CHAPTER – 2

PHYSICAL SETUP OF THE STUDY AREA

2.0 Introduction

The physical elements is an important indicators to know the geographical conditions of any areal units. Physical setup like relief, geohydrology, drainage, climate, soil, and vegetation characteristics effects in agriculture in many ways (Morepatil, 1995). They determine the type of crops, the timing of agricultural activity (agricultural seeds sowing and harvesting time), and the extent of risk involved and improvement of agriculture. The main objective of this chapter is to study physical setup of the district. Not only that, the cultural factors also influence the many aspects of agricultural system but they can only be operated by the physical background. In this chapter, these determinants are analysed for Uttar Dinajpur District which appears relevant to the changes in the agricultural land use scenario.

2.1 Physiography

Uttar Dinajpur District is a part and parcel of North Bengal. This district can be broadly demarcated into three principal physiographic zones; comprising the piedmont terraces found mostly in Chopra block to the north side, the active Mahananda floodplain which occupies more than four-fifths of the district extending from Islampur Block down into northern Itahar, and the mature floodplain that covers the lower extremities of Itahar Block. Chopra Block mainly comprises elevated *Dangas* or piedmont terraces interspaced by low lands, along with a segment of the Mahananda alluvial fan stretching over an area of 45 km^2 along its north-western fringe. Local elevations decline rapidly in the piedmont zone (300-66 m.), leading to the acceleration and free flow of major rivers like Mahananda which descends from the mountains, once their heavier colluvial sediment of gravels and sands have been deposited at the base of the foothills.

2.1.1 Relief

The general outlook of the district is flat, sloping gently southwards, as is shown by the trend of the rivers. In the southern portion of the Uttar Dinajpur District the curious formation known as the Barind, geologically classed as old alluvium, makes its appearance. The characteristic of this is an undulating land interspersed with ravines. The ravines vary from shallow stretches of low land, suitable for growing rice to deeper depressions bearing a resemblance to old river-

beds and sometimes containing water. The ridges are commonly covered with scrub jungle and stunted trees. Uttar Dinajpur District's average slope is 5º 14'' as followed by maximum slope 9º 81'' and the minimum slope is 0º 47''.

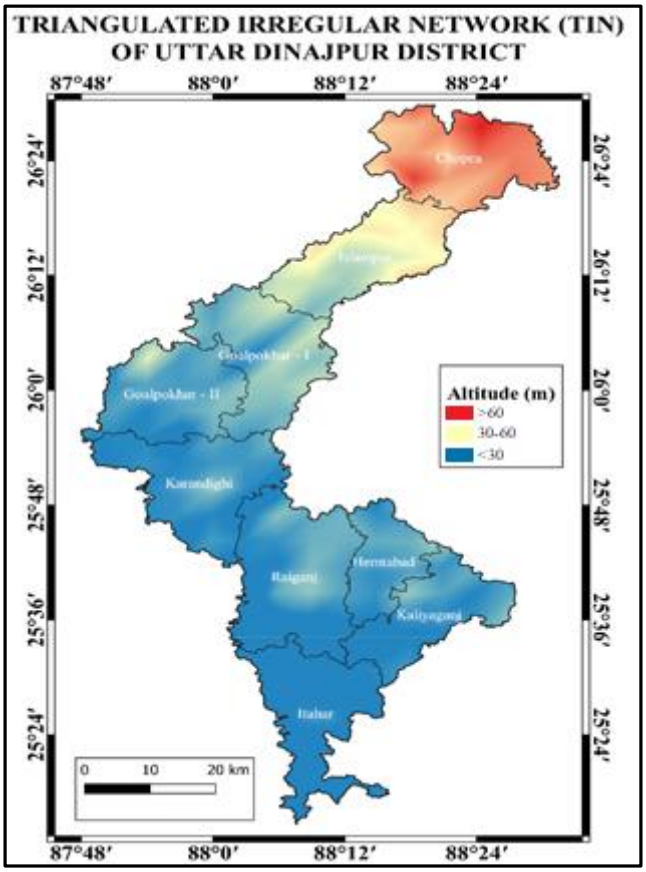


Figure 2.1 Relief character by Triangulated Irregular Network (TIN).

The thickness of this alluvial formation is not clearly known. It is generally agreed that the area of which this district forms a part, is a gap between the Garo-Rajmahal hills filled up by alluvium in comparatively late geological times.

1. The topographic ranges show the elevations in the Uttar Dinajpur touch a maximum of 92 metres in the piedmont zone and decline through the elongated length of the district to 25 metres in the mature floodplains.
2. The decline is somewhat uneven and at depressions found along isolated and water bodies in the district, elevations touch 25 metres nevertheless, with quick drop in elevations past the piedmont zone, most of Uttar Dinajpur District presents a relatively flat topographic profile except along the river valleys, with the dominant slope consequently being much lower than average slope in the district.

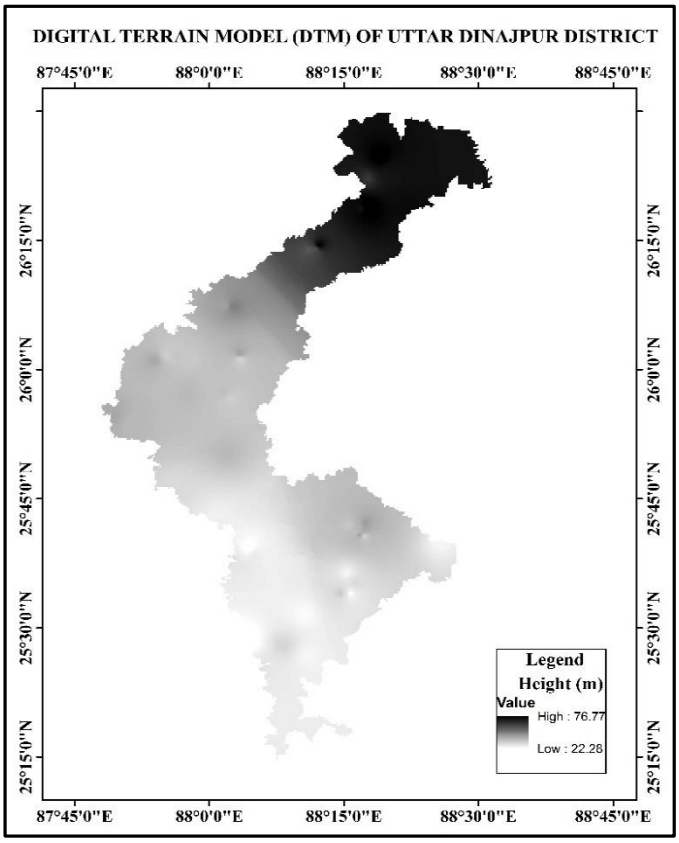


Figure 2.2 Relief character by Digital Terrain Model (DTM).

Table 2.1 Topography and Physiographic zone of Uttar Dinajpur District.

District	Total Area (km^2)	Piedmont region (300-66 m) km^2		Active flood plain (66-45 m) km^2	Mature flood plain (45-27 m) km^2		Moribund region (<27 m) km^2
Uttar Dinajpur	3,140	281.00		2,563.00	296.00		-
	Elevation Features			*Slope features			
	Max. Elevation	**Min. Elevation**	**Elevation range**	**Max. slope**	**Min. slope**	**Average slope**	**Dominant slope**
	92 m	25 m	67 m	9.48°	0.45°	5.12°	0.08°

Source: i. District Human Development Report, Uttar Dinajpur
ii. * Bhuvan, National Remote Sensing Centre, Hyderabad, Government of India.

2.1.2 Geohydrology

Geohydrology is a branch discipline the area of geology that deals with the distribution and movement of ground water in the earth's crust. From a geological point of view of a group of geologists, the district is exceptionally uninteresting. Almost the whole area is covered by alluvial deposits of recent formation. In the southern half of the district the soil consists of clayey silt, ash coloured in appearance, locally *khair*. The sand hardens this soft sticky loam and it reaches almost to the consistency of cement in the dry weather when it is unsuitable for vegetation. And in the northern half of the district and on the banks of some of the principal rivers in the south, the soil consists of sandy loam, mixed towards the north with gravel. This goes by the local name of *Pali*. An interesting geological formation called *Barind* occurs in

this district common with other parts of Eastern Bengal. This belongs to the old alluvium which is composed of beds of stiff reddish-brown clay, yellowish on the surface. The nodular limestone deposits, a frequent source of material for road metal in some parts of this district, are also found. In the whole district general rock type is alternating sand, silt and clay type which originated in two periods: one is late Pleistocene to Holocene and another is middle Pleistocene to Holocene. The detailed geohydrological situation of Uttar Dinajpur District is presented in table 2.2.

Table 2.2 Geo-hydrology situation in Uttar Dinajpur District.

Rock types	Age	Lithology	Aquifer situation	Geohydrology
Alternating sand, silt and clay	Late Pleistocene to Holocene	Fluvial facial expression with gravel, pebble and calcareous concretion	Confined aquifers down to 3000 m	Large yield prospect above 150 cum/hr with the explored depth of maximum 600 mbgl. Ground water occurs both under unconfined and confined conditions
			Unconfined and confined aquifer	
Alternating sand, silt, clay and grit	Middle Pleistocene to Holocene		Unconfined aquifer	

Source: Central Ground Water Board, 2001

2.2 Drainage network

Drainage is the flow of water through well-defined channels. The district Uttar Dinajpur is located entirely within the catchment of the Mahananda River, which occupies a low entrenched valley between the major alluvial fans of Kosi and the Tista over much of its course. The general direction of the main rivers is without exception from North to South and the ultimate destination of all is the River Ganges. In the rainy season the main rivers, such as the Nagar, Punarbhaba and Atrai are navigable by good-sized country boats to as far north as Dinajpur town, or a little above it; but in the dry season, or for some eight months in the year, the points up to which they are navigable by large boats are very much lower down and most of them are fordable almost throughout their entire course through the district. The river channels are well marked and fairly constant, though there is evidence that in the past this was not always so and that changes of course occasionally took place. In the district, the main rivers flow having many small streams or khals.

