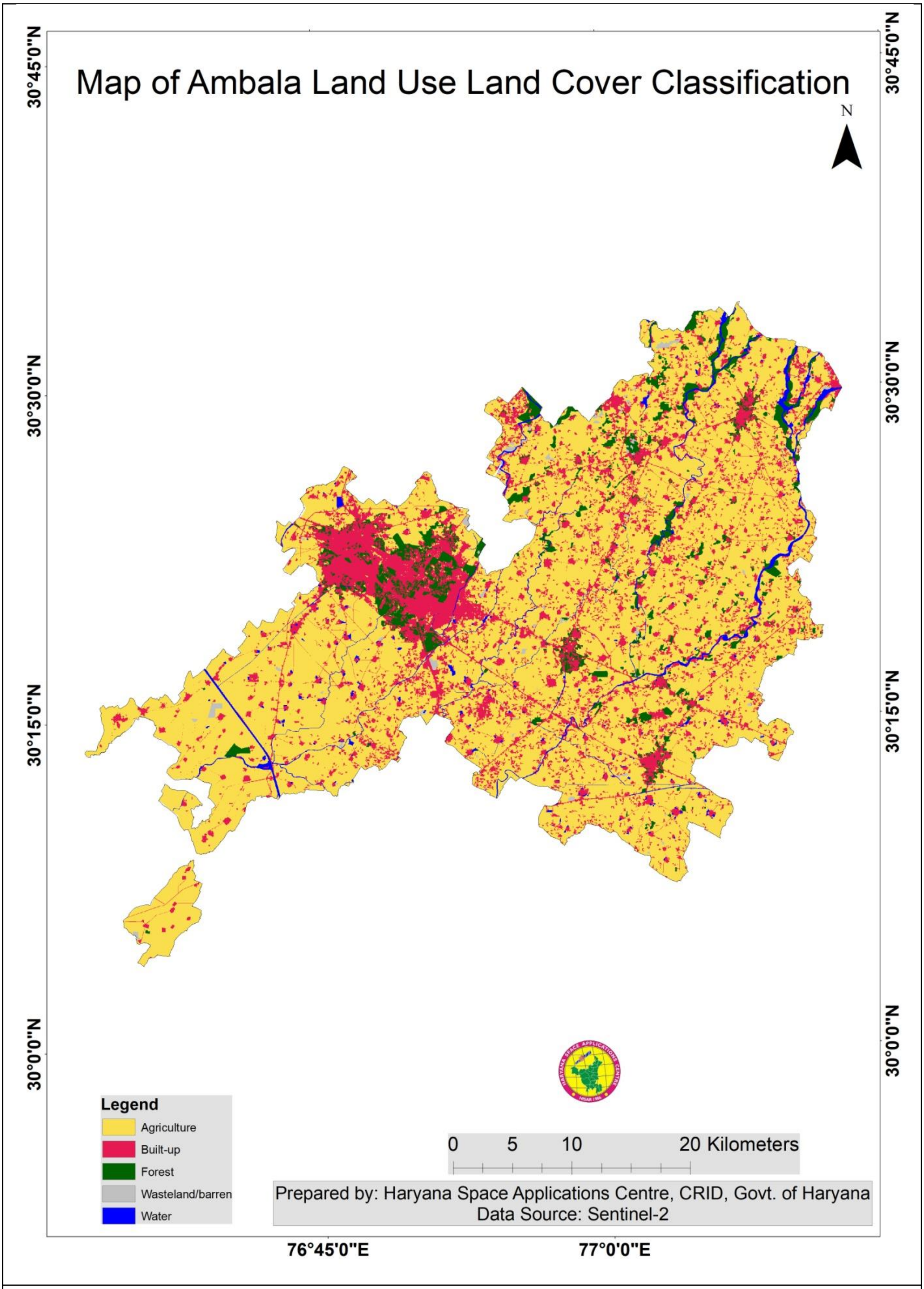


Figure 9 Landuse and Landcover of Ambala District

2. District Water Profile

2.1 Source of Water

The gross irrigated area in the district is 170860 ha and the main source of irrigation in the district is tubewell due to which there has been a rise in the extraction of groundwater for irrigation purposes and it has also led to over exploitation in few blocks. During the year 2006-2007 the availability of groundwater reached up to depth of 220 feet and upliftment of water from this depth is a herculean task and also a very costly affair at the farmers level due to predominance of rice-wheat cropping system and dependence on underground water for irrigation. The Barara and Shahzadpur block have been categorized as dark zone for ground water resource wild rest of blocks falls under grey zone. Where are 19461 tubewell and pumping set in the district to irrigate the land under agriculture. As per observation of the district hydrologist the water table has gone down to 3-5 ft in case of shallow tubewells while 10-15 feet in case of deep tubewell every year. At the Macro level, the availability of water resources may not appear to be a major problem in large parts of the district. But mere availability of water resources does not guarantee that the resources is adequately available to all stakeholders, it is available at that time when it is required and is of right quality for intended use. More than the "physical scarcity "of water it is "economic scarcity" of water which deprives the large number of users of having good access to the resource. Economic scarcity of water is alleviated show investment in infrastructure canal and dams or diversions, tanks, cisterns and ponds, wells and tubewells. There is an urgent need to have adequate baseline data on available water resources, sources of irrigation and availability of water for proper irrigation planning. This chapter will cover the desired information on available water.

2.1.1 Canals

Canal irrigation in the district is mostly through Bhakra Main Canal (Narwana Branch) in its south-western parts. A few distributaries like Sheikhupur minor of Ghuram distributary, Malaur, Naneola and Baknaur minors, Jansui distributary and Thaska distributary take off from Narwana Branch and provide irrigation in the intervening area. Naggal Lift Irrigation Scheme will provide irrigation to area lying between Dangri Nadi, Narwana Branch and Haryana State boundary under flow irrigation after commissioning of the Sutlej-Yamuna Link Canal. Tank irrigation is prevalent only in small parts of the district.

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 features. In Ambala district total 1465 ponds found with the help of satellite data on village level. The map of total waterbodies that include ponds, canals are shown in **Figure 10 A**. and Figure 10 B. are showing the monsoon waterlogged area of the district.

