In fact, geology, relief, drainage, climate, soil and vegetation are the vital determinants of land utilization. Land use is controlled by a number of physical factors and socio-economic factors.

**GEOLOGY**

Geology has both direct and indirect effect on land use. Land use of any region is the resultant product of its geological base. The nature of soil totally depends on parent materials which control the physical and chemical properties of soil and this variation of soil characteristics has a great impact on land use.

Laterite occupies nearly the whole of Paschim Medinipur district in the north and west, but in the south and east ordinary alluvium of the Gangetic delta predominates. In the north-west of the district micaceous schists crop up from beneath the lateritic flats. The lateritic rocks cover a large area, but in the majority of cases the only variety visible at the surface is a gravelly, pisolitic and nodular rock. Frequently the detrital or nodular laterite like loose gravel, commonly cemented into a solid mass, can be quarried like any other rock. Pits along the road sides are extracted as road metal, for which it is admirably adapted. This laterite contains rounded fragments and pebbles of other rocks of small size, the clay beneath being quite free from such admixture. The non-porous clay is covered by the open and fissured laterite which forms the water level of the district. In few cases there are some wells which have been sunk through the laterite.
A peculiar feature, which may be generally noticed in Bankura district, is observable in this study area also viz., that this great sheet of laterite appears invariably to dip under the small alluvial flats on both sides of the long swelling undulations, and to rise again beyond them.
Lateritic soil of Tertiary age predominates in the block of Dantan I and II, Keshiary, Narayangarh, part of Kharagpur and Chandrokona blocks. The rest part of study area is formed of recent alluvium.

<table>
<thead>
<tr>
<th>Period</th>
<th>Epoch</th>
<th>Soil Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Recent to Sub-recent Pleistocene</td>
<td>Newer alluvium consisting of sand with some silt and clay. Older alluvium containing sand, clay, yellow clay, calcareous modules, laterites and lateritic gravels.</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Mio-Pliocene</td>
<td>Sand, gravel, clay, siltstone, gritty ferruginous, sandstone coarse, yellow sandstone with clay at base.</td>
</tr>
</tbody>
</table>

Source: Geological survey of India (GSI).

**RELIEF**

Relief is the expression of surface configuration. The attributes of relief determine the capability and limitations of land use. Owing to its geographical position, Ghatal and Kharagpur sub-divisions are featured by varied physical aspects of Paschim Medinipur district in West Bengal. The north and north-west part of the study area embrace a portion of the eastern fringe of the Chhotonagpur plateau and consists of a hard laterite formation. The eastern portion of the study area has been formed out of the alluvial deposits borne down by the Hugli and its tributaries from great Gangetic system of upper India, and is similar to other districts of Bengal proper. South and south-west part of the Ghatal and Kharagpur sub divisions belongs to a maritime tract, subject to tidal waves and to the inland stretches of sea.
The study area can be divided into two major physiographic units namely

- Plateau fringe and
- Plains

The plateau fringe predominantly with lateritic topography and erosional surfaces are common in the west while the eastern part possesses the low lying plain formed of the younger alluvium.

The plateau fringe (50metres to 100metres wide) covers 40 percent of the study area. In general the plateau fringe is mainly the water-shed area of Kasai, Silai, Tangai...
rivers. An undulating terrain with deep and wide channels of relatively gentle gradient characterizes this area. This region is easily differentiated from the plains by its higher elevation and undulating nature.

Due to high relative relief the fringe zone offers a complexed terrain. In general the north western part and the study area cover the plateau area. Actually in this zone the ground has turned absolutely barren due to complete removal of the top soil, although this fringe zone is fairly well cultivated along the river valleys.

The plain area (10 metres to 50 metres wide) is a zone of aggradations and occupies the eastern and south eastern portion, which experiences a very low intensity of soil erosion. This zone comprises of the alluvial belts of Subarnarekha basin, Silai river, Kapaleswari river, Keliaghai river and its tributaries.

The slope is decreasing towards the east and south east with slight variation. Rivers are characterized by sluggish nature. This zone is composed mainly of alluvium. Therefore, it is the most fertile region of the study area which is almost free from flood damages, excepting some small pockets.