Table 2.3 The Drainage system (Main River) in Uttar Dinajpur District, 2017

Name of the Rivers	Entry point	Runs through the block	Length in the district (km)	Branches	Ending point
Mahananda	Gorahar and Damdalia	Itahar	5.7	Nagar	Gorahar and Tharais
Nagar	Karandighi	Karandighi, Raiganj	24.5	Gandhar, Tirnai, Kulik, Kayes	Itahar
Gamari	Radhariparabil	Kaliaganj, Itahar	26	Sui	Borot (Itahar)

Kulik	Hemtabad	Hemtabad, Raiganj	11	-	Gobrahar (Raiganj)
Srimati	Hemtabad	Kaliaganj, Itahar	08	-	Churaman (Itahar)

Source: Madhuparni, Paschim Dinajpur and Dinajpur District Gazetteer.

2.2.1. Mahananda River

The river Mahananda forms the northern boundary of the district for a few kilometres along its course. It flows south-westerly direction after forming the north-western boundary of the Uttar Dinajpur District (figure 2.4 and plate 2.1). The Mahananda rises within the district of Darjeeling where it is known by the name of Mahanadi. It then leaves the district and after flowing through the district of Purnea is joined by the Nagar River at a place called Mukundapur situated in police station Itahar. From this point, the combined stream of the Nagar and the Mahananda forms the boundary of the district and Malda for a considerable distance and enters Bihar at last. The large and important village beside the river Mahananda is Churaman, which is situated on its eastern bank. The direction of flow of the river as a whole is normally from the north to the south, but the direction changes at a few points on account of the meandering course of the river (West Bengal District Gazetteer, 1965).

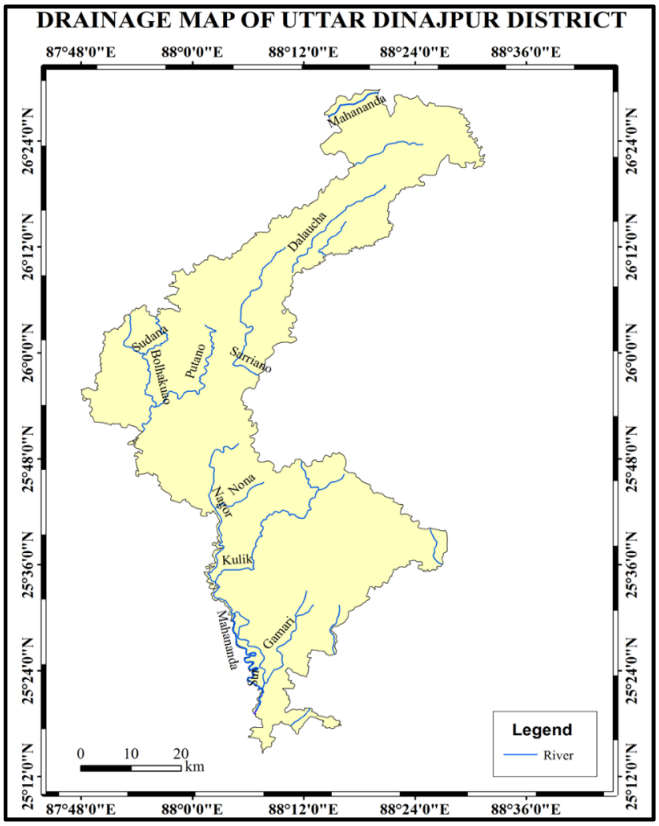
2.2.2 Nagar River

The Nagar is originated from the country of Bangladesh and flows into the district of Uttar Dinajpur at the tri-junction point of Bangladesh and Raiganj and Karandighi Block. Its bed is rocky in the upper reaches but becomes sandy lower down. The lower portion of its channels is deeper than those of most of the other rivers in this district and is hardly fordable even in dry weather. It flows through the district forming the boundary between the police stations of Karandighi and Raiganj (figure 2.4 and plate 2.1). There is no place of any great importance on its banks, except the police outpost of Atwari. The principal tributary of the Nagar is Kulik and the Nona or Gandhar. Both the tributaries are in moribund condition as there is water scarcity of the mother Rivers and both are flowing through Raiganj Block. The smaller tributaries of the Nagar River are the Tirnai, the Nuna and Kayes. Tirnai passes close to the Baliyadangi police post and joins the Nagar about 42 km from its source while the latter two enters its lower down.

2.2.3 Gamari River

The Gamari originates from Randhanipara bil areas in Kaliaganj police station and flows on a meandering course for about 16 miles more or less in the southern direction and meets the river

Sui near Borot in Itahar police station. The width of the river bed is about eighty feet and the water level varies between four to ten feet. There are small boats that ply and it is navigable during the monsoons season.



Source: Prepared by the researcher based on HDR, 2010, Uttar Dinajpur.

Figure 2.3 Drainage system of Uttar Dinajpur District.

2.2.4 Kulik River

The River Kulik enters the district Uttar Dinajpur in a north-south flow from Bangladesh creating the natural boundary between Raiganj and Hemtabad Block. Kulik passes beside the Raiganj Bird Sanctuary (figure 2.3 and plate 2.1). The total length of the Kulik River is 11 km and flows through the Raiganj and Hemtabad Block. Asia's famous and largest Birds Sanctuary with lush evergreen vegetation is situated on the bank of the river Kulik.

2.2.5 Srimati River

The Chhiramati River is called by the local name Srimati. The Srimati takes its rise in a marsh on the common boundary of the Pirganj and Kaliyaganj police station. Two principal branches join together at the tri-junction point of the police stations of Kushmandi, Itahar and Kaliyaganj. It flows along the boundary of Itahar and Kushmandi police station for about 8 km. The Srimati is a sluggish stream and not of much importance to the district. The village

Patirajpur is the most important market (Hat) in the south-western part of the district and it is situated on the right bank of the river Srimati (Madhuparni, 1399 B.Y). It is also navigable in the monsoon season.

A) NH-34 passes over the Kulik river B) River bank erosion in rainy season

C) Fery ghat as a communication lifeline D) Parmanent fish catching point.

Plate 2.1 Different rivers of Uttar Dinajpur District.

2.2.6 Major wetlands in Uttar Dinajpur District 2017

In Uttar Dinajpur District, over four-fifths area being located within the active floodplains, the fluvial regimes of the district river have been subjected to great alteration over time, thus affecting long-term settlement patterns in the district. Because of the break of gradient which caused silting and shifting of rivers, few stable settlements have survived in the district from the ancient period. This feature, which also causes the resulting drainage patterns in the northern regions to diverges, is responsible for the gradual distancing of the Tista-Rangit river system from the Mahananda-Nagar river system. Not only that, lowered gradients being encountered in the district have depressions which formed when rivers verged away from their old courses, departure a chain of oxbows, bils and cut-off meanders at the back. From the

satellite imageries (extracted from Glovis) of the district, it can be seen that a succession of light and dark areas marking a type of chain of bils that commence from the lower western part of Islampur Block, Goalpokher-I and Karandighi Block of the district (figure 2.5). Similar wetlands areas also occur in Raiganj Block along the course of Kulik River and along the dying channel of the 'Mora' Tangan through eastern Kaliaganj Block and Itahar Block. Most of the bils have a highly distributed topography indicating the possibility of land subsidence in the ancient time, during tectonic events which had distributed the ancient courses of the Teesta and Kosi.

The general direction of the main rivers is from North to South to their ultimate destination of the river Ganga. Apart from the main rivers and their tributaries, many large and small bils (shallow) depression filled with water covering large area and tanks is found in this district. Musha bil is the largest bil in Itahar Block which is located in the north-eastern side of the block and covering about 2.5 km^2 area (figure 2.5 and plate 2.2). The major wetlands and their location are given in table 2.4.

Table 2.4 Location of major wetlands (water reservoirs) in Uttar Dinajpur District.

Sl. No.	Located at		Water Bodies
	Blocks	**Village**	
1	Goalpokher-I	Borot and Ghordhappa	Danchhat Bil
		Purba Gati, Paschim Goti, Dobagachhi and Paschim Keladanta	Jolar Bil
		Jhiltalab	Kachhan Bil
2	Goalpokher-II	Belan	Kachhan Bil
3	Itahar	Bahadol	Elani Bil
		Tiabari, Simuldanga & Patirajpur	Musha Bil
		Keotal	Munia Bil
4	Raiganj	Mirual	Fakirdighi
		Chhotoparua, Barganda and Susihar.	Sirala bil
		Balia	Baliadighi
5	Karandighi	Dalmadh	Kachna Bil
6	Kaliaganj	Medinipur	Boro Bil

Source: Geo-informatics & Remote Sensing Cell, 2001 and Extracted from Satellite Imagery.

2.2.6.1 Utility of Wetlands (bils) in Uttar Dinajpur

There are many utilities which can be associated with wetlands protection. In the district, actively all of these bils are used in three purposes; one is irrigation, second, crop production in summer season (total 116.53 hectares area) and another is additional food supply (Makhna, Trapa Natans, Periwinkle, Oyster etc.). As discussed earlier, Uttar Dinajpur District is a flood prone area, so wetlands store the flood water in flood time and gradually discharge surface water. On the other hand, some backward families depend on wetlands resources- they catch fishes, vegetables (Halencha, Kalmi, Sushni, Mints, Water lily, etc.) and sell in the local

markets. According to the Water Resources Development Director of Uttar Dinajpur, a total area of 470.67 hectares of irrigation is supplied in the summer season (2018).

2.3 Climate

Uttar Dinajpur District is not as hot and humid as it is situated to the north of the Tropic of Cancer. The study area receives major rainfall especially during the period of South-west monsoon. In the district, the major climate mechanism is that of the tropical monsoon by hot summer, abundant rainfall and humid atmosphere. During the hot season, there is some amount of rainfall due to occasional depression coming from the south. The summer begins from the middle of March, while rainy season continuous from early June to late September. October and November may be called autumn when the night gets cooler. With the increase of temperature during summer the rainfall increases, caused by Nor-Wester, but the average rainfall for the whole districts comes to only is 1,241 mm in 2015. Winter starts in the middle of November. The winter is cold and dry but it is really pleasant. The sky is generally cloudless at this time.