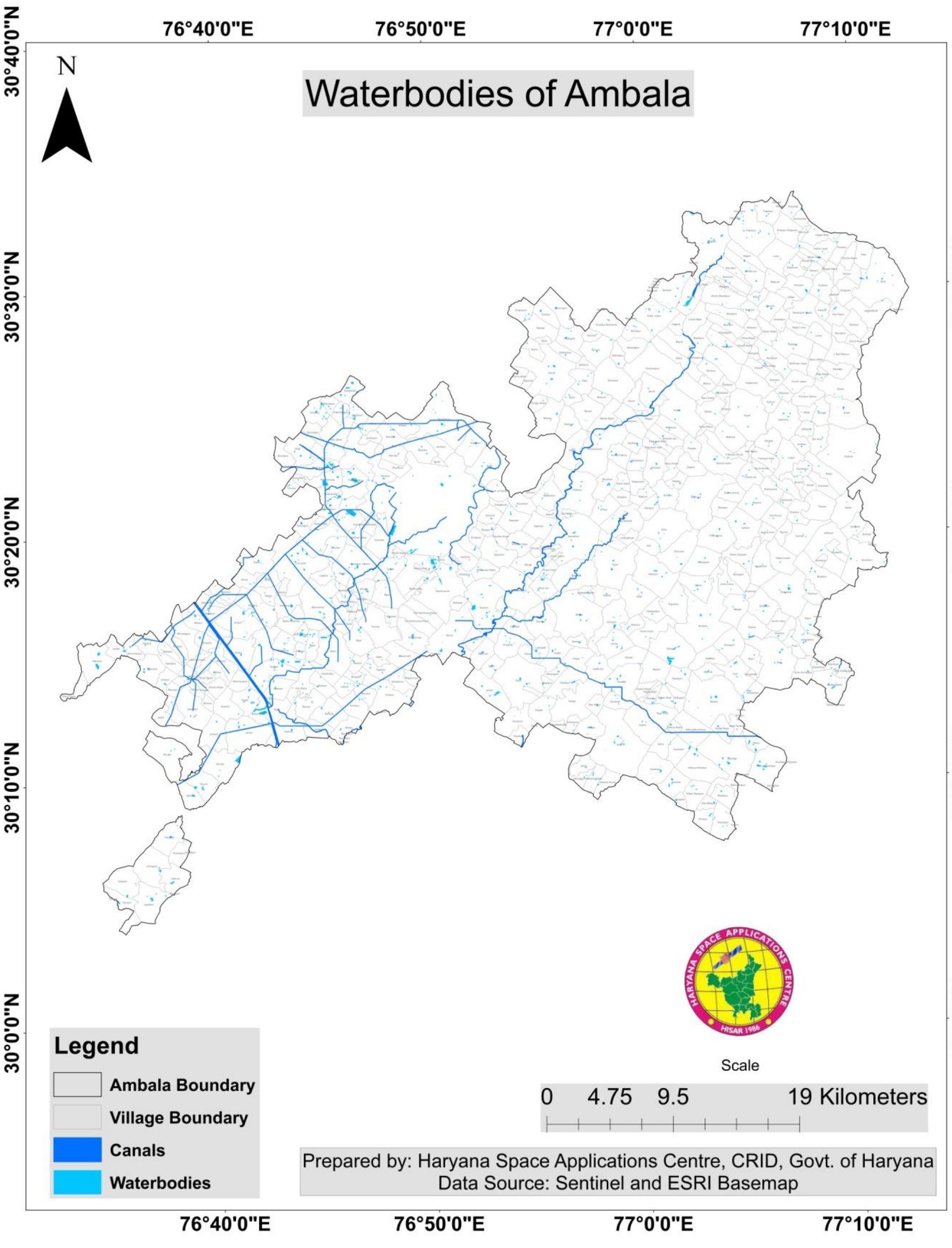


Figure 10 Water bodies of Ambala District

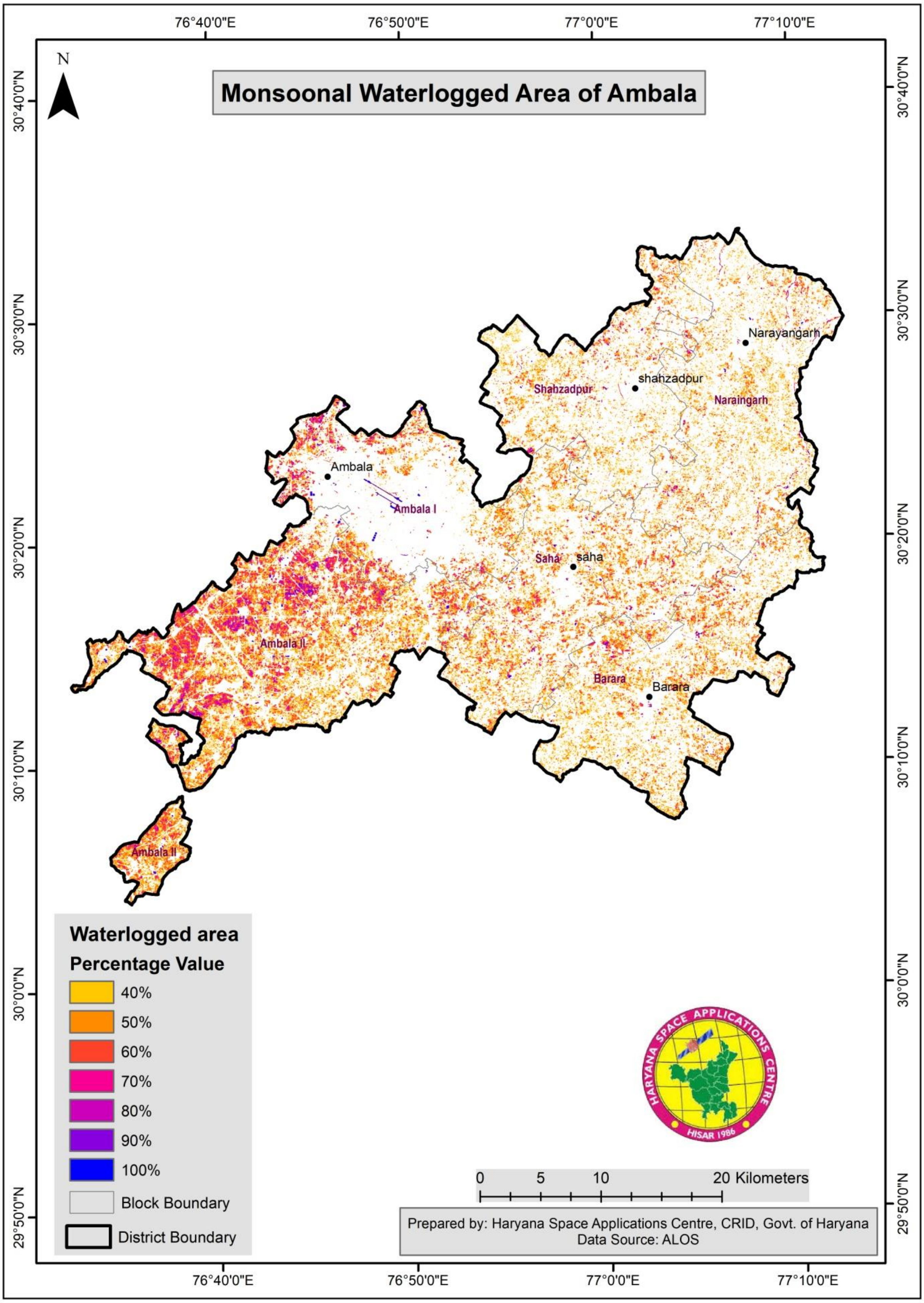


Figure 11 monsoon waterlogged area of the district

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

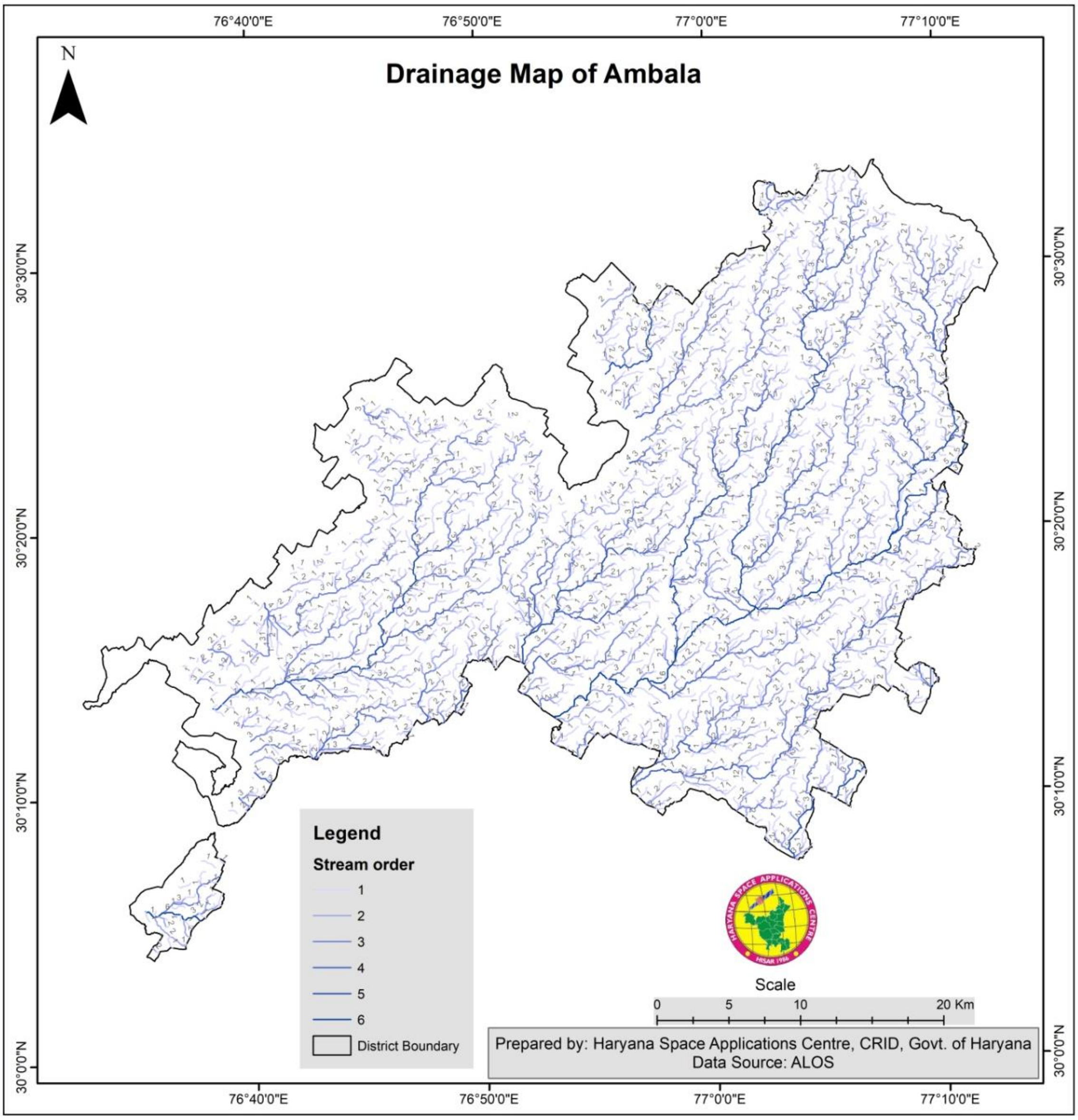


Figure 12 Drainage Map of Ambala District

Table 4 Length of Stream order of Ambala District

Stream Order	Length in Meters
1st order	1250648.27
2nd order	693196.67
3rd order	381706.28
4th order	154019.53
5th order	120196.12
6th order	39509.04

2.2 Water Harvesting System

Rain water harvesting is a method by which rainfall is collected for future use. The collected rainwater may be stored and used in many ways or directly used for recharge of ground water. Water shortages in many areas can be prevented using this technique. Every citizen in India must take steps to conserve rain water.

RECOMMENDATIONS

1. There are depressions in and around Ambala city in which rainwater is collected. This storage can be used for artificial recharge by diverting the water to deep water level areas. In order to arrest the declining trend of water levels in the district, the rooftop rainwater harvesting technology should be adopted and recharge structures may also be constructed in depression areas where water gets accumulated during rainy season. This will help in enhancing the recharge to ground water reservoir.

2. The construction of roof top rainwater harvesting structures should be made mandatory in building bye-laws, which will help in checking the falling water level trend in the towns of water level depleting areas.

3. There is a rise in water level along canal due to existing canal system, which is worked out to be 0.7 m per year and creates water logging conditions. Hence, the canals may be lined.

4. The pH of water is more than 7.5 and, Iron is more than 2 mg/l causing incrustation of well screen in deep tube wells at places in the district area and thereby shortening the life of tubewells. The periodic muriatic acid treatment of well assembly is required.

5. PVC pipe assembly may be used in case of shallow tubewells.

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

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

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.

In general, there are three main types of rainwater harvesting systems, which include direct pump, indirect pump and indirect gravity. Mentioned below (**Table 5**) is some of the most popular rain water harvesting techniques:

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

Table 5 Water Harvesting System in Ambala District

S.NO.	Activity Name	Works Completed	Works Ongoing	Expenditure (in Lakhs)
Water Conservation and Rain Water Harvesting				
1	Check Dam		0	
2	Pond / Tank		2	
3	Trench	0	0	
4	Rooftop Water Harvesting Structure (Public)	853	0	
5	Rooftop Water Harvesting Structure (Private)	0		
6	Other Rainwater Recharge Structures (Open Well Recharge, Sand Filter for open well recharge)		0	
7	Other Water Conservation Structures (Bench Terracing, Canal)		1	
	Total		**3**	**34**
Renovation of Traditional and other Water Bodies / Tanks				
1	Traditional Water Bodies Restored	325	20	
	Total	**325**	**20**	**112**
Reuse and Recharge Structures				
1	Soak Pit	1260	92	
2	Stabilization Pond	16	0	
3	Other Reuse / Recharge Structure	220	0	
	Total	**1496**	**92**	**14**
Watershed Development				
1	Gully Plug	0	0	
2	Percolation Tank		0	
3	Staggered Trenches	1	0	
4	Other Watershed Construction Activities	170	44	
	Total		**44**	**265**
Intensive Afforestation				
1	Intensive Afforestation-Nurseries	410449	1	
2	Intensive Afforestation- Plantation		2	
	Total		**3**	**158**
Awareness Programs by KVK				
1	Farmer's training programs by KVKs on Water Use Efficiency and Appropriate Crops	1197		
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	793		
	Total	**1990**		
Waste Water Treatment				
1	Use of Treated Waste Water	46		
	Total	**46**		

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 **Ambala** District for rain water harvesting is shown in Table 6 at rural and urban area. The map of water conservation activity in Ambala at rural and urban level is shown in **Figure 13**.

Table 6 Water Harvesting technique in Rural area and Urban Area.

In Rural Area		
Sr.No.	**Block Name**	**Total No of Activity**
1	Ambala -I	512
2	Ambala -II	81
3	Barara	861
4	Naraingarh	242
5	Saha	452
6	Shahzadpur	419
In Urban Area		
1	Ambala	136

2.2.3 Water Harvesting System Roof Top

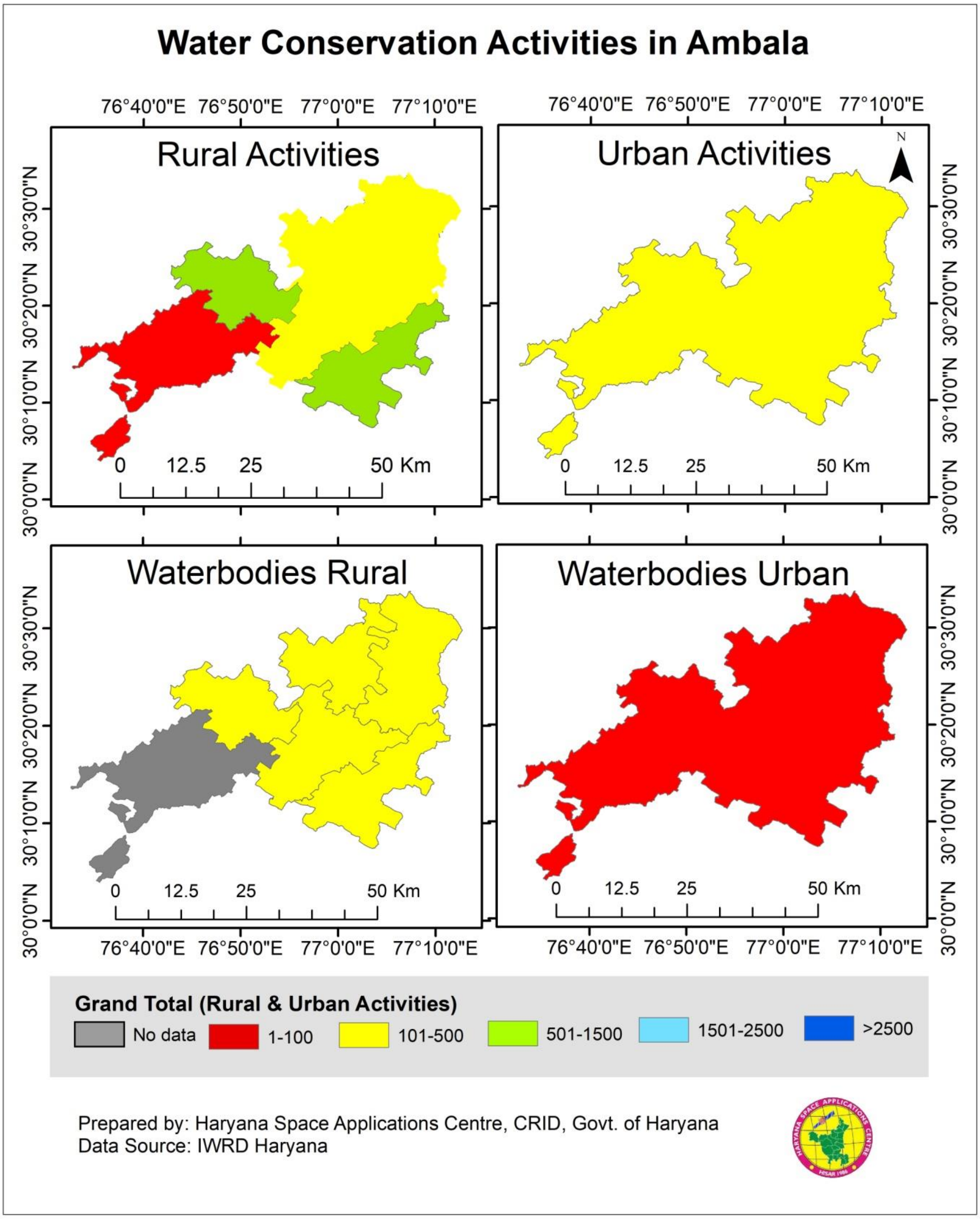


Figure 13 Water Conservation Activity in Ambala District

2.2.4 Sewerage Treatment Plant

Sewage treatment is the process of removing contaminants from wastewater and household sewage water. Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally". Estimated sewage generation for the State of Haryana is 1816 MLD and total treatment capacity (including proposed) is 1880 MLD (153 STPs). The sewerage treatment plant map is shown in Figure 13. In Ambala District total 11 Sewage treatment plant are installed. In Ambala District there is one major biomedical waste management site in Shahzadpur Block. District have two major common effluent treatment plant in Ambala-I and Shah block.