Relief can be analyzed by morphometric techniques like relative relief, average slope, dissection index etc. Generally, morphometry may be defined as the measurement and mathematical analysis of the configuration of landforms. In morphometric analysis topographic maps on which the surface relief is portrayed by the contours provide sufficient clues to visualize and reconstruct the analysis of regional morpho-units. In the present context, different morphometric attributes (average slope, relative relief, and dissection index and drainage density) have been applied to represent the nature of topography and its relevant relationship with land utilization.
**Average Slope:**

The term slope commonly refers to “some small element or area of the land surface, which is inclined from the horizontal” (Strahler, 1968). Slope is a product of exogenetic and endogenetic forces such as lithology, surface material, surface elevation, relative heights, climate, magnitude of weathering and erosion, vegetal cover and others numerous factors. Slope thus defined is a “function of structure, process, time and tectonics” (Ahmad, 1985).
The Wentworth’s method of slope analysis is a general and random method of average slope determination from a contour map based on the following formula:

\[
\text{Average Slope} = \frac{\text{(Number of contour crossing per unit side of a square grid / length in K.M)} \times \text{contour interval}}{636.60}
\]

The study area is the transitional zone between Chhotonagpur plateau fringe and alluvial plain and is traversed by Kapaleswari and Keliaghai rivers. The study area has been divided into three categories for assessing the intra-regional capability and limitations for agricultural development.

Fig. no. 04 illustrates that the major parts of Ghatal and Kharagpur sub divisions are under level of 30 minute category which covered about 88 percent of the study area. Actually total eastern part falls under this category. Very gentle (30-60 minute) and gentle (above 1 degree) slopes are found in some parts of Chandrokona I and II, Kharagpur- I, Keshiary, and Dantan- I blocks covering an area of about 8 percent and 4 percent respectively. Thus, the level ground slopes in the alluvial tracts offer physical possibilities for agricultural land utilization.

**Relative Relief:**

The term relative relief denotes actual variations between the highest and lowest heights in a unit area with its local base level. It has been differently termed as “amplitude of relief or local relief because it ascertains the amplitude of available relief to relate the altitude of the highest and the lowest points of any particular area” (Prasad, 1985). According to Singh (1988) relative relief “overcomes the difficulty or presenting the three-dimensional relief characteristics with the help of two-
dimensional maps.” From the relative relief map we may assume the nature of topography or terrain whether it is plains, plateau or hilly country.

Smith’s method (1935) has been followed to show varying amplitude of relief over the area. It is obtained by calculating the vertical differences between the highest and lowest points in each grid of 4 square kilometers.

RELATIVE RELIEF
(After Smith)
Ghatal and Kharagpur sub-divisions, Paschim Medinipur district

Source: Computed by the author

Fig. 05
The relative relief map shows that there is no such abrupt variation in relative relief in the study area, although the western lateritic undulating tract reflects some changes. Three major categories (Fig. 05) of relative relief have been identified in the present context for analytical interpretation.

*Extremely low Relative Relief (below 5 metre) zone:* From the fig.no.(05), the maximum area falls under this category which covered about 90 percent of the study area and occupied by the whole area of Daspur I and II, Ghatal, Chandrokona II, Debra, Pingla, Sabong, Narayangarh, Dantan II, Mohanpur blocks and considerable area of Dantan I, Kharagpur I and II, Keshiary blocks. This category covers continuous stretches of alluvium in the east along the Keliaghai, Kasai, Kapaleswari, Silai rivers and scattered patches of alluvium in the west.

*Moderately low (5-15metre) and Low (above 15metre) Relative relief zones:* These categories occupy parts of Keshiary, Kharagpur I, Chandrokona I and Dantan I blocks having undulation on surface.

*Dissection Index:*

From the geomorphological point of view the consideration of dissection index is very important in understanding the terrain characteristics of an area. It indicates the stages of evolution of the landforms. The word dissection refers to the mechanism and magnitude of relief incision in response to an area’s geology, lithology, surface elevation, angularity. Dov Nir (1957) stated that it is the index of the degree to which the dissection has absence of dissection and vertical cliffs respectively. This is advancement in the expression of the landscape.
To prepare the map of dissection index, the grid wise values of dissection are obtained by the equation: Maximum altitude – Minimum altitude / Maximum altitude.

On the basis of dissection index (Fig.06) the study area has been divided into three major categories that are low, moderate, and moderately high.
Low (below .10 metre) Dissection zones: This zone occupies considerable areas of Keshiary, Chandrokona II, Dantan I and almost all areas of Ghatal, Daspur I and II, Pingla, Sabong, Debra, Mohanpur where altitudinal variation is not so significant. This category covers an area of about 80 percent and offers possibilities for agricultural land utilization.

Moderate (.10-.40 metre) Dissection zone: Covering an area of about 16 percent, this zone occupies the parts of Kharagpur I and II, Dantan I and II, Chandrokona I and II blocks.

Moderately high (above .40 metre) Dissection zone: This zone covers the major areas of western part of the Chandrokona I block which covers about 4 percent areas.

DRAINAGE

The drainage determines the degree and intensity of land use. Water is essential for proper land utilization. The drainage network determines the land use patterns. The river system of Ghatal and Kharagpur sub divisions consist of the Keliaghai river, Silai river, Kasai river, Kapaleshwari river, Subarnarekha river and its tributaries and sub tributaries.