In the study area temperature starts rising rapidly in the area from the beginning of March. The summer heat is particularly oppressive due to the high moisture content in the air. The maximum temperature reaches 40°C in May but this time the night temperature continuous to remain high, because of oppressive humidity. The minimum temperature in winter season is 15°C in January. November to January is the driest month, though even in these months there are occasional showers. During the early winter, the sky gets clear and the last week of December and the whole of January are the coldest months of Uttar Dinajpur District. The weather is uncomfortable during the monsoon season. The monsoon season stops in early October when the temperature begins to fall.

2.3.1 Rainfall characteristics

The average annual rainfall in the district is 2,042 mm for the last 5 years. Rainfall in Uttar Dinajpur district is not uniform. There is a sharp difference in average annual rainfall between northern 4 Blocks namely Chopra, Islampur, Goalpokher-I and Goalpokher-II and southern 5 Blocks namely Karandighi, Raiganj, Hemtabad, Kaliaganj and Itahar. Thus, among the southern blocks, the highest annual rainfall is received by Itahar which approximately 1,450-1,550 mm yearly but among the northern blocks, Chopra receives the highest rainfall which is approximately 2,400-2,800 mm yearly. The highest amounts of rainfall recorded throughout 24 hours were 34.29 cm on the 21st of September 1942 at Itahar and 21.72 cm on the 11th of

September 1920 at Raiganj (District Gazetteer, West Dinajpur, 1965). The average annual rainfalls in the district 1951-2017 is represented in the table 2.5.

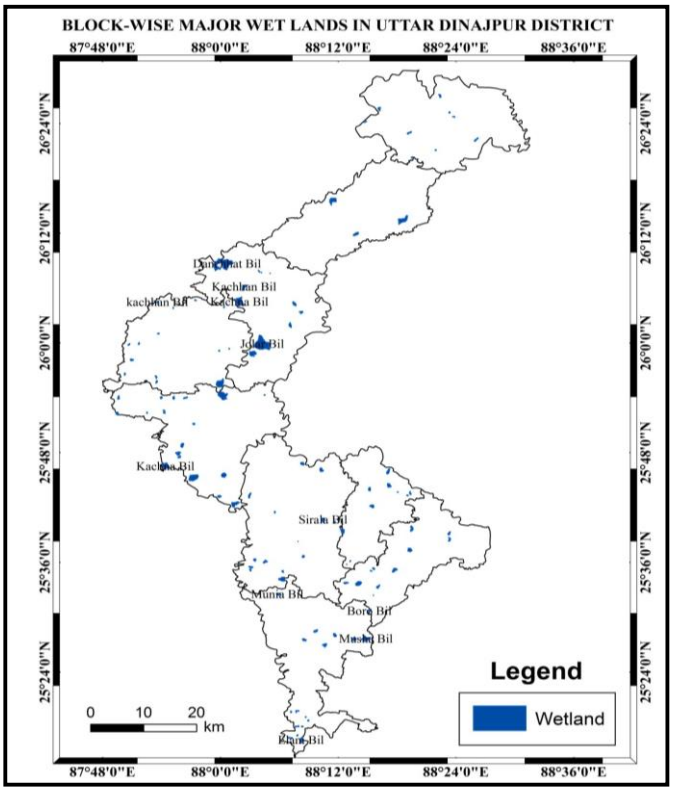


Figure 2.4 Major wetlands in Uttar Dinajpur District.

A) Bil water use only for irrigation purpose B) Mukhna Cultivation

C) Paddy cultivation in summer season

Plate 2.2 Major wetlands (Bils) in Uttar Dinajpur District.

Table 2.5 Annual average rainfall in Uttar Dinajpur District (1951-2017).

Years	**1951**	**1961**	**1971**	**1981**	**1991**	**2001**	**2011**	**2017**
Average annual rainfall (mm)*	2,220	1,690	2,180	1,999	2,186	2,092	2,042	2,066
No. of rainy day**	80	82	96	87	90	88	85	87

Source: i*) Water Resources Development Directorate (WRDD): Jalsampad Bhawan, Government of West Bengal, Karnojora, Uttar Dinajpur

ii**) Office of the Director of Agriculture, Government of West Bengal, Karnojora, Raiganj, Uttar Dinajpur.

From the table 2.5 and figure 2.5, it is observed that the highest rainfall 2,220 mm was in 1951 (which is the highest rainfall in 60 years of the district) and the lowest rainfall was 1,690 mm in the year 1961, while 80 rainy days were in 1951 and it increased 82 rainy days in 1961. Between 1951 and 2017, total rainy days increased but the total rainfall is decreased. In the year 1951, total rainy days were 80 days while it increased to 87 days in 2017. The total rainfall was 2,220 mm in 1951 and it decreased to 2,066 mm in 2017. The distribution of rainfall is 2,059 mm/year on an average, and more than 85 per cent rainfall is received between the month

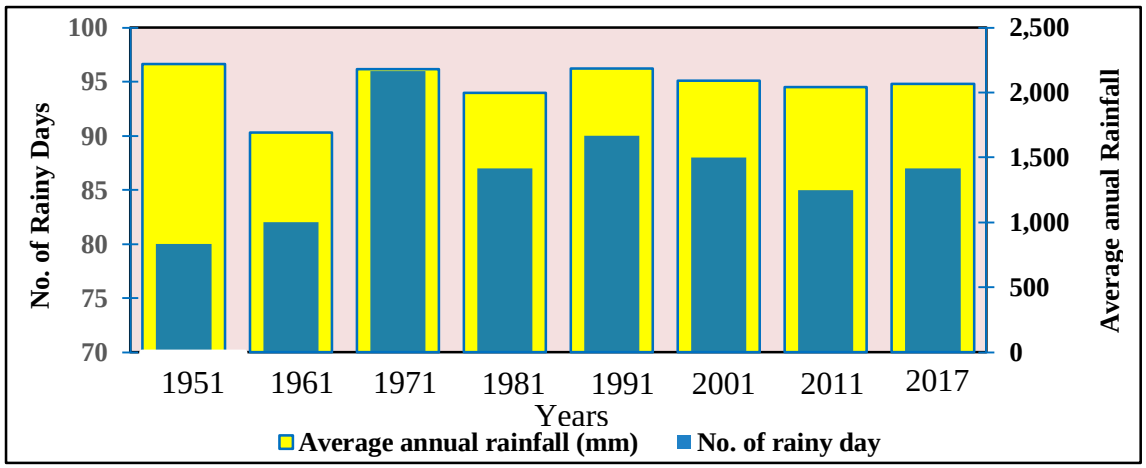


Figure 2.5 Average rainfall and no. of rainy days in Uttar Dinajpur District (1951-2017).

of April and October; rest 15 per cent rainfall is received during the rest of five months of the year. During the rainy season, there is more water in the fields then is necessary and during the rest time of the year, crops cannot grow because of the paucity of water. The precipitation during the rainy season is so much that large scale irrigation schemes on the gravity flow model cannot be of much use (West Dinajpur Districts 5th five-year plan, 1991). According to E.M. Crowther's leaching factor, the district receive very little leaching during the prolonged summer season. It is clear from the table 2.6 (Appendix II) rainfall in the district is decreased year to year.

2.3.1.1 Agro-climatic region in Uttar Dinajpur District

On the basis of climates and dimensions of the district, there are two sub-divisions in the district belonging to two separate agro-climatic zones which are the standard classification of Indian adopted classification. Agro-climatic zones of Uttar Dinajpur District are shown in the table 2.7.

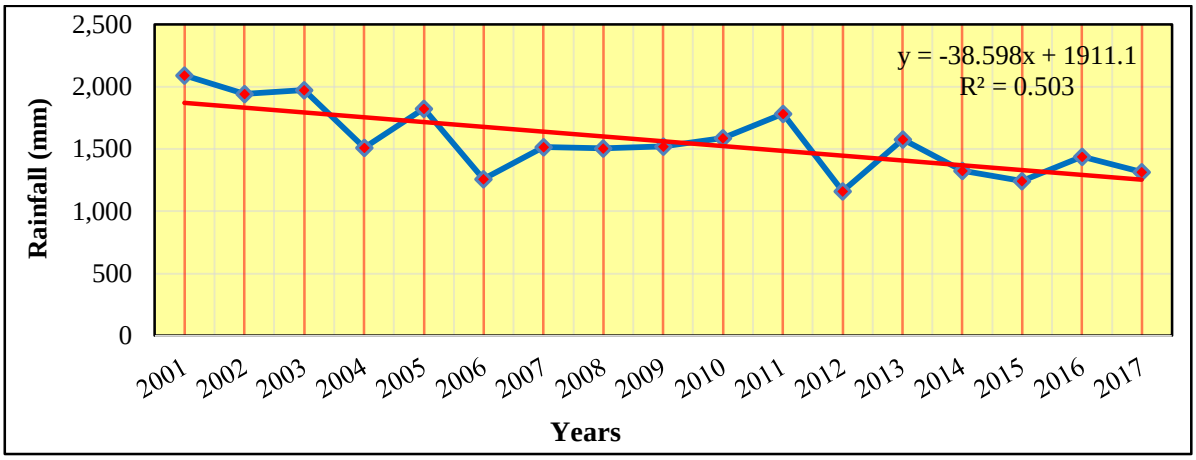


Figure 2.6 Trend of rainfall in Uttar Dinajpur District.

Table 2.7 Agro-climatic zones in Uttar Dinajpur District.

Agro-climatic zones	Agro-climatic sub-zones	Sub-divisions	No. of C.D. Blocks	Name of the C.D. Blocks
Eastern Himalaya Zone-II	Terai-Testa flood plain	Islampur	5	Chopra, Islampur, Goalpokher-I, Goalpokher-II and Karandighi
Lower Gangetic Plain Zone-III	Gangetic flood plain	Raiganj	4	Raiganj, Hemtabad, Kaliaganj and Itahar

Source: District Human Development Report 2010, Uttar Dinajpur District.

From the table 2.7 it is revealed that, the northern part spreading from Chopra Block to Karandighi Block lays on a part of the Testa-Terai floodplain within the Eastern Himalayan Region-II (Located in Islampur subdivision) and the southern part spreading from Raiganj to Itahar Block lays on a part of the Gangetic floodplain within the Lower Gangetic Plain Region-

III (located in Raiganj sub-division) in the district. So, differences exist between seasonal maximum and minimum temperature, seasonal humidity patterns and seasonal rainfall patterns in the two subdivisions as well as different blocks in the district. On account of that, differences between settlement patterns and agricultural land use patterns are different. But in the monsoon time, however, the relative humidity in both agro-climatic zones becomes nearly equal because of the presence of high vapour pressures in both zones.