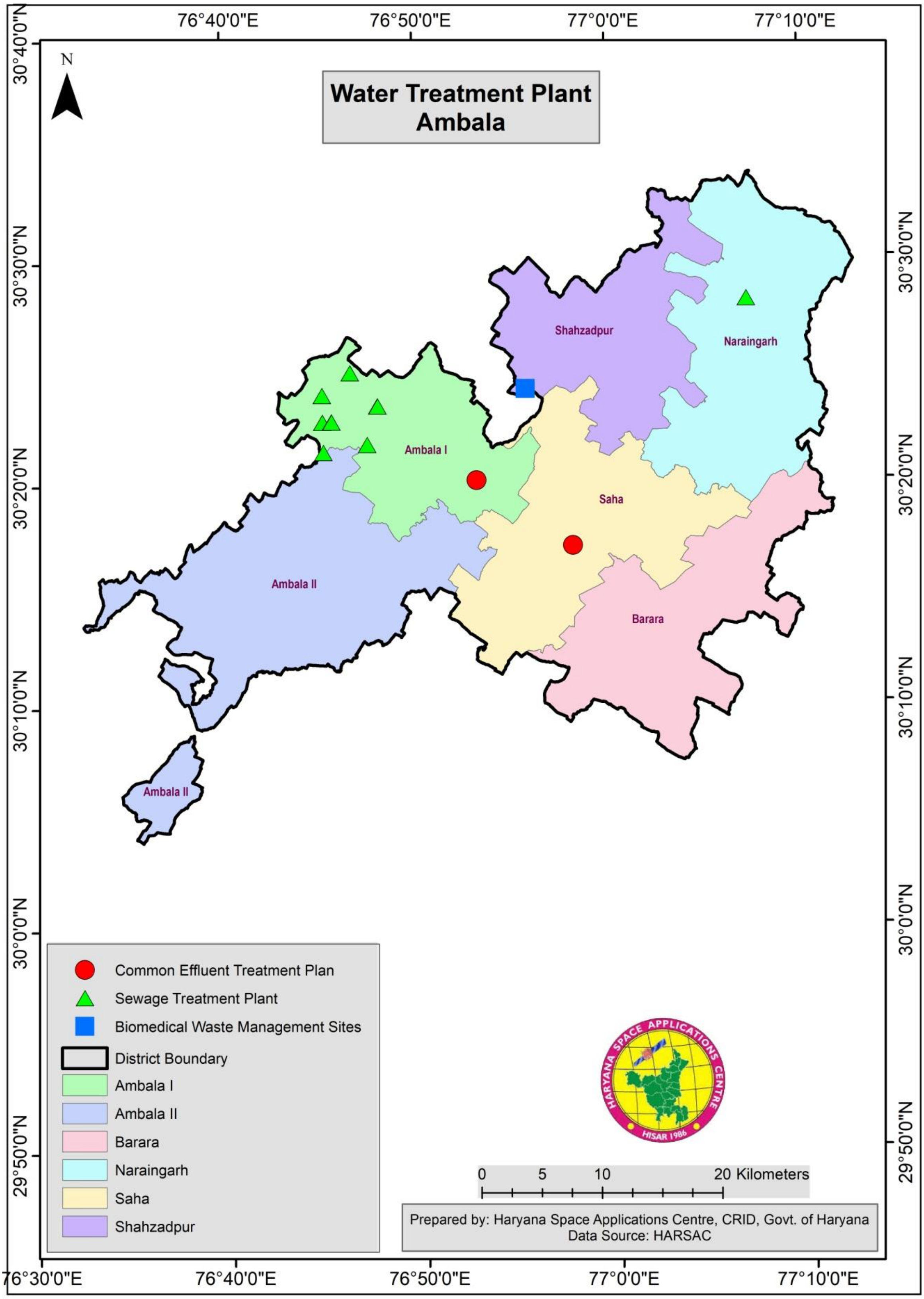


Figure 14 Water Treatment Plant Map of Ambala District

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.

Major sources of irrigation in the district are tubewells and canals. 85.6 per cent of the net sown area was irrigated in the district. 98,000 hectares of area was irrigated through electric tubewells and diesel pump sets, 14,000 hectares by government 20 canals, less than 500 by tanks and 1,000 hectares by other sources which might include Kuhl or duct irrigation during 2009-10. There were 21,197electric and 5,119 diesel pumping sets in the district during 2010-11(P). Tubewells are the principal source of irrigation and 86.7 percent of the net irrigated area is served by tubewells. Old traditional method of well irrigation has been replaced by tubewell irrigation. These have become popular after Independence when government encouraged farmers by providing easy term loans and it was economical to operate electric tubewell as the rural electrification progressed at a fast rate.

4. Water Availability

The gross irrigated area in the district is 170860 ha and the main source of irrigation in the district is tubewell due to which there has been a rise in the extraction of groundwater for irrigation purposes and it has also led to over exploitation in few blocks .During the year 2006-2007, the availability of groundwater reached up to depth of 220 feet and upliftment of water from this depth is a herculean task and also a very costly affair at the farmers level due to predominance of rice-wheat cropping system and dependence on underground water for irrigation. The Barara and Shahzadpur block have been categorized as dark zone for ground water resource wild rest of blocks falls under grey zone. Where are 19461 tubewell and pumping set in the district to irrigate the land under agriculture. As per observation of the district hydrologist the water table has gone down to 3-5 ft in case of shallow tubewells while 10-15 feet in case of deep tubewell every year.

At the Macro level, the availability of water resources may not appear to be a major problem in large parts of the district. But mere availability of water resources does not guarantee that the resources is adequately available to all stakeholders, it is available at that time when it is required and is of right quality for intended use. More than the "physical scarcity "of water it is "economic scarcity" of water which deprives the large number of users of having good access to the resource. Economic scarcity of water is alleviated show investment in infrastructure canal and dams or diversions, tanks, cisterns and ponds, wells and tubewells. There is an urgent need to have adequate baseline data on available water resources, sources of irrigation and availability of water for proper irrigation planning. This chapter will cover the desired information on available water.

4.1 Surface Water Availability

The district area is occupied by Indo gangetic alluvium. There are no surface features worth to mention except that the area is traversed and drained by seasonal streams namely Tangri, Beghana and Markanda. Physiographically, the area is flat terrain. However, a little part in the extreme north - eastern area of the district is occupied by Shivalik Hills and falls in the zone of "Dissected Rolling plane". The area slopes towards southwest with an average gradient of 1.5 m/km. The general elevation in the district varies between 245m to 300m above MSL. District area falls in in Yamuna sub basin of Ganga basin and is mainly drained by the river Tangri, Beghana and Markanda. The total water availability in the district is 68.51 MCM with majority under Ambala-I Block with 67 MCM. The surface water availability has been estimated in Ambala-I, Ambala-II, Saha, municipal corporation Ambala and Pinjore. The surface water shows the availability through canal under major and medium irrigation.

4.2 Ground Water Availability

The Central Ground Water Board has drilled 20 exploratory borehole, 3 slim holes, and 13 piezometers to delineate and determine potential aquifer zones, evaluation of aquifer characteristics etc. Surveys conducted in the area reveal that alluvial thickness in the district is large and thickness of alluvium thins down towards southwest. In south west and western parts of the district the sediments are fine grained in nature, and constituted of fine to medium grained sands, clays, silts and kankar with occasional gravel. The clays are usually brown to yellowish in colour and sticky to silty in nature. The sands are usually fine grained; hence it becomes difficult to develop wells so as to give sand free water with conventional well designs. Towards east and south eastern part of the district the clays are cream or light grey coloured and are soft and silty. The sands are also mostly medium to coarse grained in nature in comparison to the fine texture of sands in south western and western part of the district.

The ground water exploration revealed the presence of multiple aquifer groups down to a depth of 450 m. comprising fine to medium grained sand, clay, silt, and kankar with occasional gravel. The formation in general is fine grained in nature. The first granular zone forms the water table aquifer and occurs up to 167 m depth and is underlain by 10 to 15 m thick clay bed. The second aquifer occurs at a depth ranging between 65 to 294 m with varying thickness of 26 to 152 m. This aquifer constitutes comparatively less coarse material than the first group and is characterized by presence of Kankar. The third one is characterized by fine sandy beds alternating with thick clay beds at a depth ranging from 197 to 385 m exist between 180 and 205 m depth. The fourth aquifer occurs below 212 m onwards. Shallow tubewells are generally constructed up to a depth of 40 m. The discharge of shallow tubewells ranges 100 to 600 liters per minutes for a moderate drawdown. Deep tubewells constructed to a depth of 150 m yield up to 2000 to 3000 liters per minutes for 6 m to 10 m drawdown. However deeper tubewells tapping aquifer zones between 150 m to 400 m depth, discharge ranges from 248 to 3293 LPM for a drawdown ranging from 2.84 to 12.93 m. Transmissivity values ranges from 154 to 4900 m2/day, Storativity 1.39x10-4 to 1.01×10^{-1}. In general, hydraulic conductivity values of aquifer zones decreases with depth, with in 150 m depth it is around 10 m/day and for deeper horizons between 150 m to 400 m was around 6 m/day. The following map (**Figure 14**) depicts the ground water depth in Ambala district and the **Table No 7** gives the description of ground water resource and development potential of Ambala District.

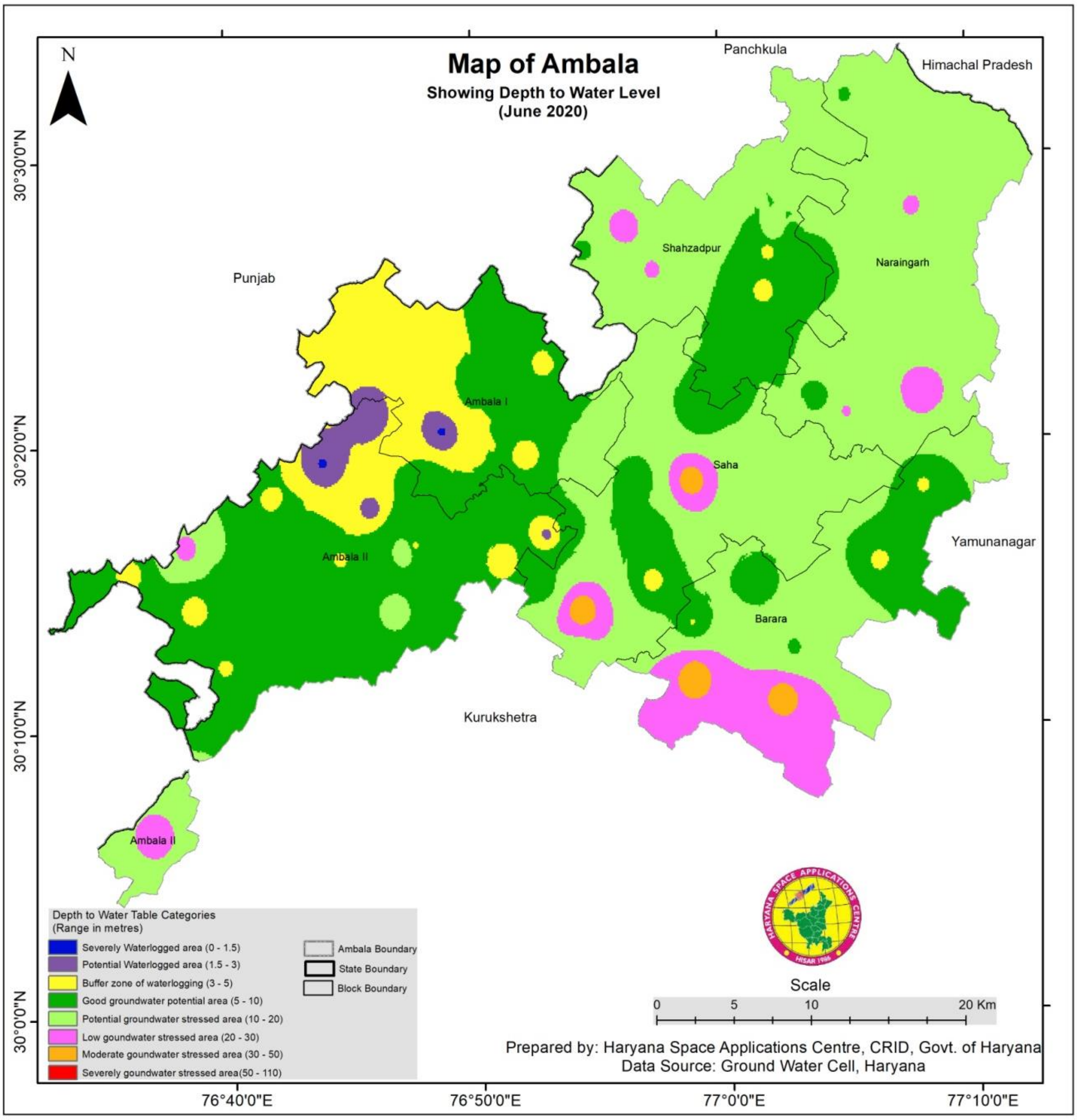


Figure 15 Ground water Availability Map of Ambala District

Table 7 Ground water availability in the district

Blocks	Status of Blocks as per central ground Water Board Notification				Ground Water (MCM)		
	Over Exploited	**Critical**	**Semi-critical**	**Safe**	**Draft (MCM)**	**Recharge/ Availability (MCM)**	**Gap (MCM)**
Ambala-I			■		91.08	139.96	48.88
Ambala-II		■			56.08	72.75	16.67
Barara	■				77.69	66.92	10.77
Naraingarh	■				100.15	96.22	3.93
Saha	■				78.13	70.27	7.86
Shahzadpur			■		57.2	86.4	29.2
Total					460.33	532.52	117.31