Keliaghai River:

The river Keliaghai, second tributary of the river Haldi, originates from Dudhkundi in Jhargram police station of Paschim Medinipur district and flows in an easterly direction through the Narayangarh and Sabong Police Stations till it unites with the Kasai river to form the Haldi river. During its course of journey from the high land in the western part towards east, it meets with number of tributaries namely, Deuli, Kapaleswari, Kalinondap, Ganpath, Chandia on its left and Baghai on its right. River
Kapaleswari meets Keliaghai at Langalkata of Sabong police station and further down the river new Cossye meets at Dhewbhanga. After the confluence point, the river is named as Haldi and finally falls into river Hugli. The stream length of the river from its origin is 106 kilometres and the catchment area of the river is about 2145 square kilometers. The Keliaghai river and its feeders drain a considerable area between the river Kasai and river Subarnarekha.


Fig. 07
Plate- 01
Sand deposition

Plate- 02
Major obstacle of the course of Silai river

Plate- 03
Floating bridge over Silai river
In the summer season, the Keliaghai river dwindles to a narrow channel with trickles of flow, but during the monsoon season it swells up quickly causing floods and high run off.

**Silai River:**

The principal tributary of the river Rupnarayan is the Silai or Silabati river. This river enters Midnapur district from the Manbhum district on the north and flows in a tortuous course. It runs first in an easterly direction through the north of the Midnapur sub-division and then it turns to the south-east and south through in Ghatal sub-division near Narajiole and lastly it takes a sharp turn to the north and eventually it falls into the Rupnarayan river at Bhandar. It is fed by two small streams from the Bankura district on the north, the Purandar and Gopa, and by the Chandur and Kubai in Midnapur district, but its largest tributary is the Buri, which takes its rise in the north-west of the district and flows east till it empties itself into the Silai river near Narajole. The Silai river is navigable throughout this year for a short distance. Besides, during rainy reason both sides of Silai river are inundated due to high intensity of rainfall and high siltation of the river beds.

Plate- 04
Debris of pollutant material in the Silai river
**Kasai River:**

The principal tributary of the Haldi river is the Kasai river which originates from Jabarband at an elevation of 641 metres in the hills of Chhotonagpur range, about 48 kilometres north east of Purulia town and enters into the Midnapur district in the north-west from Bankura district. It follows an exceedingly tortuous course, running towards south and south west and then eastwards past the town of Midnapur, which is situated on its north bank and cross over the Debra Block. The river traverses a length of 368 kilometres through the districts of Purulia, Bankura, and Paschim Medinipur before it joins the river Keliaghai at Dheubhagna to form Haldi. The river upto Midnapur district and Mohanpur block is known as kasai after which further down upto kapasatikri, it is known as Cossey river. At Kapasatikri, the river bifurcates into two branches known as the old Cossey and the new Cossey. The old Cossey after flowing for another 10 kilometres bifurcates into Palashpai khal and Durbachati river. The Palashpai khal flows for 16 kilometres over Daspur block II before joining with Rupnarayan river.

**Kapaleswari River:**

The river Kapaleswari originates in Kharagpur block II and has a total stream length of 40.50 kilometres up to its confluence with the river Keliaghai at Langalkata in Sabong police station. The river has a catchment area of 254.25 square kilometers. It is a tributary of Kaliaghai river.

**Subarnarekha River:**

The Subarnarekha river originates from Chhotonagpur plateau near Ranchi (Jharkhand) at an elevation of 610 metres and enters into the Kharagpur sub-division
along the Keshiary and Dantan I blocks and finally falls in to the Bay of Bengal. In Paschim Medinipur district, the only tributary of this river is Dolong.

Besides, there are also some canals in the study area like Midnapur high level canal, Palashpai khal, Ketia khal etc.

Thus, the drainage system of the different rivers and its tributaries reflect the most dominant geomorphic agents of the fluvial changes of the area and accordingly has a direct and indirect impact on the transformation of land.

**Drainage Density:**

Drainage density means the relative spacing of drainage density (Strahler, 1954). It may be defined as a measure of the texture of a drainage system, expressed as the ratio of the total length of all channels within a unit area. It is a meaningful index of potential sustainability in terms of water availability forming a basic farm input in the agricultural land use operation.

Drainage density in the present study has been calculated by the following formula:

\[
\text{Drainage density} = \frac{\text{Total length of streams channels in unit area}}{\text{Area of the same unit}}
\]

Fig. no.08 shows three major categories of drainage density zones which have been identified in the present context for analytical interpretation.
Very low (below 0.5) Drainage Density zone: The zone of very low drainage density is found in parts of Daspur I, Debra, Kharagpur II, Sabong, Pingla, Dantan I and II, Keshiary blocks. This zone is mainly alluvial tract.