2.3.2 Temperature

The district has excessive heat in the summer season. The mean maximum temperature and mean minimum temperature is recorded in May and January respectively. The relative humidity varies from 64.32 to 98.31 per cent. The period from November to February is dry but cool. The variation of temperature over the year in the district from 2007 to 2015 is shown in table 2.8 (Appendix IIa).

2.4 Soil Condition

The soil of this area is alluvium and mostly sandy to sandy loam in texture and porous. Uttar Dinajpur District (study area) is bestowed with very fertile soil. The older alluvium is estimated to be of Pleistocene age. The texture of old alluvium varies from heavy clay to clay loam with poor internal drainage capacity and the soils are either neutral or slightly acidic in reaction. The new alluvium soil varies from sandy to sandy loam in texture with fair drainage capacity and slightly acidic to very acidic in reaction. Soils of Uttar Dinajpur District may be classified into following types;

i. Old Alluvium
ii. Alluvium and
iii. New Alluvium.

i. Old alluvium

In the district, the old alluvium varies from heavy to clay to clay loam with poor internal drainage capability and the soil are neutral to slightly acidic. This type of soil is found in Itahar and partly in Raiganj block, Kaliaganj, Hemtabad block in the district. Old alluvium covers 23,251 hectares of the district which is the predominant group and 14,289 hectares is another group.

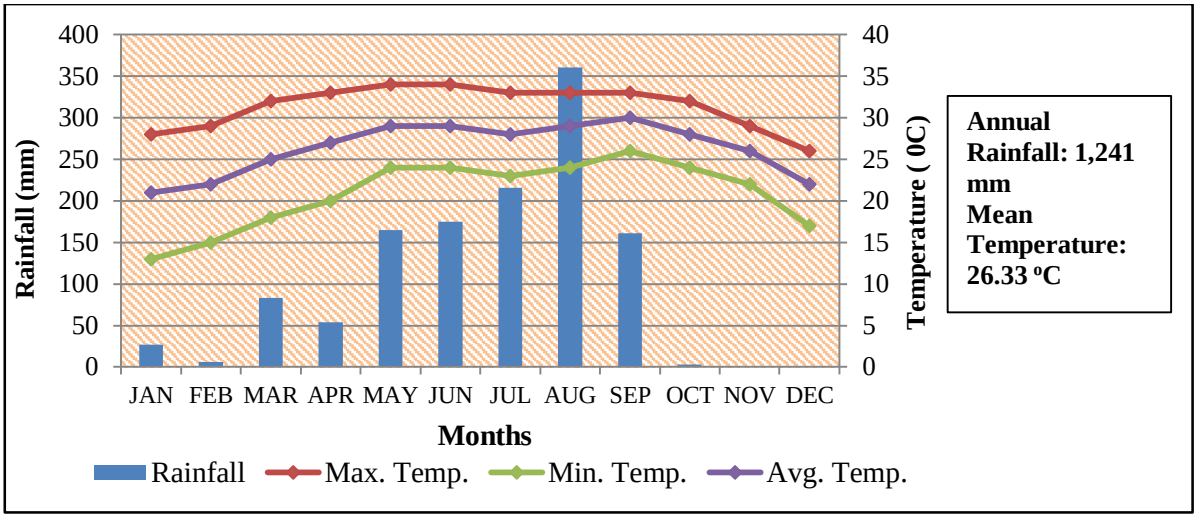


Figure 2.7 Annual rainfall and temperature of Uttar Dinajpur District.

Table 2.9 Soil groups in Uttar Dinajpur District, 2011

Name of the C.D. Blocks	Area Cultivation (ha)	Soil types			
		Predominant group	Total area (ha)	Other group	Total area (ha)
Chopra	28,420	Alluvium	25,578 (90)	New alluvium	2,842 (10)
Islampur	24,820	Alluvium	22,338 (90)	New alluvium	2,482 (10)
Goalpokhar-I	28,000	New alluvium	22,400 (80)	Alluvium	5,600 (20)
Goalpokhar-II	20,000	Alluvium	12,000 (60)	New alluvium	8,000 (40)
Karandighi	29,050	Alluvium	20,335 (70)	Old alluvium	8,715 (30)
Raiganj	36,000	Alluvium	28,800 (80)	Old alluvium	7,200 (20)
Hemtabad	23,000	Old Alluvium	13,800 (60)	Alluvium	9,200 (40)
Kaliaganj	14,540	Old Alluvium	9,451 (65)	Alluvium	5,089 (35)
Itahar	32,000	Alluvium	2,400 (75)	Old alluvium	8,000 (25)

Source: Office of the Principal Agricultural Officer, Karnojora, Uttar Dinajpur, 2011
Note: Figure in the parentheses indicates the percentage value.

ii. Alluvium group

This type of soil is found in Raiganj, Karandighi, and some part of Kaliaganj, North-East part of Hemtabad, Goalpokhar-II block. The texture of alluvium soil varies from loam to sandy loam and clay loam. Total 1,33,051 hectares area is covered by the predominant alluvium group and 25,213 hectares are covered by other groups in this district.

iii. New alluvium group

This type of soil is found in Islampur, Chopra, Goalpokhar-II of Islampur sub-division and Karandighi Block of Raiganj sub-division of the district. The top layer is formed by silt, while the underground layer is composed of gravel.

2.4.1 Soil texture

For an understanding of the agronomic classification of soils, information on the fundamental characteristics of the physical make up of soils; soil texture and structure is needed (Singh and

Dhillon., 2005). Soil texture refers to the relative proportions of the three mineral fractions namely; sand, silt and clay in soil samples as determined in the laboratory by mechanical analysis. The United States Department of Agriculture (USDA) has set standard definitions of soil textural classes in which the proportions of sand, silt and clay are in percentages. In the district, block-wise said information can be presented in forms of and textural ternary diagram of sample villages has been demonstrated in Appendix IVa and figure 2.8.

In general, the study area is flat and sloping gently toward the south. Barind Tract - a geological formation of old alluvium covers the region and extends further south. The highest elevation is only 30 metres the district has no hills. The soils have formed recently and have shallow black and brown alluvium soils consisting of sandy loam mixed with gravels. The character of most of the blocks soil is loam and clay loam type. Loam soils are pleasing for most uses and have sufficient amounts of water and plant nutrients for plant growth but clay loam soils have high water holding capacity i.e. mostly suitable for paddy cultivation. The texture of old alluvium varies from heavy clay to clay loam with poor interior drainage capability and the soil is neutral as well as slightly acidic response. The texture of alluvium soil varies from loam to sandy loam and clay loam with an intermediate internal drainage scheme and this type of soil is faintly acidic in reaction. On the other hand, new alluvium soil varies from sandy to sandy loam in texture with fair drainage potential i.e. minor to extremely acidic in reaction. Block-wise soil texture and their groups are shown in the table 2.10.

From the table, 2.10 it is clear that the dominating, as well as highest coverage soil type in the district, is sandy loam which covers 40.72 per cent area (96,080 hectares) of the total cultivated area. It is interesting that clay covers only 3,040 hectares (1.29 per cent) and this type of soil is absent in three blocks namely Islampur, Chopra and Goalpokher-II. Total 54,810 hectares of sandy soil area is covered by the five blocks which are located in the northern part of the district. Rest 4 Blocks (Raiganj, Hemtabad, Kaliaganj and Itahar) which is located in the southern part there is no sandy type of soil. Loam and clay loam covers about 35 per cent over the district.

Table 2.10 Soil texture and their size in Uttar Dinajpur District.

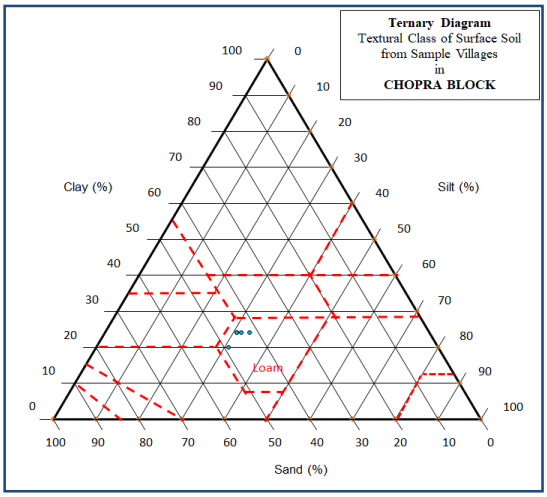
Name of the C.D. Blocks	The cultivable area with different soils (hectares)				
	Sandy	**Sandy Loam**	**Loam**	**Clay Loam**	**Clay**
Chopra	16,230	11,190	500	500	-
Islampur	13,710	10,110	500	500	-
Goalpokhar-I	11,160	10,260	5,580	500	500
Goalpokhar-II	8,000	7,700	4,000	300	-
Karandighi	5,710	11,420	8,560	3,060	300
Raiganj	-	31,500	3,500	600	400
Hemtabad	-	500	12,860	9,140	500
Kaliaganj	-	12,400	1,390	500	280

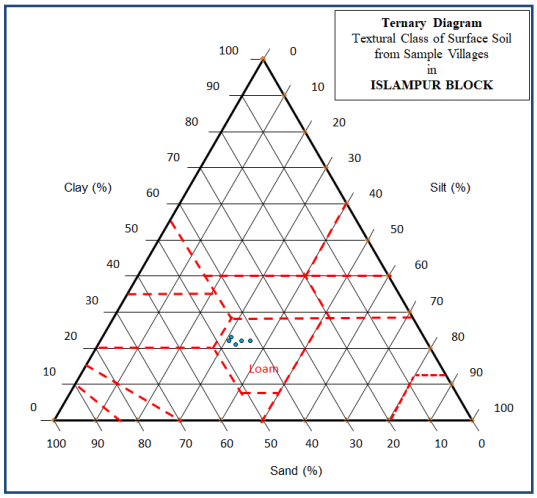
Itahar	-	1,000	12,500	17,500	1,050
District	**54,810**	**96,080**	**49,390**	**32,600**	**3,040**
% of the total cultivated area.	23.23	40.72	20.93	13.81	1.29

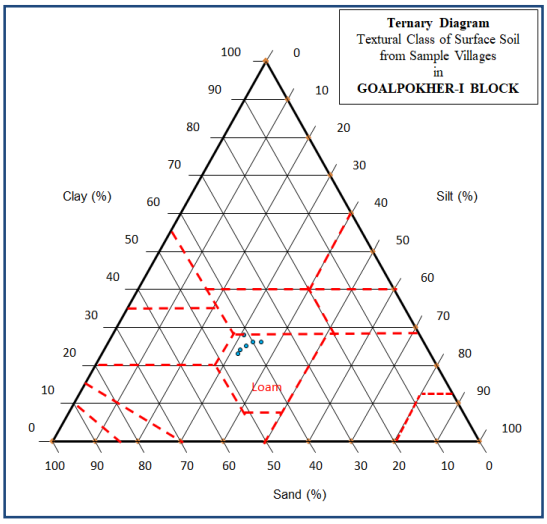
Source: NBSS & LUP, Regional Centre, Kolkata.