4.3 Ground Water Quality

The ground water is alkaline in nature of the district. The pH values ranges from 7.07 to 10.10 indicating that the ground water is neutral to alkaline (weak base type in nature). Specific conductivity is a measure of total dissolved solids present in water and it ranges from 741 to 3500 micro/mhos at 250C and it is directly related to low values of chlorides. The fluoride (F) values range from0.19 mg/l to 2.45 mg/l but in general it is within the permissible limit except at Patwi (2.45 mg/l) and Saha (2.11mg/l) in the district. Thus, the ground water of the district is well within the permissible limits set by the BIS :10500: 1991 and is categorized as fresh and is suitable for domestic /drinking /irrigation purposes. The ground water is slightly to moderately alkaline in nature. The pH values range from 7.14 at Kurali to 8.28 at Pinjola with a mean pH value of 7.75. The EC of ground water ranges from 620 S/cm and an average mat 25°C at Pinjola. In most of the water samples, EC is below 2000 S/cm in the area. The hardness value of ground water ranges from 120mg/l at mEC is 1955 Panjokhara to 510 mg/l at Kakru. However, exceptionally high concentration of 901mg/l is recorded at Kurali. Among cations, the concentration of calcium ranges between 20mg/l at Pinjola and 178 mg/l at Kurali. Magnesium concentration ranges between 9.7mg/l at Panjokhara and 111 mg/l at Kurali. In majority of ground water samples, calcium and magnesium concentrations are less than 100 mg/l and their average concentrations are 84 mg/l and 45mg/l respectively. The sodium content varies widely from 83mg/l at Khan Ahmadpur to 325mg/l at Pinjola whereas potassium content ranges from 0.05 mg/l at Khan Ahmadpur to 85mg/l at Kurali. However, exceptionally high concentrations of 420 and 800mg/l are encountered at Kakru and Pinjola respectively. The average value of sodium is found to be 198. Among anions, bicarbonate is the dominant anion. Carbonate is found to be absent whereas bicarbonate concentration is found to be ranging between 320mg/l at Panjokhara and 1051 mg/l at Pinjola. Its average value is 632mg/l. The chloride concentration in most of ground water samples is within the desirable range of 250mg/l (BIS 1991) and it varies between 13mg/l at Ambala Cantt. and 375mg/l at Kurali with mean value of 175 mg/l. The sulphate content in ground water ranges from 28mg/l at Khan-Ahmadpur to 250 mg/l at Kurali with exception of ground water of Pinjola where its concentration is 620 mg/l. The nitrate (NO3) concentration is within the permissible limit (45mg/l) and it ranges from trace at few places to 214mg/l at Kakru with an average of 71 mg/l. The fluoride (F) content in ground water of the district is less than 1.0 mg/l and it ranges between 2.53 mg/l at Naraingarh and 02.60 mg/l at Naggal. Water quality range from 0-45 is good, 45-60 is fair and >60 is very poor quality of water. So, based on that Ambala district's water quality vary from good to poor (**Figure 15**). for the whole district. Whereas block wise water quality index value is shown in **Table 8.**

Table 8 Block wise average water quality index value in Ambala District

Block Name	**Average Water Quality Index Value**
Ambala I	98.1
Ambala II	88.4
Barara	52.1
Shah	61.7
Naraingarh	96.4
Sahzadpur	73.9

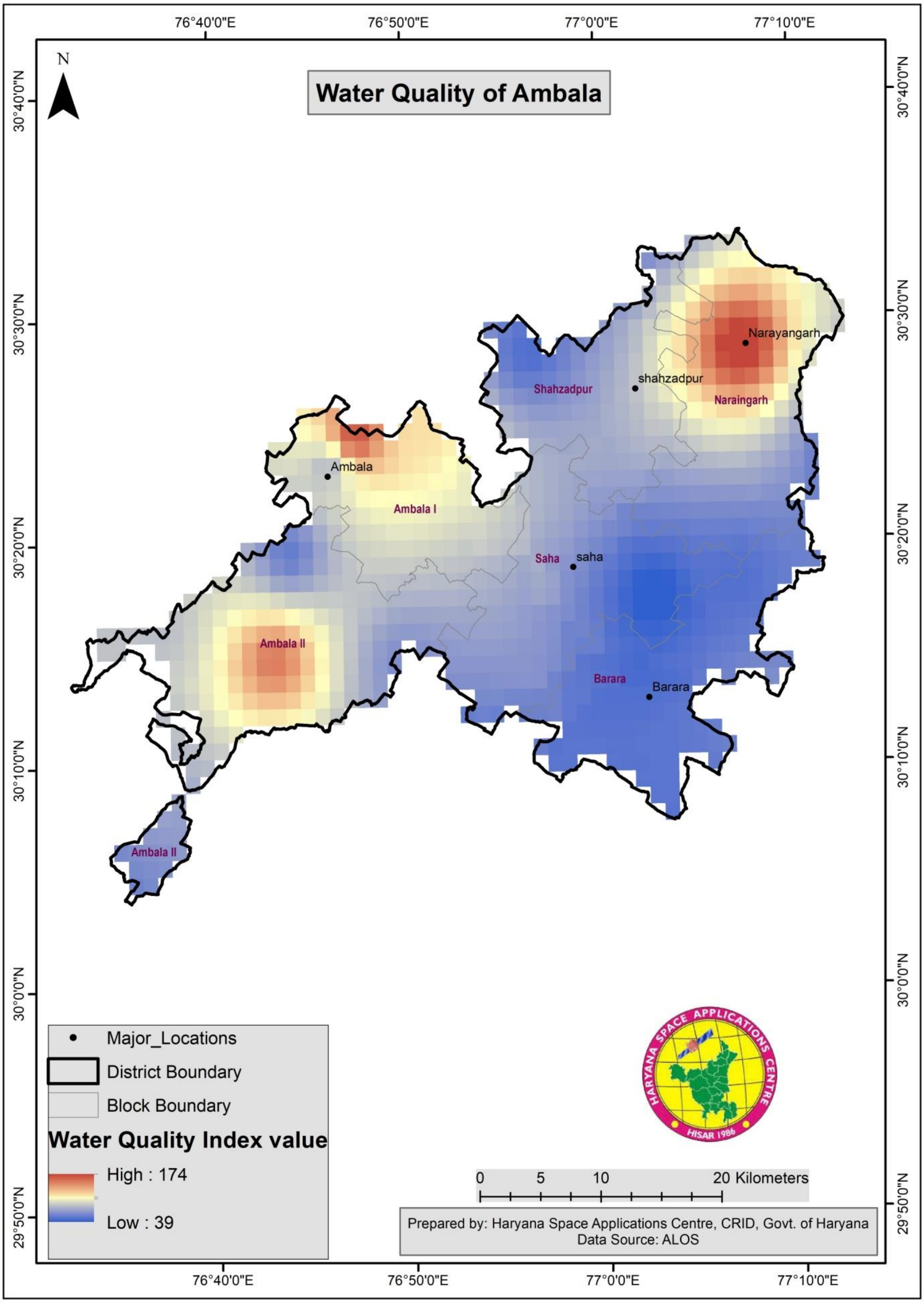


Figure 16 Water quality index of Ambala District

5. Aquifer System

6. Water Requirement/ Demand

The previous chapters deal with the general profile, water profile and water availability of Ambala district. This chapter deals with current and projected demand of water for various sectors. The demand for water has been calculated on the basis of data obtained from different departments.

6.1 Domestic Water Demand

Data of census 2011 and 2001 has been considered to arrive at the growth rate of population of the district. As per Census 2011, the district has shown a decadal growth rate of 11.23%. Current population in 2016 has been calculated by assuming a growth of 1.123% per annum over a period of 5 years. (2011-2016). Projected population has been calculated in similar way by assuming a growth of 1.123% per annum over a period of six years (2016-2022).

It has been assumed that per capita daily water requirement of people residing in urban areas of the district is 150 L and for the population in rural areas the daily per capita daily water requirement is 70 L using the same norms. Domestic water supply demand has been worked out and given in the table 10. The earlier chapter deals with general profile, water profile and water availability of Ambala district.

As per 2011 census, total population of district was 1128350 which is projected to be 1193146 in the current year 2016. The projected population has been compounded from the current year and it is expected to be 1275831 by the end of 2022. The current domestic water demand in the district is 91.20 MCM and it is projected to increase 97.52 MCM by the end of 2022 due to increased urbanization and more demand of freshwater by the population. Among blocks, Shahzadpur has the highest water demand under domestic sector and it stands at 50.70 MCM, which is 51.99% of total present water demand in the district followed by Ambala-I with 23.74%. Table 9 showing the domestic water Demand in the District.

Table 9 Domestic water Demand in The District.

Blocks	2011	2016	Gross Water Demand (MCM) in 2016	Projected Population 2022	Gross Water Demand (MCM) in 2022
Ambala-I	492027	520282	21.65	556337	23.15
Ambala-II	164382	173822	7.12	185868	7.61
Barara	142207	150373	5.65	160794	6.05
Naraingarh	130441	137932	5.21	147490	5.57
Saha	105871	111951	4.14	119709	4.44
Shahzadpur	93422	98787	47.41	105633	50.7
Total	1128350	1193147	91.18	1275831	97.52

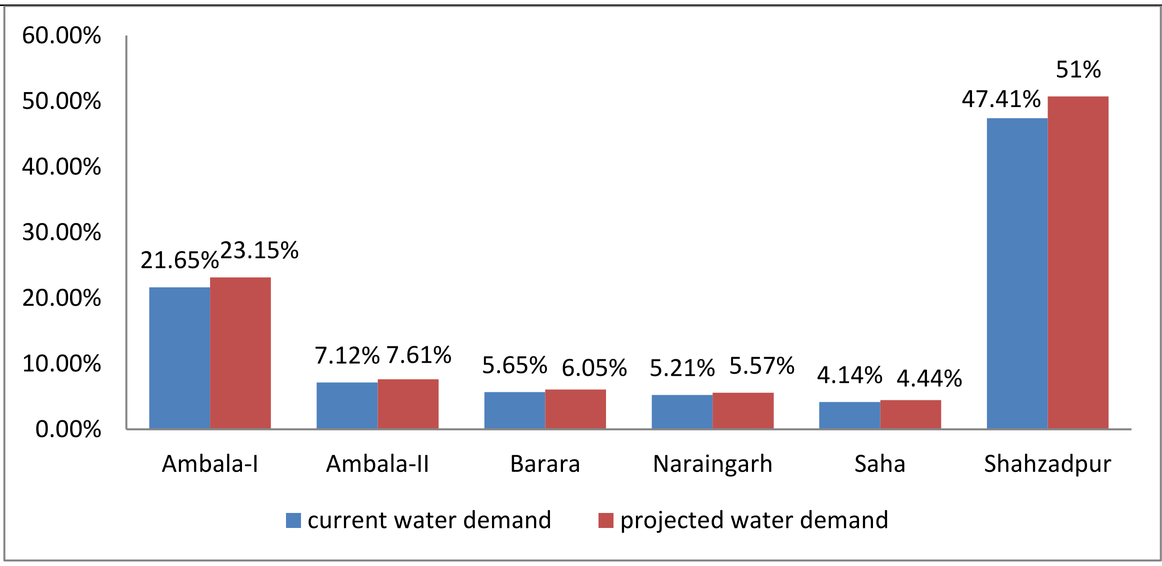


Figure 17 Current and projected water demand in the district under domestic sector.

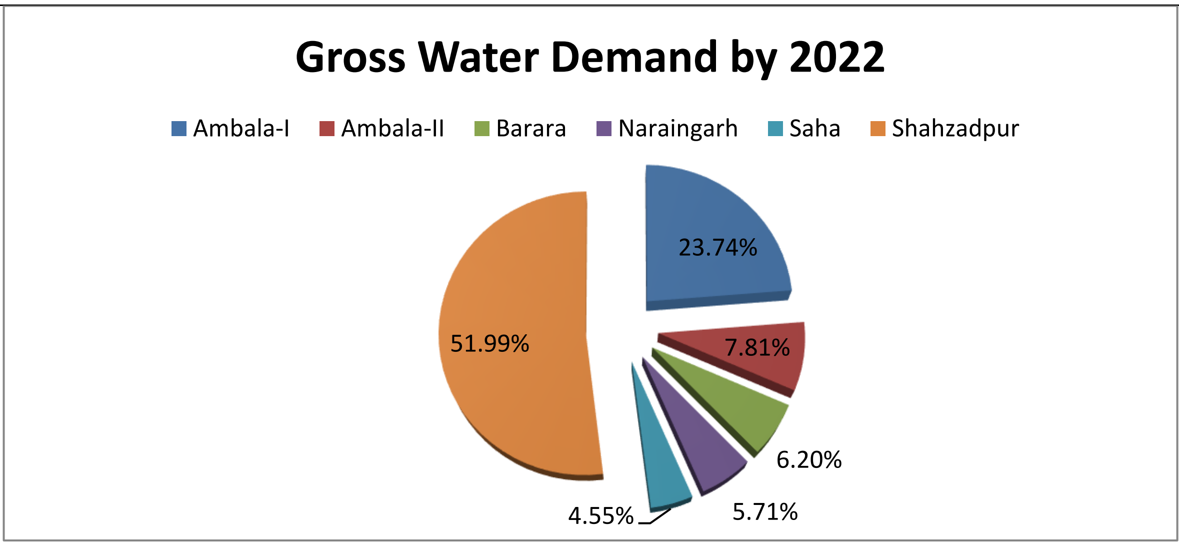


Figure 18 Blockwise Gross water demand in the district by 2022

6.2 Crop Water Requirement

Crop water requirement for the blocks and district have been calculated based upon the cropping pattern followed in the various blocks of the district. Cropping pattern under irrigated and rain fed system is different in the district.

Table 10 Crop water demand in the district

Blocks	**Area sown (ha)**	**Irrigated Area (ha)**	**Crop Water Demand (MCM)**	**Water Potential Requirement (MCM)**	**Existing Water Potential (MCM)**	**Water potential to be Created(MCM)**
Ambala-I	48924	48719.77	287.53	287.53	286.93	0.6
Ambala-II	14959	14757.15	68.03	68.03	67.38	0.65
Barara	32456	32046.8	182.76	182.76	181.51	1.25
Naraingarh	32589	31278.72	199.53	199.53	194.15	5.38
Saha	23244	22937.01	115.41	115.41	114.46	0.95
Shahzadpur	22027	21120.48	300	300	300	0
Total	**174199**	**170859.93**	**1153.26**	**1153.26**	**1144.43**	**8.83**

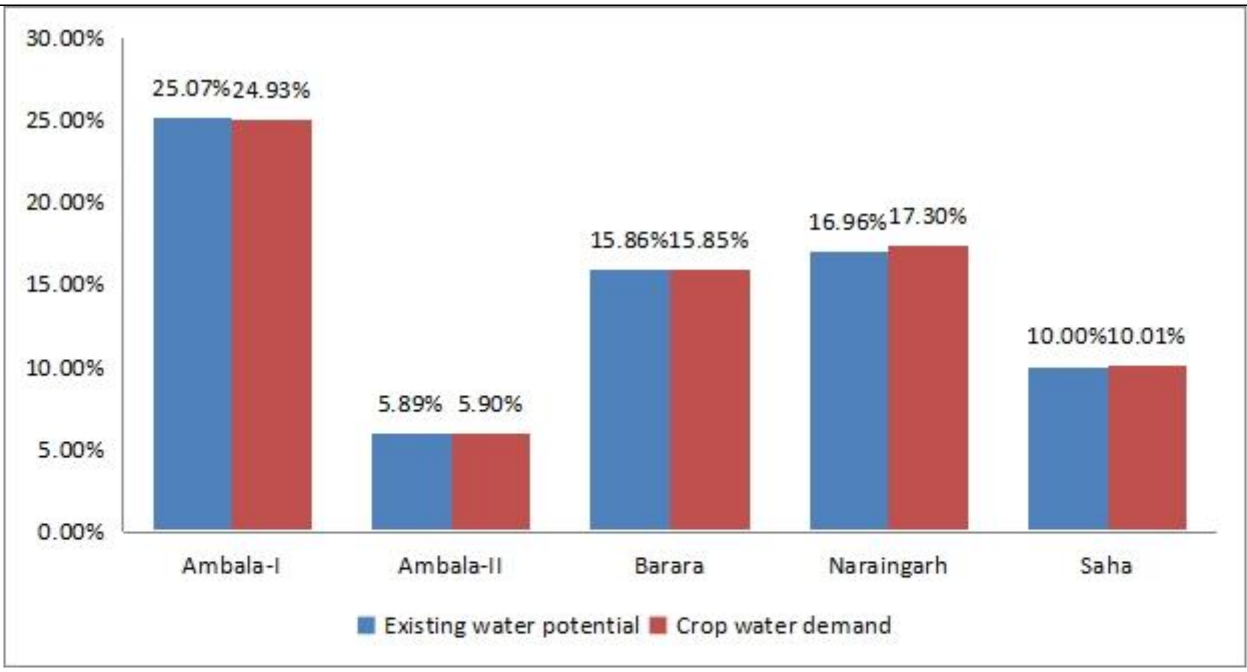


Figure 19 Existing water potential and crop water demand in district

Water potential required has been derived from water required by crops cultivated under rainfed conditions. Therefore, the existing water potential represents the water requirement of crops cultivated in irrigated areas. The existing water potential available in the district is 1144.43 MCM. The projected water demand for crop irrigation is 1153.26 MCM. It can be concluded from the above table that a total water potential of 8.83 MCM is to be created in the district to fulfill the requirement of crops.

6.3 Livestock Water Requirement

The requirement of water by livestock in the district has been derived from livestock census (2007 & 2012), as discussed in second chapter. The table below represents the animal wise water requirements well as water requirements of the district for livestock.

Table 11 Livestock water demand in district.

Blocks	Livestock Population	Present water Demand (MCM)	Water demand in 2022 (MCM)	Water potential to be created (MCM)
Ambala-I	221417	1.45	1.84	0.39
Ambala-II	122698	1.24	1.42	0.18
Barara	189084	1.28	1.57	0.29
Naraingarh	263063	1.7	1.96	0.26
Saha	102031	0.85	1	0.15
Shahzadpur	121199	0.45	0.59	0.14
Total	**1019492**	**6.97**	**8.38**	**1.41**

The assumption for the water requirement of livestock has been provided below:

1. Poultry: 200 ml to 500 ml per day

2. Pigs: 6 gallons or 25 liters per day (70- 80 kg growing pigs)

3. Cows: 40 liters per day

4. Buffaloes: 60 liters per day

5. Goats: 6 liters per day

6. Sheep: 4-5 liters per day

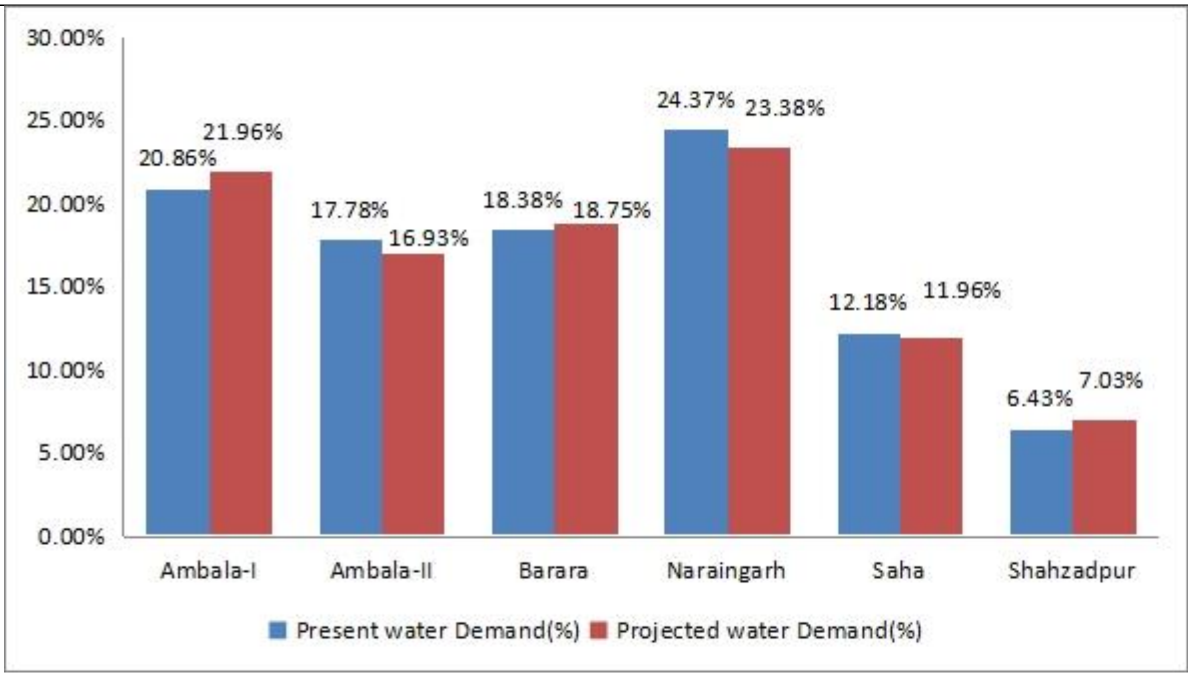


Figure 20 Livestock water demand

6.4 Industrial Water Demand

Industrial water demand in India is on the rise. Also Water used in district industry is very high due to combination of factors including obsolete process Technology, recycling and reuse practices and poor wastewater treatment. This is very low level of awareness about the problem and needs for wastewater treatment by industry. Efficiency of utilization in all the industrial uses of water should be optimized and an awareness of water as a scarce resource should be fostered. Water resources should be conserved and its availability increased by maximizing retention, eliminating pollution and minimizing losses. Conservation consciousness should be promoted through education, regulation, incentive and disincentives. Though some of the issues related to the industrial water have been addressed in National water policy (NWP) 2002; but no clear vision for regulating and controlling industrial water use has been given the key to the problem lies in effective management of water resources. Suitable measures including improved process Technology, effluent treatment, reuse of process water for more than once; re-circulating of process water in the same use of number of times; rainwater harvesting; waste- minimization must be adopted. Industrial water demand and potential is given in the table 12 and 13.

Table 12 Industrial profile of district

Block	Name of the Industry	Current water demand (MCM)
Ambala-I	Viking Garments, Hari Palace, Ambala City	30000 Ltr. Per day
Ambala-I	Simran Ice Factory, Nahan House, Ambala city	25000 Ltr. Per day
Ambala-I	Aggarwal Ice Factory, Naya Bans, Ambala city	50000 Ltr. Per day
Ambala-I	Mahaluxmi Ice Factory, Court Road, Ambala city	25000 Ltr. Per day
Ambala-II	Partap Spintax, Mohra, Ambala	60000 Ltr. Per day
Ambala-II	Epic Agro Industry, Mohra, Ambala	150000Ltr. Per day
Saha	Kandhari Beverages HSIIDC, Saha	150000 Ltr. Per day
Saha	Molson Coors, HSIIDC, Saha	800000 Ltr. Per day
Saha	Samriti products Pvt. Ltd., Saha	40000Ltr. Per day
Saha	Mount Shivalik, Saha	60000 Ltr. Per day
Naraingarh	NV distillery, Badhauli, Naraingarh, Ambala	70000 Ltr. Per day

Table 13 Water Demand for Industries

Blocks	Present water Demand (MCM)	Water demand in 2022 (MCM)	Existing Water Potential (MCM)	Water potential to be created (MCM)
Ambala-I	0.047	0.049	0.047	0.002
Ambala-II	0.077	0.08	0.077	0.003
Barara	0	0	0	0
Naraingarh	0.026	0.027	0.026	0.001
Saha	0.383	0.399	0.383	0.016
Shahzadpur	0.022	0.023	0.022	0.001
Total	**0.555**	**0.578**	**0.555**	**0.023**

The water demand calculation has been arrived from the existing water demand for industrial uses as per the central ground water board report for the Ambala district and it is 0.55 MCM. The growth in the water demand for the estimated year of 2022 has been estimated from the fact that the industrial growth in the Haryana for the year 2015-2016 has been 4%, taking the growth rate as the base, the water demand also has been projected for 2022.

As per the report of MSME, there are three industrial area in the district listed as below:

1. HSIIDC, Ambala Cantt.
2. Industrial Growth Centre , Saha Phase I
3. Industrial Growth Centre , Saha Phase II

4.5 Water Demand for Power Generation

There are no thermal or Hydel-thermal based power stations in the district. Hence the data regarding water demand for the district cannot be estimated.

4.6 Water Demand for various sectors

In Ambala, water is required for domestic use, crop irrigation and livestock drinking purpose, industrial use and power generation. Total present annual water demand for Ambala is 1251.45 MCM. Maximum water is required for crop which constitutes about 92.19 $ of the total present water demand in the district followed by domestic with 7.29 %. Below table 14 Sector-wise Water demand in the district.

Table 14 Sector-wise Water demand in the district.