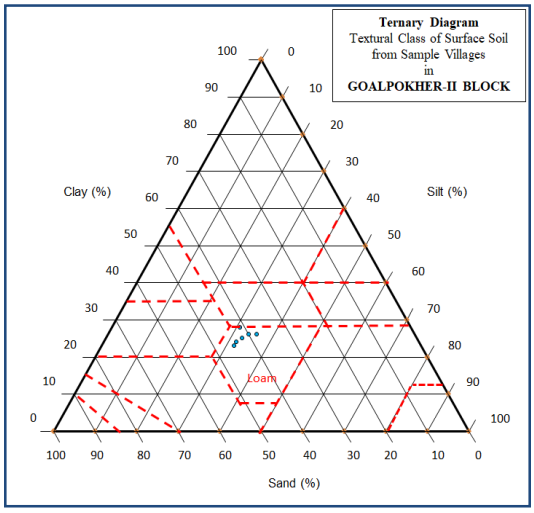
2.4.2 Soil Structure

Soil structure refers to the agreement of soil particles into larger units. Soil structure is an essential physical attribute of any soil. The structural properties of the soil depend finally upon the character of the individual grains and how they are held together in peds. The preparation of particles of varying sizes is of great significance in determining the relationships that exist in soil water, soil air and plant. The significance of soil structure has been recognized for most of the recorded agricultural activities in the past. For much of this time, it was perceived as the soil tilth-the structural state of seedbed resulting from tillage and affecting crop response (Hadas, 1997).









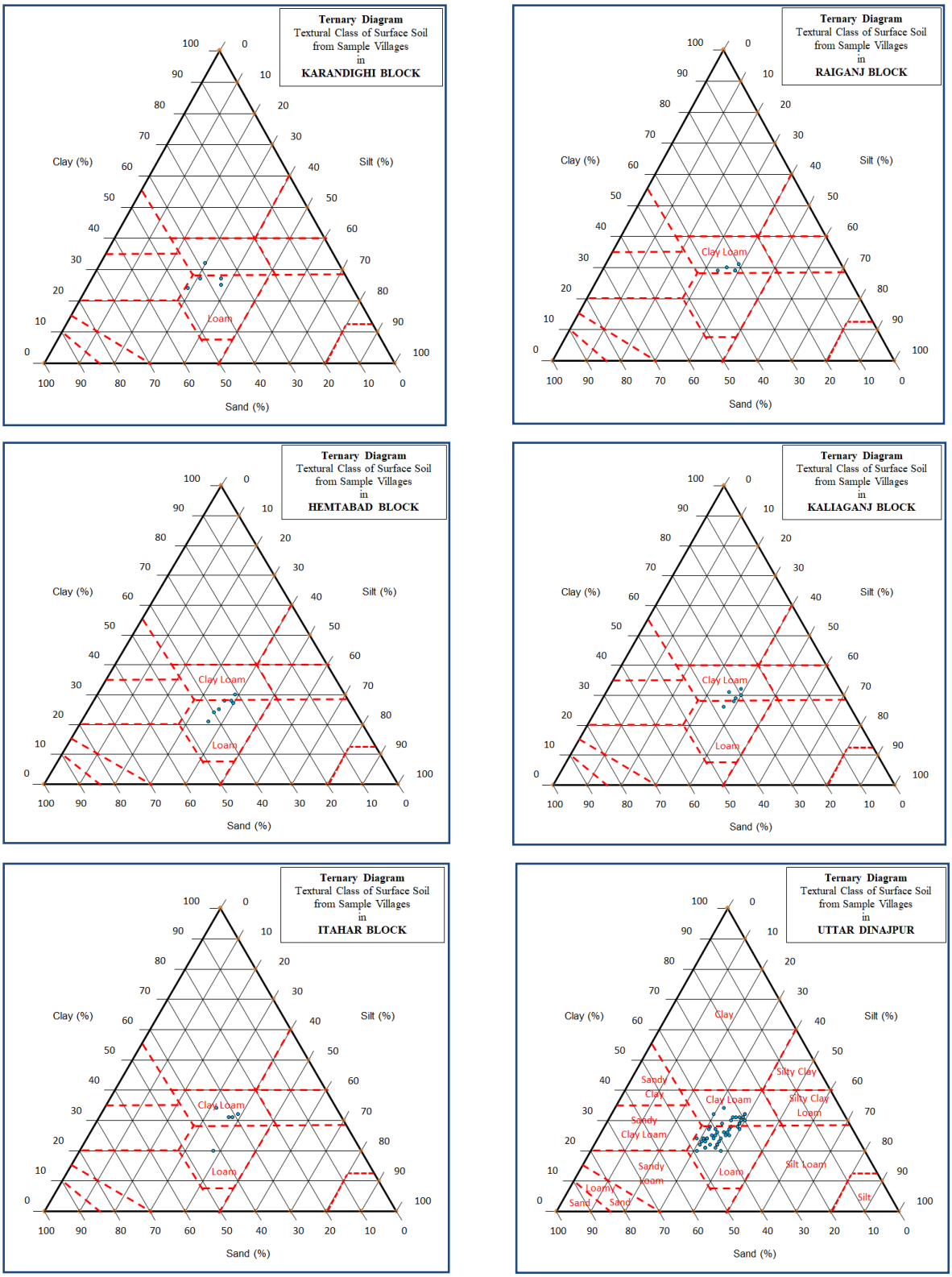


Figure 2.8 Block-wise soils textural ternary diagram of Uttar Dinajpur District.

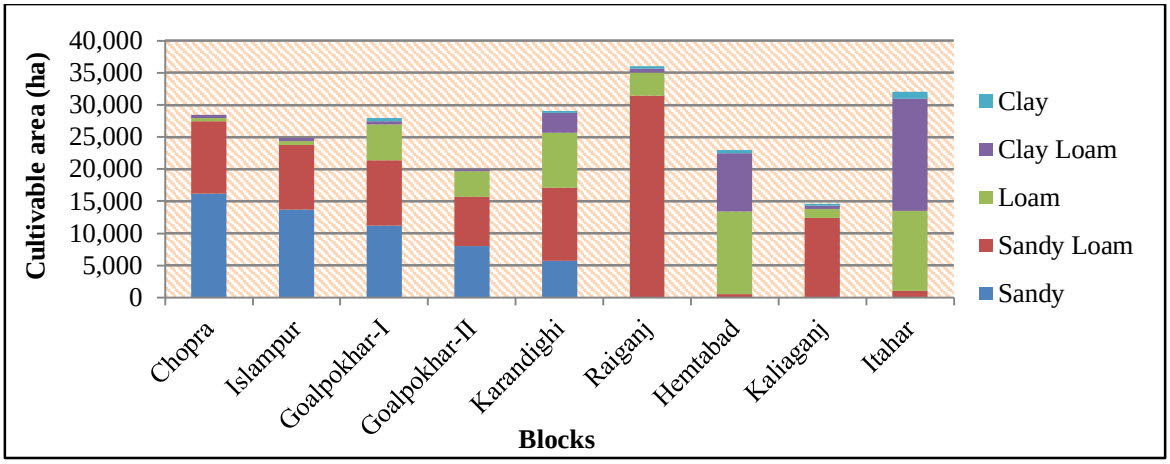


Figure 2.9 Textural classes of soil in Uttar Dinajpur District.

Soil structure controls and regulates the amount of water and air present in the soil depending on the source of its moisture capability, porosity which helps the seed sowing and growth of the agricultural crops. In the district, most of the blocks are covered by the granular structure of soils which is represented in the table 2.11.

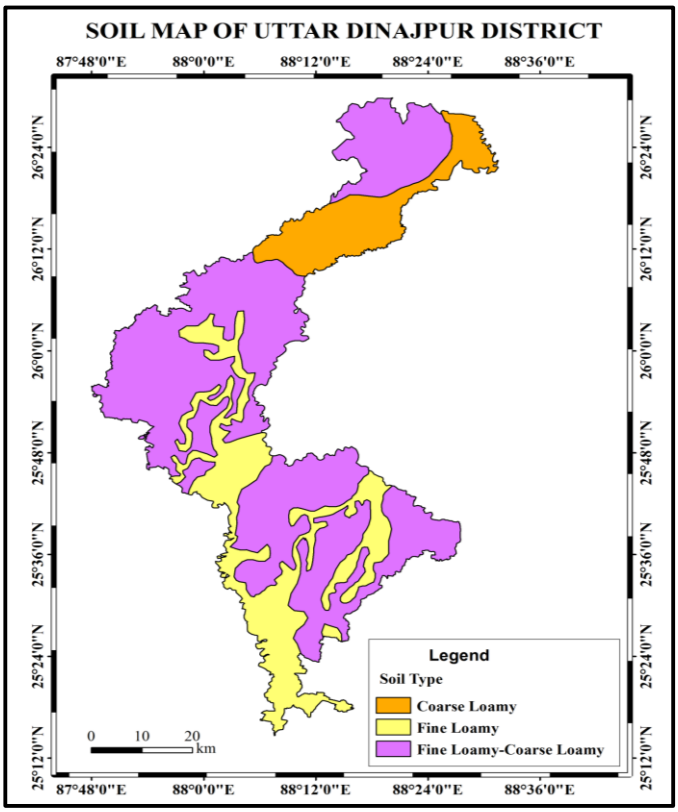
Table 2.11 Block-wise types of dominant soil structure of Uttar Dinajpur District.