Blocks	Sector-wise Water demand				Total (MCM)
	Domestic (MCM)	Crop (MCM)	Livestock (MCM)	Industries (MCM)	
Ambala-I	23.93	287.53	1.74	0.05	313.26
Ambala-II	7.54	68.03	1.49	0.08	77.14
Barara	4.51	182.76	1.54	0	188.8
Naraingarh	4.23	199.53	2.04	0.03	205.82
Saha	3.11	115.41	1.02	0.38	119.92
Shahzadpur	45.95	300	0.54	0.02	346.51
Total	**89.27**	**1153.26**	**8.37**	**0.56**	**1251.45**

The Blockwise present water demand in the district is given in figure below:

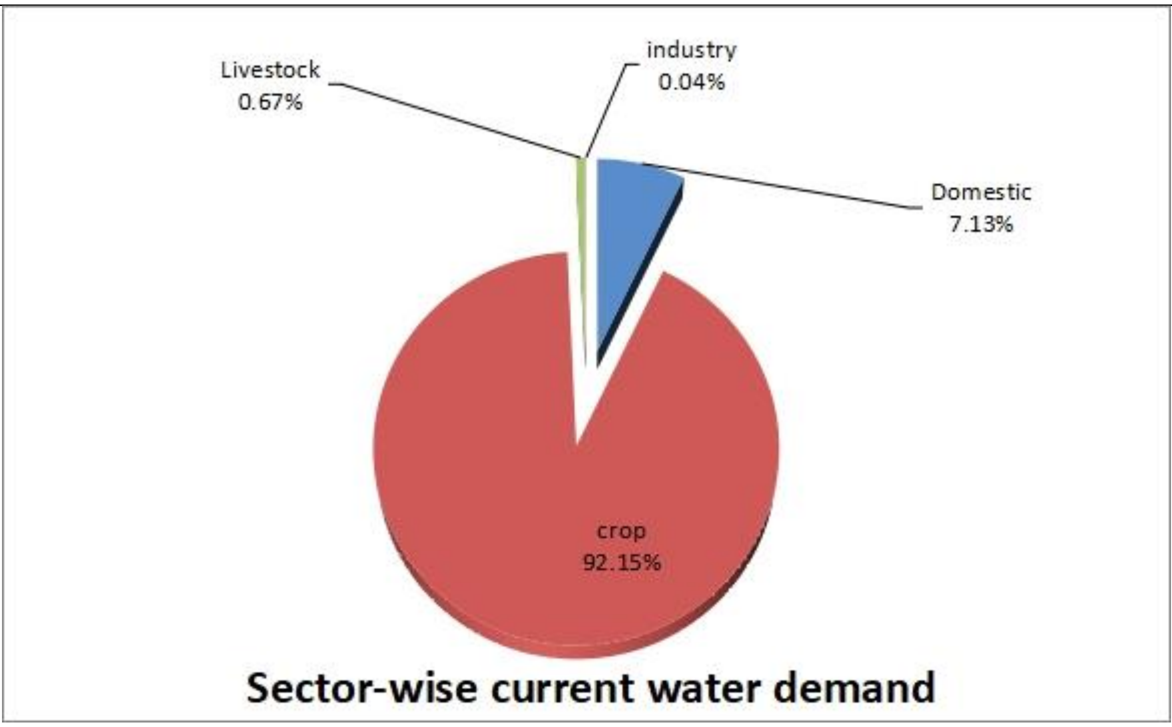


Figure 21 Sector-wise current Water demand in the district

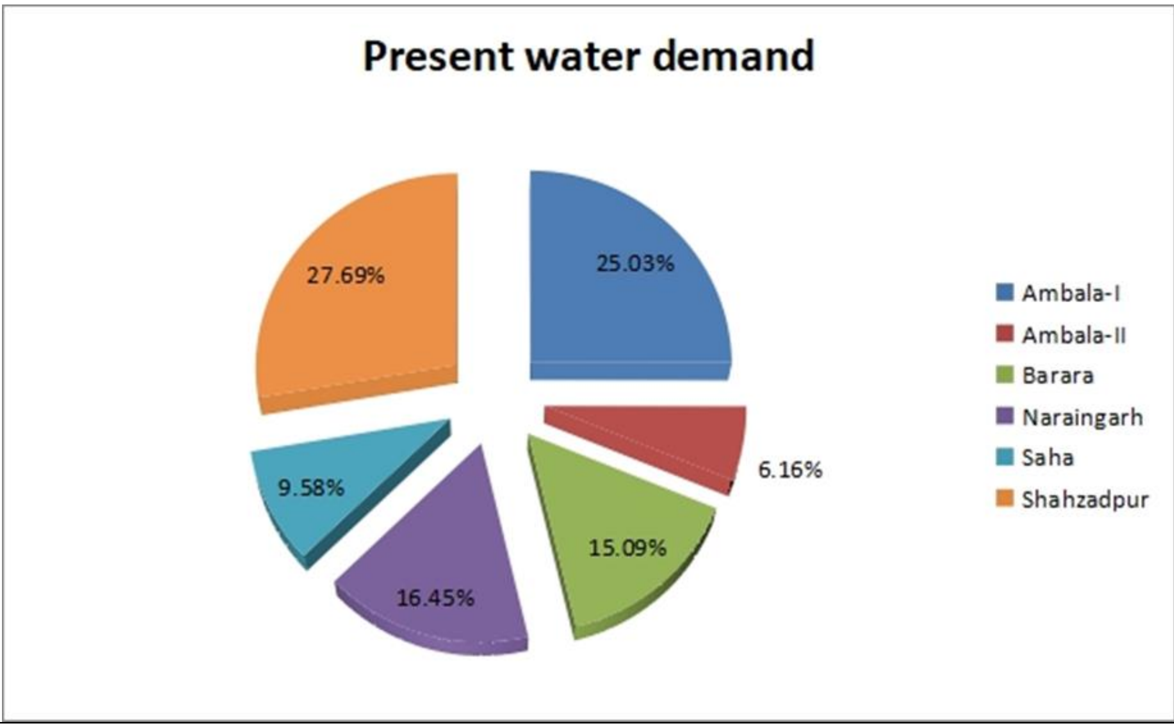


Figure 22 Blockwise present water demand in the district

The projected water demand in the district at the end of year 2022 will be 1260.23 MCM which is 8.78 MCM higher than current year water demand in the district. The major sector which forms the major part of projected water demand in the district is Agriculture where the crop water requirement is projected to be 1153.26 MCM. Table 15 is showing the Projected Sector-wise Water demand in the district.

Table 15 Projected Sector-wise Water demand in the district

Blocks	Sector-wise Water demand (2022)				Total (MCM)
	Domestic (MCM)	Crop (MCM)	Livestock (MCM)	Industries (MCM)	
Ambala-I	25.59	287.53	2.4	0.05	315.57
Ambala-II	8.07	68.03	1.85	0.08	78.03
Barara	4.82	182.76	2.05	0	189.63
Naraingarh	4.52	199.53	2.55	0.03	206.63
Saha	3.33	115.41	1.3	0.41	120.45
Shahzadpur	49.13	300	0.77	0.02	349.92
Total	**95.46**	**1153.26**	**10.92**	**0.59**	**1260.23**

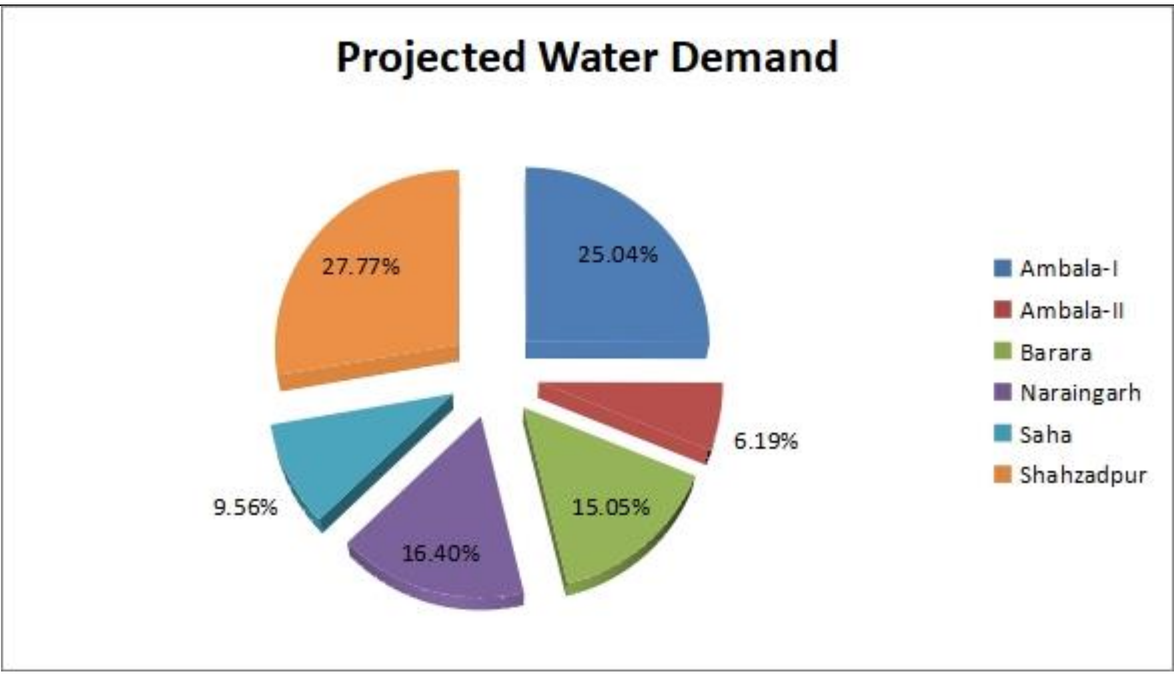


Figure 23 Blockwise projected water demand in the district

7. Water Budget

Water availability is through surface water received from canals and groundwater. Dynamic groundwater availability depends on both natural resources such as amount of rain recharge from surface water resources. Annual water available in the district is 601.03 MCM against annual demand 1251.45 MCM, which will further increase in coming years. Projected water demand during 2022 is expected to be 1260.23 MCM. Presently there is no shortage of water. Since Ambala district is not blessed with good perennial river systems, so any increase in water demand requires careful planning for future water resources.

Table 16 Water budget of the district

Blocks	Existing water availability (MCM)		Total (MCM)	Water Demand (MCM)		Projected Water Gap (MCM)
	Surface Water (MCM)	Ground water (MCM)		Present (2016)	Projected (2022)	
Ambala-I	67.01	139.96	206.97	313.26	315.57	108.6
Ambala-II	1.12	72.75	73.87	77.14	78.03	4.16
Barara	0	66.92	66.92	188.8	189.63	122.71
Naraingarh	0	96.22	96.22	205.82	206.63	110.41
Saha	0.39	70.27	70.66	119.92	120.46	49.8
Shahzadpur	0	86.4	86.4	346.51	349.92	263.52
Total	**68.52**	**532.52**	**601.03**	**1251.45**	**1260.24**	**659.2**

7.1 Strategies for Water Conservation

7.1.1 Measures of Water Conservation

Water conservation measures in industries should include: (i) review of alternate production processes and technologies from water consumption point of view; (ii) ensuring sound plant maintenance practices and good housekeeping, minimizing spills and leaks; and (iii) optimization of treatment to achieve maximum recycling. Another established technique for maximum water recovery is the water pinch analysis technique. However, this technique only focuses on maximizing freshwater and wastewater reduction via reuse and regeneration.

What We can do to Conserve Water?

- Use only as much water as you require. Close the taps well after use. While brushing or other use, do not leave the tap running, and open it only when you require it. See that there are no leaking taps.
- Use a washing machine that does not consume too much water. Do not leave the taps

running while washing dishes and clothes.

- Install small showerheads to reduce the flow of the water. Water in which the vegetables & fruits have been washed - use to water the flowers &plants.
- At the end of the day if you have water left in your water bottle do not throw it away, pour it over some plants.
- Re-use water as much as possible
- Change in attitude & habits for water conservation
- Every drop counts!

7. 2 Improve water management

The close link between forests and water, and the traditional relationship between agriculture and water, need to be recognized and protected to ensure sustained productivity.

- National water management policies should take account of the impact of trade in water-intensive goods on water availability and ecosystems integrity. For example, in water scarce regions, people should grow crops with low water requirements, or of high value compared to the water used. Options for improving the water balance by importing water intensive goods from water-rich regions should be explored, where appropriate and cost-effective.
- The potential of rainwater harvesting for augmenting rural and urban water supply is increasingly becoming recognized. This alternative should be further explored and utilized.
- Proper water pricing must be an integral part of water policies. However, care must be taken to ensure that the poor and socially disadvantaged are not denied access. Moreover, there must be adequate monitoring and control of market mechanisms.

7.2.1 Public Education and Awareness

- Public awareness and education on the importance of protection of the coastal and ocean environment helps to meet social and economic needs and aspirations of the country in the long run.
- Awareness campaigns on existing regulations for management of coastal areas need to be conducted. Education and communication material on the need for conservation and protection of rare and endangered species need to be developed.
- Research findings on marine resources, their development and management have to be demystified. The educational and communication material targeted at the public has to be developed in local languages.

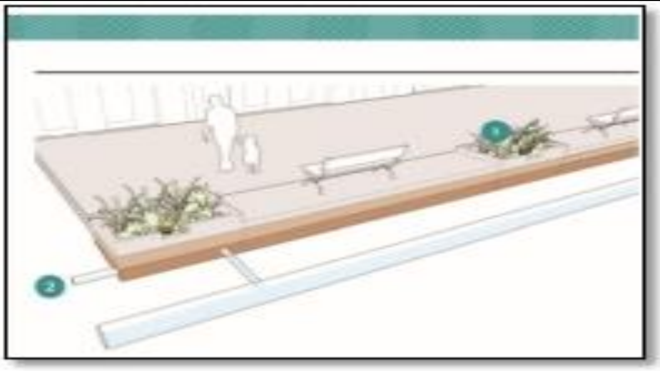
- ➢ Opportunities for interactions between communities, policy makers, regulating agencies, NGOs, scientists, etc. need to be increased.

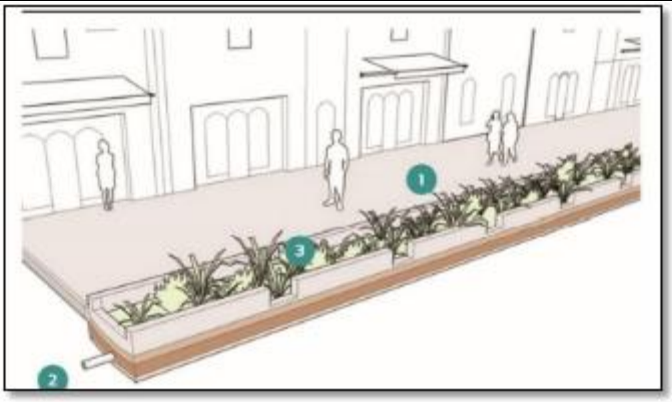
- ➢ Appropriate strategies and decision making tools that would enhance the capabilities of professionals, Government, and non government organizations to take up local and community level action programmes need to be developed.

7.3 Water Sensitive Urban Design

As more and more portions of the district become urbanised, 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 more scarce in terms of frequency.

Table 17 Following table shows the methods of water table recharge strategies in urban area

Sr. No.	Method	Image
1	**Flow Through Planters**	 

2	**Pervious Strips**	
3	**Pervious Pavement**	 
4	**Stormwater Tree**	

7.3.1 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 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. The wasteland that could be used for plantation for conservation of water in Ambala district is shown in **Figure 20** and **Table 18** shows the plantation target in Ambala District.

Table 18 Wasteland Stats of Ambala District

Block Name	**Wasteland Area (sq feet)**	**Plantation at 5 feet spacing**
Ambala I	12551651.33	2510330
Ambala II	26586174.73	5317235
Barara	28017197.04	5603439
Naraingarh	151056236.96	30211247
Shah	54841285.66	10968257
Shahdazpur	121906060.33	24381212
Total	**394958606.1**	**78991721**

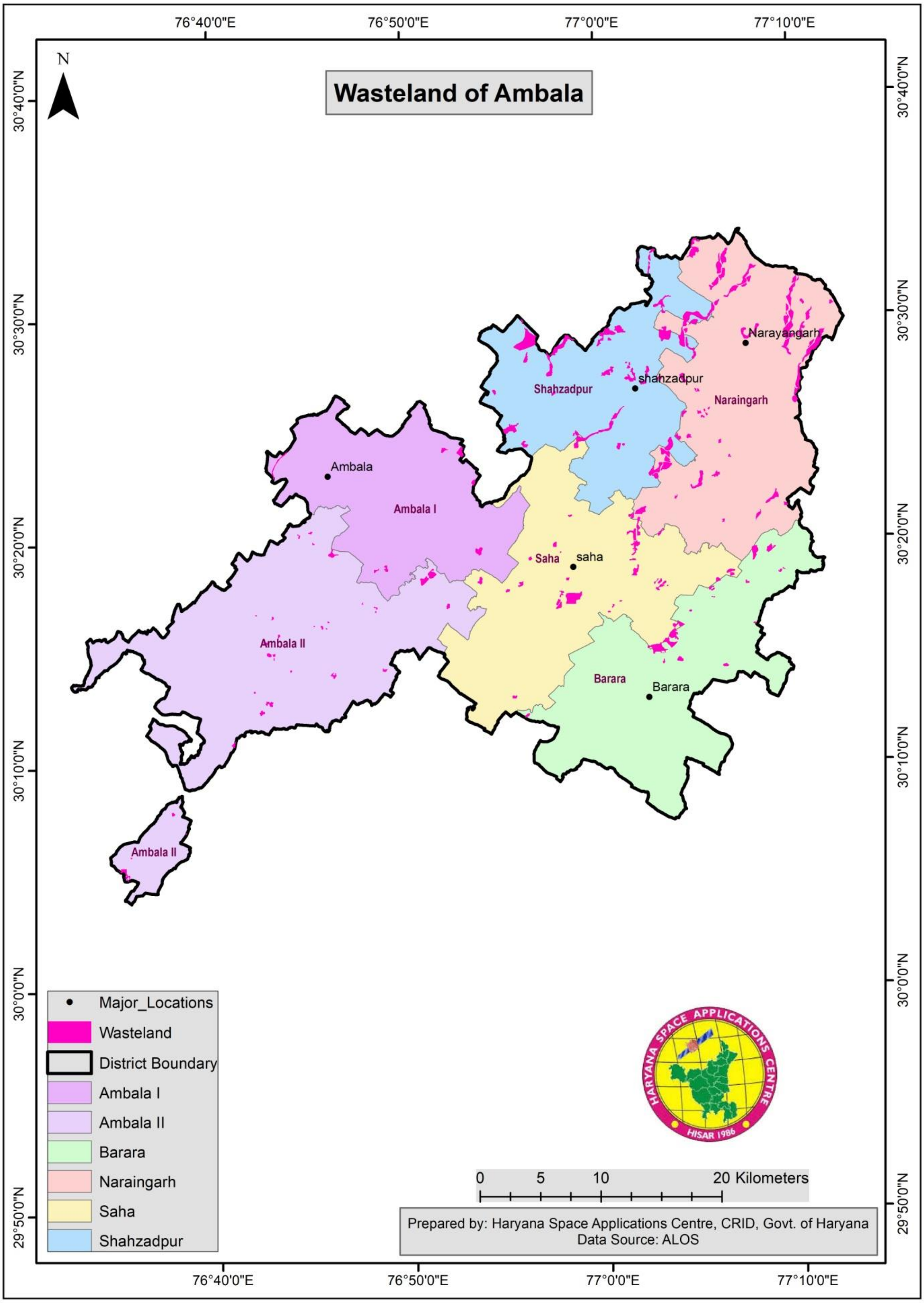


Figure 24 Wasteland Map of Ambala District

7.4 Surface water management

7.4.1 Pond restoration and rejuvenation

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

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

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

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

Therefore ponds form a fundamental part of the hydrological cycle in the environment and has allowed a rich cultural, agricultural and societal practices to flourish in India Since ponds can be formed in a much broader range of environments and landscapes, they demonstrate a wide range of physiochemical activities that allows a wide range of flora and fauna to flourish.

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

1. Pond Identification and Pond profiling

2. Project Feasibility Assessment

3. Administrative Approvals (Demarcation, GIS mapping, and Panchayat Resolution)

4. Detailed Project Report

5. Financial Approval

6. Community Mobilization

7. Cleaning and Levelling

8. Civil Work, Micro-STP Installation and Waste Management

9. Landscaping and Beautification

10. Sustainability Plan (O & M)

11. Monitoring and Evaluation

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

7.4.2 Decentralize Treatment Plant

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

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

Decentralized wastewater treatment systems could be a feasible alternative for areas which are not connected to sewer networks as well as ones which are newly developed, so that the construction of their infrastructure is inadequate, not ready or would be executed in the future. Therefore, for local communities in the peripheries of urban development that exist outside the city center and rural areas where open drainage systems still exist. Over the past three decades, the city limits of Ambala 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 are a feasible solution that may allow for localized treatment which may eventually be reused for secondary purposes. Like other systems, decentralised systems must be properly designed, maintained, and operated to provide optimum benefits.

The following table (**Table 19)** shows a list of generic conditions that are most often found in Ambala according to the type of treatment considerations and other main constraints such as land availability and population, given that finances are a constant.

Table 19 Indicators and factors to decide the type of decentralised treatment required

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

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. The following image shows the various stakeholders involved in IEC Activities (**Figure 21**) and **Table 19** shows the numerous activities and interventions that can be carried out for IEC.

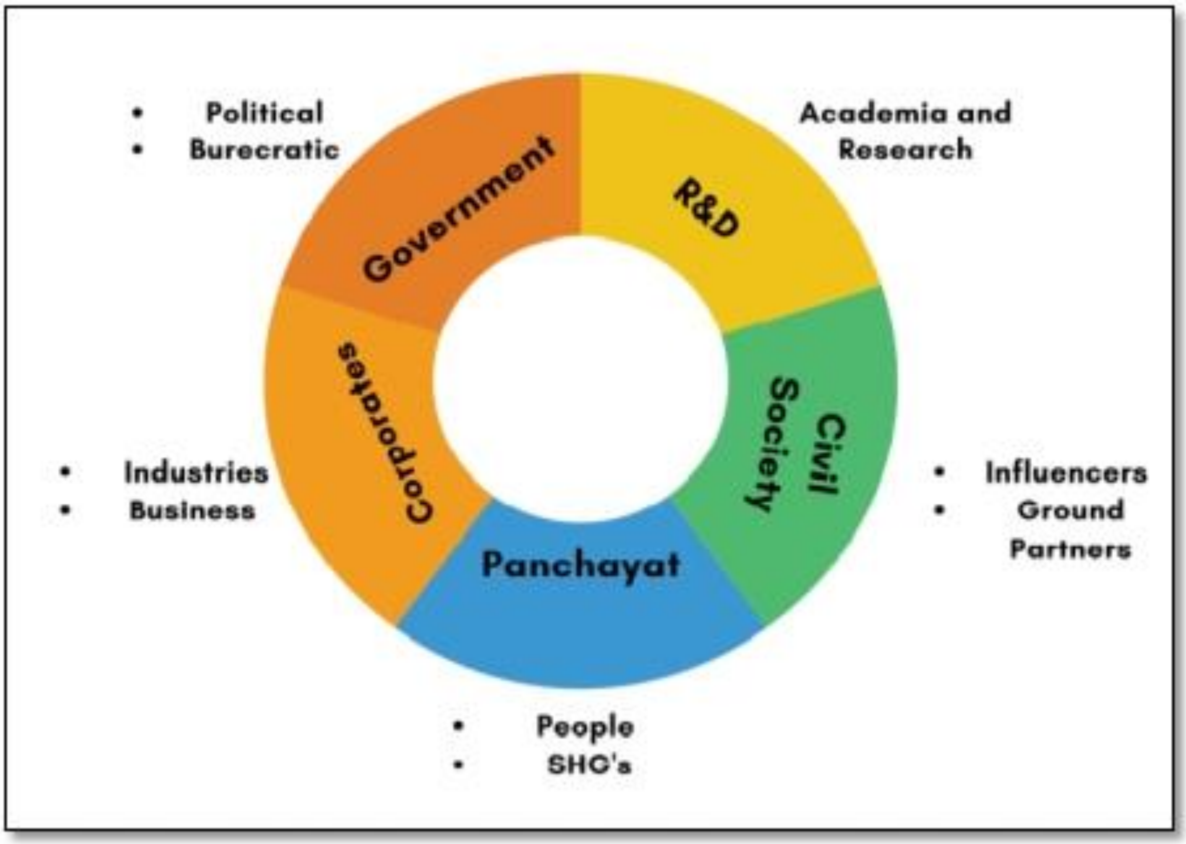


Figure 25 the various stakeholders of IEC Activities

Table 20 The numerous activities and interventions that can be carried out for IEC

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

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

12	Plantation Drives	- Awareness on Plantation drives	- Urban (RWA, MCG, MC) - Rural (Pond Sites) - Schools -NGO's	-To increase the green Cover To increase the water holding Capacity	- Plant List Nursery Database - Distribution Chain Management Posters	Better environment for Future Generations
13	Collaborations	- For IEC	- NYK - District Youth Affairs and Sports -Kalagram -NGO's -Durga Shakthi -Civil Defence -Lion Club	To involve stakeholders to facilitate sessions	- Letter of Collaboration -Google form	- No Overlapping of the work or activities - More effectiveness in Catch the rain Campaign

8. Proposed Activity

8.1. Rainwater harvesting

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

There are some factors that affect the rainfall water harvesting which needs to be focused for the development of suitable sites of water harvesting. These factors include rainfall, slope, soil texture, drainage, topography and land use / land cover and integration of these factors using weighted overlay analysis that results in suitable sites for rainwater harvesting. These sites are then classified into various suitability levels, namely, not suitable, less, medium, good and very good. The most suitable sites for rainfall water harvesting are shown in map (**Figure 24**). 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 21).**

Table 21 Block wise area under very good suitable site proposed for rain water harvesting

Block Name	**Area (Very Good suitability area in Sq meter)**
Ambala I	160313528
Ambala II	316333583
Barara	225728928
Naraingarh	272735083
Shah	245906329
Shahzadpur	200298932