Name of the C.D. Blocks	Types of dominant Soil Structure
Chopra	Platy
Islampur	Platy
Goalpokhar-I	Columnar
Goalpokhar-II	Columnar
Karandighi	Granular
Raiganj	Granular
Hemtabad	Granular
Kaliaganj	Granular
Itahar	Granular

Source: Researcher's field observation in different block, Uttar Dinajpur District.

It is clear from the table 2.11 platy structure of the soil is found in two blocks namely; Chopra and Islampur. This type of soil structure helps to impede the downward movement of water and plant roots through the soil. Columnar type of soil structure is found in two blocks namely; Goalpokhar-I and Goalpokhar-II. The columnar structure is very dense and it is very difficult for plant roots to penetrate these layers. Modern techniques such as deep ploughing have help to bring back some degree of fertility of these soils which is necessary for plant growth. Granular types of soil structure are observed in rest five blocks namely; Karandighi, Raiganj, Hemtabad, Kaliaganj and Itahar. This structure of soil is suitable for good porosity and easy movement of air and water. Not only that, combination of eases in tillage, good humidity and air management capabilities and good arrangement for planting and germination

system. So, these blocks are suitable for the cultivation as well as production and the productivity rate per hectare of crops is high.



Source: NBSS & LUP, Kolkata.

Figure 2.10 Soil map of Uttar Dinajpur District.

Table 2.12 Soil structure of Uttar Dinajpur District.

Sl. No.	Soil Structure Types	Soil Structure Range	No. of C. D. Blocks	Name of the C. D. Blocks
1	Platy	-	2	Chopra, Islampur
2	Columnar	-	2	Goalpokher-I and Goalpokher-II
3	Granular	-	5	Karandighi, Raiganj, Hemtabad, Kaliaganj and Itahar

Source: Compiled by the researcher from table 2.11

From the soils structural study, there are three types of soil structures are found all over the district. Soil structures are classified on the basis of their solid parts into different categories such as platy, columnar and granular structures. These are summarized in the table their situations platy in the soils is observed in two blocks namely; Chopra and Islampur. But columnar structure soil is observed in two blocks namely Goalpokher-I and Goalpokher-II. Granular type of soil structure is observed in rest blocks namely Karandighi, Raiganj, Hemtabad, Kaliaganj and Itahar with respect of solid parts were mapped in figure 2.11.

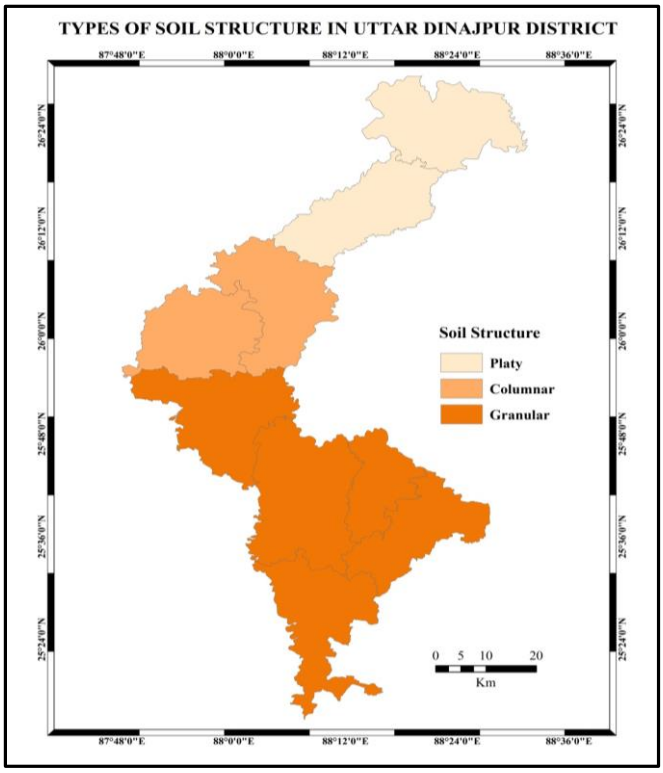


Figure 2.11 Dominant of soil structure in Uttar Dinajpur District.

Table 2.13 Block-wise soil density of Uttar Dinajpur District.

Name of the C.D. Blocks	Soil Density (gm/cm^3)
Chopra	2.50
Islampur	2.51
Goalpokhar-I	2.59
Goalpokhar-II	2.51
Karandighi	2.38
Raiganj	2.50
Hemtabad	2.60
Kaliaganj	2.56
Itahar	2.43
(Mean = 2.508889 & SD = 0.071141)	

Source: Soil testing laboratory results computed by the researcher.

2.4.3 Soil density

Soil density is expressed by its weight per unit volume. Generally, two types of soil density accepted for the expression of soil i.e. particle (also termed as true density) and bulk density. Soil density depends upon the inorganic and organic constituents of the soil. It expressed in gram per cubic centimetre (gm/cm^3). Block-wise soil density gm/cm^3 is presented in the table 2.13. Particle density for normal soil is 2.65 gm per cubic centimetre (De and Sarkar, 1993). In the district, soil densities of all blocks are under the normal value. It indicates that the low amounts of minerals such as magnetite, limonite, zinc, hematite etc. are present in soil. Among the nine blocks, comparatively high soil density is found in Hemtabad Block (2.60 gm/cm^3) and the lowest is found in Itahar Block (2.43 gm/cm^3) (table 2.13). In this reason farmers of

district are used in their agricultural land high amount of chemical fertilizers for increasing soil fertility and production of crops.

Table 2.14 Soil density status in Uttar Dinajpur District.

Sl. No.	Soil Density Class	Soil Density (gm/cm^3)	No. of C. D. Blocks	Name of the C. D. Blocks
1	Low	<2.50	2	Karandighi and Itahar
2	Medium	2.50-2.58	5	Chopra, Islampur, Goalpokher-II, Raiganj and Kaliaganj
3	High	>2.58	2	Goalpokher-I and Hemtabad

Source: Compiled by the researcher from table 2.13

The soils from the study area are classified on the basis of their density over the district into different categories such as low, medium and high density. These are summarized in the table 2.14. Soil density in first 0 to 25 cm and soil density indicated that their positions have low in the soils which covered in two blocks namely; Karandighi and Itahar. 2.12). But medium status soil density is observed in five blocks namely Chopra, Islampur, Goalpokher-II, Raiganj and Kaliaganj with availability density ranging 2.50-2.58 (gm/cm^3). High soil density (>2.58 gm/cm^3) is observed in two blocks namely Goalpokher-I and Hemtabad were mapped in (figure 2.12).

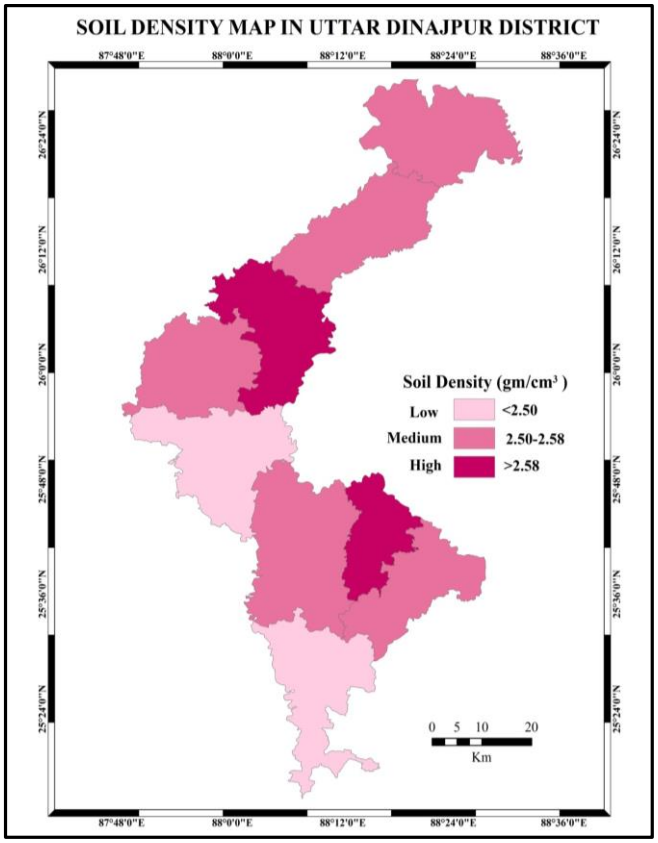


Figure 2.12 Soil density situations in Uttar Dinajpur District.

2.4.4 Soil hygroscopic moisture

Water contained in soil is called soil moisture (IEASSA, 2013). Moisture content in soil plays an important role in soil-plant relationship. All plants receive moisture from the soil and the main source of soil water is rainfall on the soil which gets a meagre portion of rain water through percolation. Major portion of rain water is lost by the evaporation and runoff. Soil-water interactions influence many of the ecological functions of soils and practice of soil management. These interactions determine how much rainwater runs into and through the soil and how much runs off the surface (Brady and Weil, 2002). In the district, average slope about 5° which is main barrier to water percolation. But soil moisture is important for agriculture because soil moisture acts as a nutrient itself, microorganisms require water for their metabolic activities and it is a principal constituent of the growing plant. For the better understanding, block-wise soil hygroscopic moisture (%) is presented in the table 2.15.

Table 2.15 Block-wise soil hygroscopic moisture in Uttar Dinajpur District.

Name of the C.D. Blocks	Soil Hygroscopic Moisture (%)
Chopra	0.18
Islampur	0.14
Goalpokhar-I	0.18
Goalpokhar-II	0.33
Karandighi	0.29
Raiganj	0.13
Hemtabad	0.26
Kaliaganj	0.19
Itahar	0.24
Mean=0.215556 and SD=0.064483	

Source: Soil testing results computed by the researcher.

In the district, most of the blocks having soil hygroscopic moisture are low. Because temperature is high and this raises the evaporation rate of soil moisture. Not only that, soil texture and structure of major blocks is loamy and granular types. So, infiltration rate of soil is high and generally soil moisture of the upper soil is decreased. Among the nine blocks, lowest soil hydroscopic moisture is observed in Raiganj Block (0.13 per cent) and the highest moisture is observed in Goalpokher-II Block (0.33 per cent). For increased soil moisture, irrigation water supply is necessary on the top soil in regular basis. Irrigation affects temperature condition by flexible the temperature of the surface layer of the soil which control the soil moisture and progress of plants and improvement of the quality of the crops.

Table 2.16 Soil hydroscopic moisture status.

Sl. No.	Soil Hydroscopic Moisture Class	Available Moisture (%)	No. of C.D. Blocks	Name of the C.D. Blocks
1	Low	< 0.21	5	Chopra, Islampur, Goalpokher-I Raiganj and Kaliaganj
2	Medium	0.21-0.28	2	Hemtabad and Itahar

3	High	>0.28	2	Goalpokher-II& Karandighi

Source: Compiled by the researcher from table 2.15

In the present study the availability of soil hydroscopic moisture are classified into different categories such as low, medium and high density on the basis of the water absorbed on the top soils in the district. These are summarized in the table 2.16. Soil moisture contents are taken from top 0 to 25 cm soils. Soil hydroscopic moisture is found in five blocks namely; Chopra, Islampur, Goalpokher-I, Raiganj and Kaliaganj were mapped with low moisture (figure 2.13). But the medium status of hydroscopic moisture is observed in two blocks namely Karandighi and Itahar with availability moisture ranging (0.21-0.28 per cent). High soil hydroscopic moisture (>0.28 per cent) is observed in one block namely Goalpokher-II and Hemtabad in the study area (figure 2.13).

2.4.5 Water holding capacity (%)

Soil water holding capacity (WHC) is the amount of water that a given soil can hold for crop use. But soil texture and organic matter are the important components that determine soil water holding capacity. Water holding capacity from an agricultural standpoint is the amount of water a soil can retain for use by growing crops. Water holding capacity depends on soil texture. According to some experts of the Natural Resource Conservation Service (NRCS, 1933) 'texture by feel' method is to help determine soil water holding capacity. As soil texture component sand feel gritty and therefore not hold a lot of water as a result because pores are so larger. Water can rapidly move through it but not enough water available for plant growth. Next component silt feel smooth and it is the ideal soil texture because of its small pores present which can hold the maximum amount of water with the highest accessibility to plants. Clay feels sticky and it can hold a lot of water but will do so tightly in pores so a lower per cent is available to plant. To know actual condition of water holding capacity in the district, block-wise water holding capacity is to be considered and presented in the table 2.17.

Table 2.17 Block-wise soil water holding capacity in Uttar Dinajpur District.

Name of the C.D. Blocks	Soil water holding capacity (%)
Chopra	39.62
Islampur	38.71
Goalpokhar-I	31.60
Goalpokhar-II	54.40
Karandighi	18.30
Raiganj	26.80
Hemtabad	37.35
Kaliaganj	10.10
Itahar	33.33

Source: Soil testing laboratory results computed by the researcher.

From the table 2.17, soil water holding capacity (%) highest is observed in Goalpokher-II Block (54.4 %) and the lowest water holding capability (%) is observed in Kaliaganj Block (10.1%). It is because in Goalpokher-II Block soil organic matter comparatively high and soil texture type is loamy which have better drainage, moisture and humus and in Kaliaganj Block soil character almost opposite than Goalpokher-II Block. Generally, soil water holding capacity is controlled by the soil texture and organic matter. The quantity of organic materials in a soil moreover influences the water holding capacity. As the level of biological substance rises in a soil, the water holding capacity also rises due to the affinity of biological matter for water (Malhotra, 2016). Not only that, the higher percentage of silt and clay sized particles carry the higher water holding capacity.

Table 2.18 Soil water holding capacity (%) status.

Sl. No.	Soil Water Holding Capacity Class	Available Capacity (%)	No. of C.D. Blocks	Name of the C.D. Blocks
1	Low	<20	2	Karandighi and Kaliaganj
2	Medium	20-40	6	Chopra, Islampur, Goalpokher-I Raiganj, Hemtabad and Itahar
3	High	>40	1	Goalpokher-II

Source: Compiled by the researcher from table 2.17

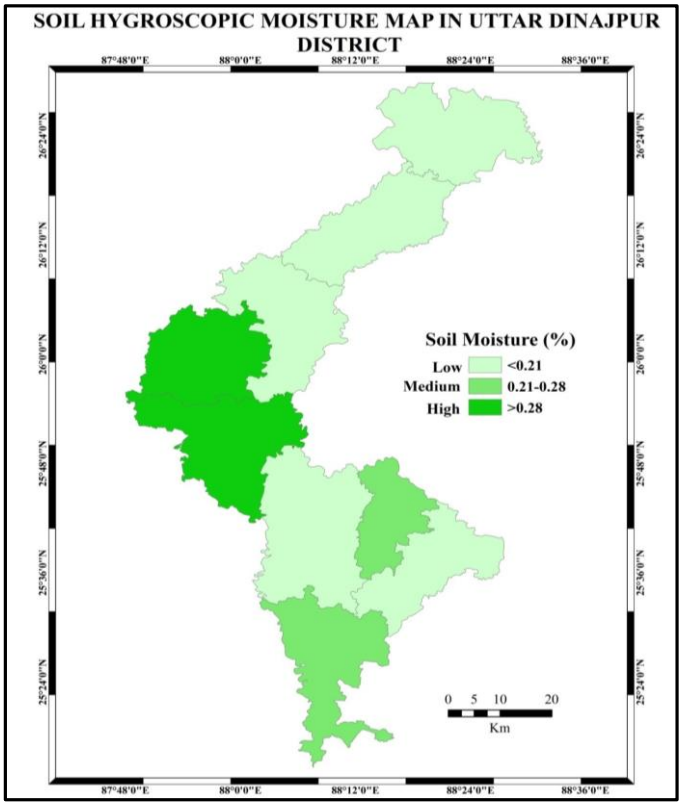


Figure 2.13 Soil hygroscopic moisture status in Uttar Dinajpur District.

The present study the availability of soil water holding capacity (%) are classified into different categories such as low, medium and high density on the basis of the water storage on

the top soil in the district. These are summarized in the table 2.18. Soil water holding capacity contents are taken from top 0 to 25 cm soils.

Soil water holding capacity is found in two blocks namely; Karandighi and Kaliaganj Blocks were mapped with low moisture (figure 2.14). But the medium status of hydroscopic moisture is observed in six blocks namely Chopra, Islampur, Goalpokher-I, Raiganj, Hemtabad and Itahar with availability water holding capacity ranging (20-40 per cent). High soil hydroscopic moisture (>40 per cent) is observed in one block namely Goalpokher-II in the study area (figure 2.14).

2.4.6 Soil porosity

In general, the soil mass is made up of soil particles together with a certain amount of empty space unoccupied by the soil particles. This empty space is known as pore space. On the other side, the true density is greater than the apparent density owing to the spaces between the soil particles, which are collectively known as the pore space (Wright, C. H, 1994). Pore spaces may be formed due to the movement of roots, worms and insect; expanding gasses trapped within these spaces by the ground water or dissolution of the soil parent material. Porosity percentage in surface layer of cultivated soil varies from 30 in sandy soil to 60 in clayey soils. But after ploughing soil pore space diminishes with the setting down of soil particles (De and Sarkar., 1993). Soil porosity concerns the oxygen found within these pore spaces and all plants need their oxygen for respiration. So, a well-aerated soil is important for growing crops. In the district, pore space varies from one block to other blocks. Block-wise pore space percentages are considered in the table 2.19.

Table 2.19 Block-wise soil pore space in Uttar Dinajpur District.

Name of the C.D. Blocks	Soil pore space (%)
Chopra	10.88
Islampur	13.33
Goalpokhar-I	14.10
Goalpokhar-II	8.69
Karandighi	33.33
Raiganj	22.06
Hemtabad	19.30
Kaliaganj	38.89
Itahar	17.89

Source: Soil testing results computed by the researcher.

Soil pore space, the division of soil volume and it is not occupied by solids, is relatively easy to conceptualize and measure. Pore size distribution is a complex topic, in part from the lack of clear and unique concept of a soil pore as a discrete object (Nimmo, 2005). Among the nine Blocks, comparatively high pore space in soil is found in Kaliaganj Block (38.89 per cent)

because soil type in this block is loamy to fine textured as well as clayey and lowest is found in Goalpokhar-II Block (8.69 per cent) because soil type in this Block is sandy and soil texture is silty loams to clay loam (table 2.19).

Table 2.20 Soil pore space (%) status

Sl. No.	Soil Pore Space Class	Available Space (%)	No. of C.D. Blocks	Name of the C.D. Blocks
1	Low	<15	4	Chopra, Islampur, Goalpokher-I and Goalpokher-II
2	Medium	15-30	3	Raiganj, Hemtabad and Itahar
3	High	>30	2	Karandighi and Kaliaganj

Source: Compiled by the researcher from table 2.19

In pore space study the availability of soil pore space (%) are classified into different categories such as low, medium and high on the basis of the vacant spaced (%) on the top soils in the district. These are summarized in the table 2.20. Soil pore space contents are taken from top 0 to 25 cm soils. Soil pore space is found in four blocks namely; Chopra, Islampur, Goalpokher-I and Goalpokher-II were mapped with low pore space (figure 2.15). But the medium status of soil pore space is observed in three blocks namely Raiganj, Hemtabad and Itahar with availability vacant spaced in soils ranging (20-40 per cent). High soil pore space (>40 per cent) is observed in two Blocks namely Karandighi and Kaliaganj in the study area (figure 2.15).

2.5 Natural vegetation

The forest area of Uttar Dinajpur District mainly consists of mixed deciduous type vegetation of the Northern tropics. The shapes and sizes of the forests are very erratic and mostly spread in small pockets. There are some pockets of natural forests and comprises of Sal trees except a small patch in Rajabhum mouza in Chopra Block. The important pocket of the forest area is built around the shore of river Kulik and it is located near the Raiganj Bird Sanctuary. The total area of Kulik forest is around 1.6 km^2.