Table 22 Assigned Weight for layers

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

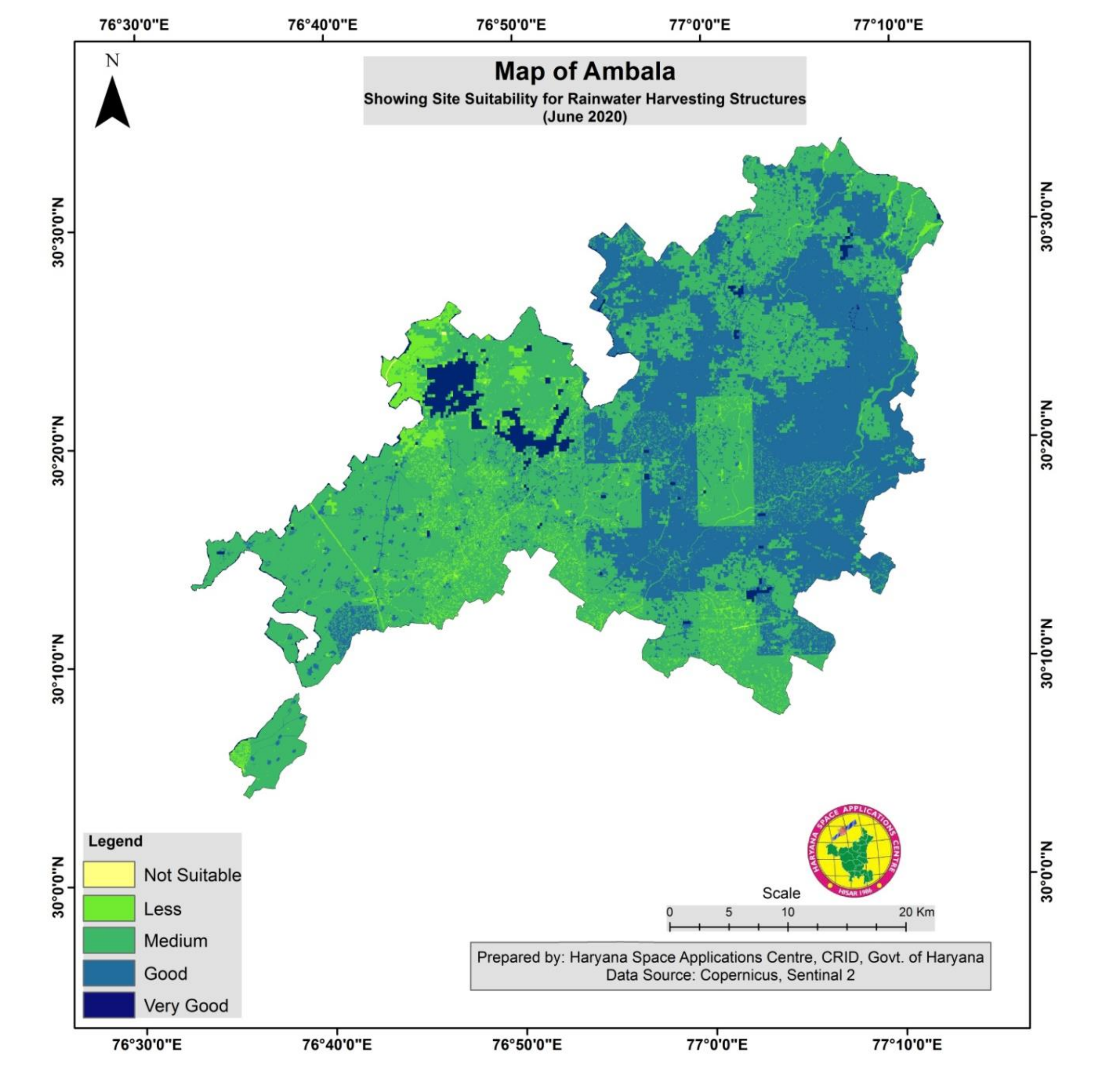


Figure 26 Site Suitability Map for Rainfall Harvesting Structure in the Year 2020

8.2 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 25** shows the proposed suitable site based on multi criteria. **Table 22** Block wise proposed suitable site on multi-criteria.

Identify the suitable sites on Streams order.

1. 13 Mini percolation Tanks, on Ist order Stream
2. 11 percolation Tanks, 2nd Order Stream
3. 7 pakka check Dams 3rd Order Stream
4. 3 Micro Irrigation tanks 5th Order

Table 23 Block wise proposed suitable site on multi-criteria

Sr. No.	Block Name	Mini percolation Tank	Percolation Tank	Pakka Check Dam	Annicut	Micro Irrigation Tank
1	Ambala I	0	0	1	0	0
2	Ambala II	0	0	0	0	0
3	Barara	4	1	1	0	0
4	Naraingarh	6	4	4	0	2
5	Shah	2	4	1	0	1
6	Shahzadpur	1	2	0	0	0

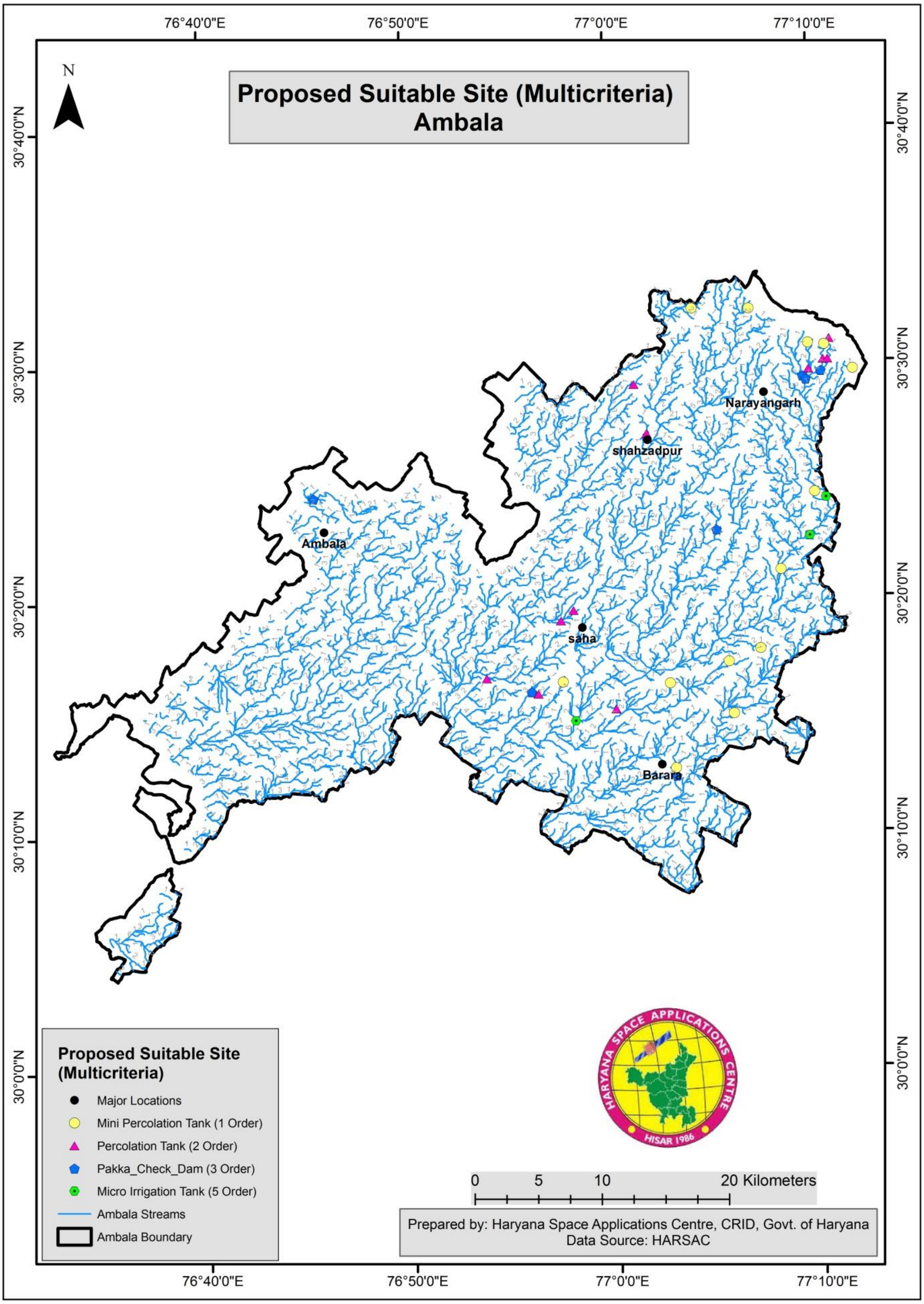


Figure 27 Proposed suitable sites based on multicriteria in Ambala District

8.3 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 26** shows the proposed suitable sites based on drainage structure in Ambala district.

Table 24 Proposed harvesting structures on Ambala based on drainage

Sr. No.	**Stream Order**	**Harvesting Structures**	**Count**
1	1st Order	Mini percolation Tanks	453
2	2nd Order	Percolation Tanks	364
3	3rd Order	Pakka check Dams	450
4	4th Order	Annicut	218
5	5th Order	Micro Irrigation tanks	208

Table 25 Block-wise proposed suitable sites based on drainage structure

Sr. No.	**Block Name**	**Mini percolation Tank**	**Percolation Tank**	**Pakka Check Dam**	**Annicut**	**Micro Irrigation Tank**
1	Ambala I	18	17	20	6	2
2	Ambala II	103	80	83	40	38
3	Barara	79	86	65	59	13
4	Naraingarh	90	64	119	47	54
5	Shah	99	59	101	27	82
6	Shahzadpur	64	58	62	39	19

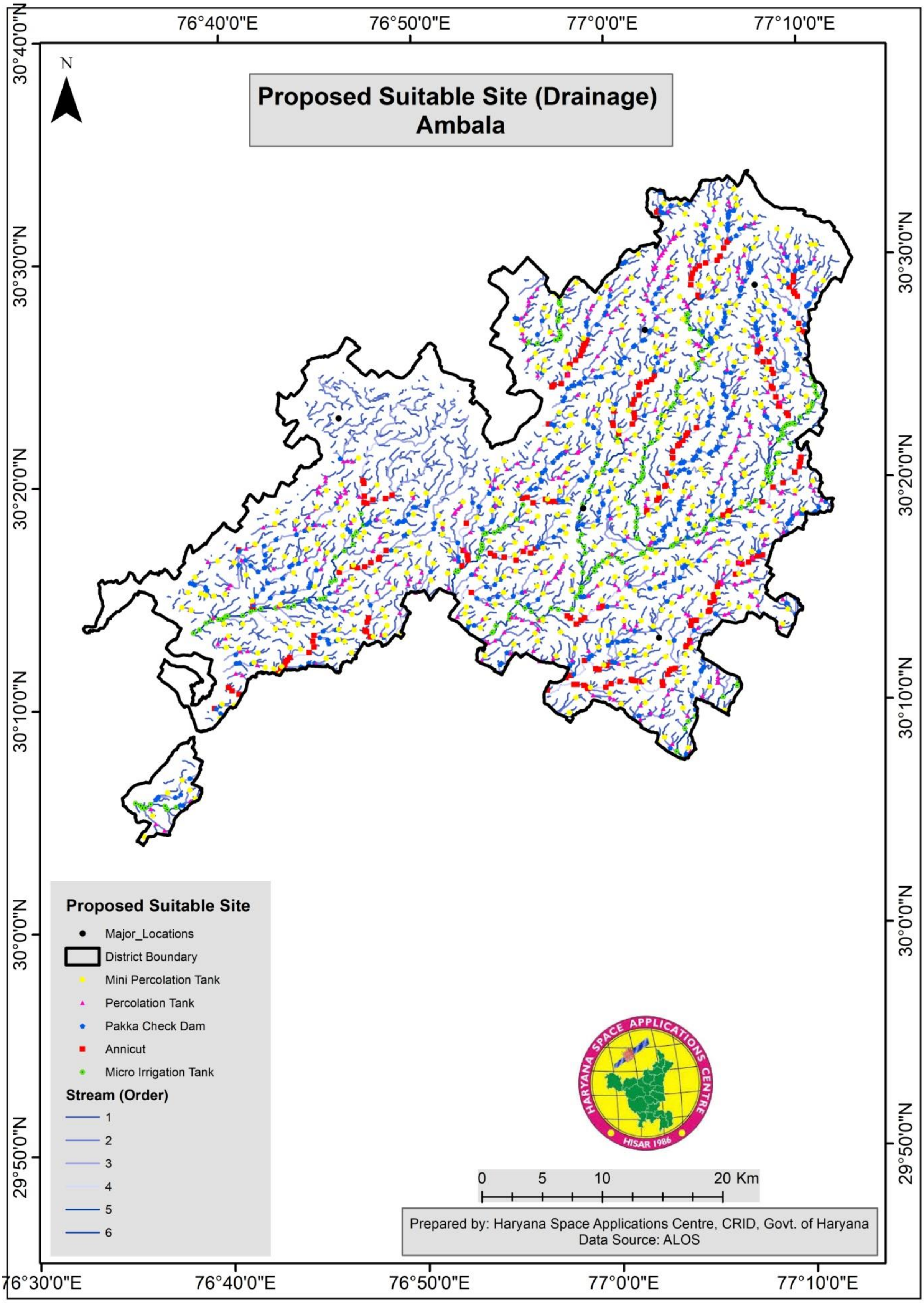


Figure 28 Proposed suitable sites based on drainage in Ambala District

Conclusion

Due to rapid urbanization, the Ambala 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 while village level information is available at https://ambala.gov.in/

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