Uttar Dinajpur District is mostly marked for its forest resources which have much significance in regard to the concentration of some dependent population. The study area cover under forest is 610.71 hectares or 6.01 km^2 which is about 0.20 percent of the district and 0.006 percent of West Bengal. The forest type is mainly the Northern tropical mixed deciduous forest. The area covered by pockets type natural forest is 282.11 acre or 116.09 hectares. The different forest types and their percentage of Uttar Dinajpur District are represented in the table 2.21.

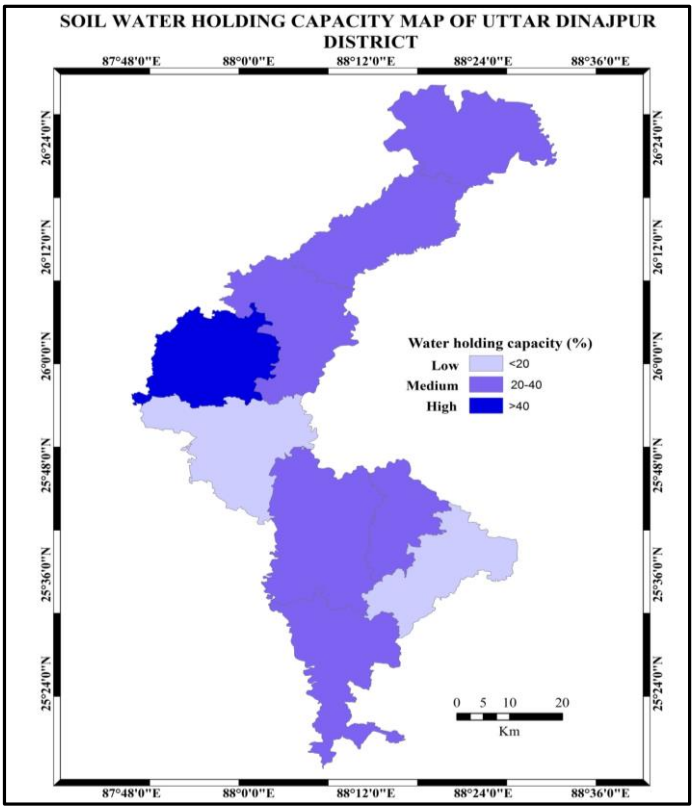


Figure 2.14 Soil water holding capacity of Uttar Dinajpur District.

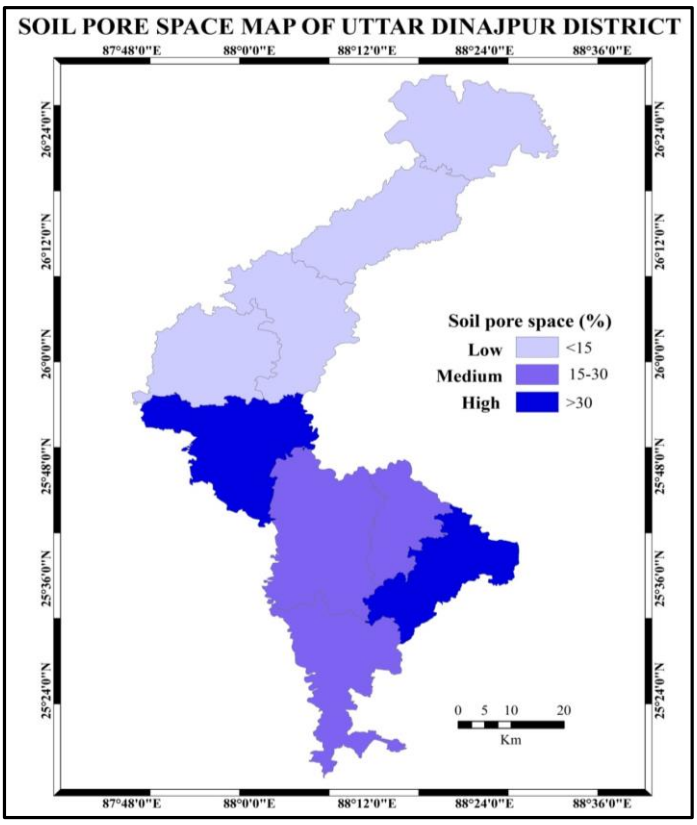


Figure 2.15 Soil pore space map in Uttar Dinajpur District.

Table 2.21 Type of forests and their respective areas in Uttar Dinajpur District (2013-2014).

Sl. No.	Forest types	Area (ha)	Area in %
1	Reserved	236.09	38.66
2	Protected	102.67	16.84
3	Unclassified	271.87	44.50
Uttar Dinajpur	**Total**	**610.73**	**100.00**

Source: DFO, Raiganj Forest Division, Karnojora, Uttar Dinajpur.

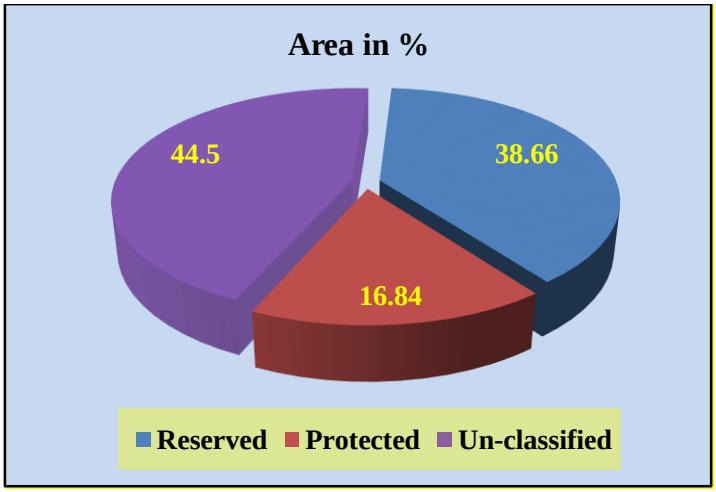


Figure 2.16 Forest types of Uttar Dinajpur District.

2.5.1 Composition of forest

The most common flora species found within the whole forest area are Sissoo, Siris, Akaskmoni, Khair, Lali, Kadam, Mingiri, Sidha, Jarul, Arjun, Sal and Sheora etc. The forest in this district is plantation type but Sal is mainly of coppice origin. The dependence of people of both the district in terms of economy is not remarkable. But due to the huge rural population in comparison to urban, there is a considerable dependence of local people on wood products and firewood. It has been estimated that per capita annual consumption of fire wood in a rural area is 730 thousand tonnes in the district keeping in view that per capita consumption per day is about 1 kg (DFO, Uttar Dinajpur., 2016). The pressure of increasing population is also a cause of extension of cultivation across the forest fringes in a productive area. As a result, the forest of Uttar Dinajpur is characterized by a lack of compactness.

As forest is controlled by the forest department there are continuous efforts in research work to increase productivity on a unit area basis. But the land outside the control of the government is still lying in unplanned productivity conditions in respect of forestry. There is the scope of enhancement of production in these lands. As in Uttar Dinajpur District, forest land is very less, more area outside the forest land to be brought under social forestry activity

with enhanced productivity of forest product, and then there will be a further scope of establishing small scale forest-based industries in this district.

2.5.2 Better development of forest

For better development of forests increase in medicinal and aromatic plant like Ashok, Lemongrass, Makna, Kalamegh, Swarpogandha, Isabgol, Ming oil, Jasmine essence, Menthanol, and many others may be planted. These are possible export items that are already being planted in different part of the blocks of the district.

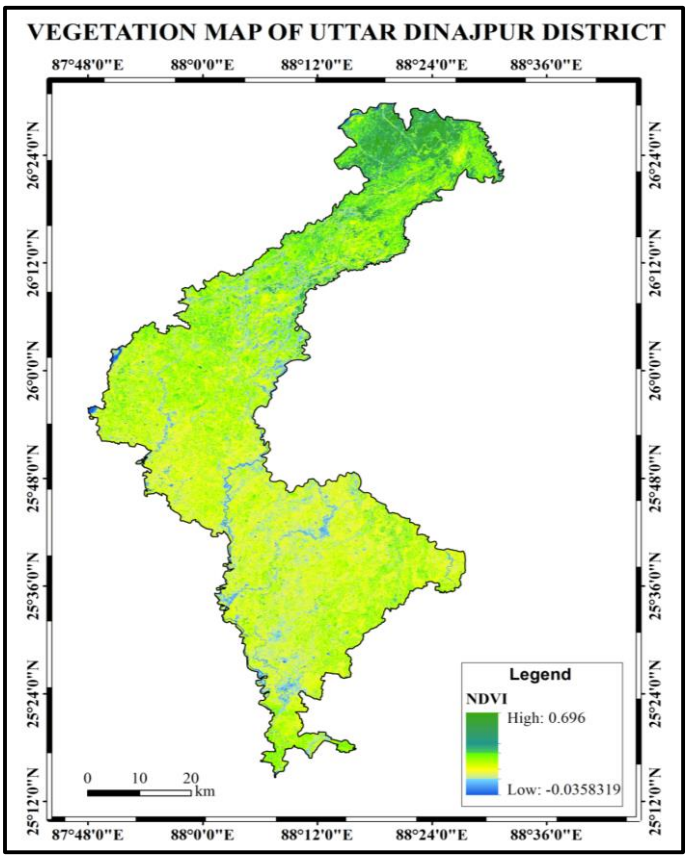


Figure 2.17 Forest cover in Uttar Dinajpur District.

2.6 Conclusion

So, it can be concluded from the above discussion that the agriculture depends upon the physical environment. The physical environment offers in different blocks completely different possibilities to which people cannot think he superior. Rainfall is essential to explore the probability of the use of groundwater and surface water resources which is one and only source of water conservation. Drainage is another source of quality water supply of irrigation in the agriculture sector. The intensity of irrigation depends upon the availability of water for various crops grown under different climatic conditions.

Since agriculture is directly connected to its physical atmosphere and variations in it are bound to influence agricultural land use. Previously, it has been eminent that agricultural use of land is affected by the circuitously felt change in climate; slope influences are however gradients imposes control on cultivation as well as partially indirect variations in climate and soil occurs on different slope aspects. The soil texture, structure, hygroscopic moisture, water holding capacity, soil density, etc. consequently, must be productive and have significant potential for crop growth.

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