Low (0.5-1) Drainage Density zone: The areas of low drainage density zone occur in the parts of Mohanpur, Dantan II, Kharagpur I, Daspur I and II blocks.
Medium (above 1) Drainage Density zone: The areas of medium drainage density are found along the river Silai mainly in Ghatal and Chandrokona I blocks.

CLIMATE

Climate is an important determinant of land use.

Climate of the study area is characterized by hot and humid tropical monsoon climate.

The region is distinguished as aw type according to koppen’s classification with a wet dry seasonal condition.

Table- 01 Temperature and rainfall Distribution of Ghatal and Kharagpur Sub- divisions, 2006

<table>
<thead>
<tr>
<th>Month</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Mean</th>
<th>Normal Rainfall</th>
<th>Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>33</td>
<td>10</td>
<td>21.5</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>February</td>
<td>38</td>
<td>13</td>
<td>25.5</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>March</td>
<td>37</td>
<td>18</td>
<td>27.5</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>April</td>
<td>39</td>
<td>22</td>
<td>30.5</td>
<td>49</td>
<td>71</td>
</tr>
<tr>
<td>May</td>
<td>38</td>
<td>22</td>
<td>30</td>
<td>135</td>
<td>115</td>
</tr>
<tr>
<td>June</td>
<td>38</td>
<td>24</td>
<td>31</td>
<td>260</td>
<td>163</td>
</tr>
<tr>
<td>July</td>
<td>35</td>
<td>25</td>
<td>30</td>
<td>291</td>
<td>407</td>
</tr>
<tr>
<td>August</td>
<td>37</td>
<td>25</td>
<td>31</td>
<td>302</td>
<td>376</td>
</tr>
<tr>
<td>September</td>
<td>33</td>
<td>24</td>
<td>28.5</td>
<td>258</td>
<td>245</td>
</tr>
<tr>
<td>October</td>
<td>34</td>
<td>21</td>
<td>27.5</td>
<td>162</td>
<td>41</td>
</tr>
<tr>
<td>November</td>
<td>32</td>
<td>15</td>
<td>23.5</td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td>December</td>
<td>30</td>
<td>12</td>
<td>21</td>
<td>12</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: I.M.D, Govt. of India.

In the month of January, which is the coldest month in the year, temperature ranges between 10°C and 12°C. On the other hand the average maximum temperature for the month of May is as high as 32.2°C.
June, July and August are the months of low pressure when mean atmosphere pressure remains 995.5 mb.

August is marked by maximum humidity (84 percent). Midnapur District records maximum rainfall (336.3mm) which decreases to the west. The monsoon precipitation (annual coverage 1450mm) is less in the undulating west than that of the eastern alluvial tract (1750mm) in the east because of its interior location from the Bay of Bengal.
Temperature:

The general temperature of Paschim Medinipur district remains more or less hot throughout the year like other districts of southern part of West Bengal. High day temperature is a feature in the hot summer months. The year 2006 received highest
maximum temperature of 39°C in the month of April. The temperature remains high during the months from March to September. The minimum winter temperature ranges between 15°C and 22°C. The average annual temperature of the district is about 27.29°C. The following table (table-01) shows the month wise temperature and rainfall for the district of Paschim Medinipur for 2006.

**Rainfall:**

Due to the northward movements of cyclonic storm from the south of the Bay of Bengal a very meager amount of rainfall occurs in the cold months of November, December, January and February. During this time cloudy weather and light rainfall occurs due to the passage of northerly trade winds. Heavy rainfall occurs owing to the occasional incursions of cyclonic storms during the period from May to October. The monsoonal precipitation is mainly associated with cyclonic storms and inland depressions. The annual rainfall varies from 1400 millimeter to 1600 millimeter. In the year 2006 the month of July has received the maximum rainfall of 407 millimeter. Annual heavy downpour has become a menace of flood in the district of Paschim Medinipur.

**SOIL TYPES**

Soil is the part and parcel of land and it is the basic determinant of land use. The types and patterns of land use changes with the variation of soils in different environmental situation. The degree and intensity of use of the land also varies with the quality of soils.

The soils of the Kharagpur and Ghatal sub divisions can broadly be grouped into three major types-lateritic soil, older alluvial soil and newer alluvial soil.
The north western part and the south western part of the study area are covered by lateritic soil which is found in parts of the area covering mainly Keshiary, Narayangarh block, Kharagpur I and Chandrokona II blocks. This type of soil is mainly derived from the laterite which contains quartz, pebbles, and other rock fragments. This soil is loam to sandy, loam of reddish brown colour and iron concretions are present in this soil.
This older alluvial soil is found in the central part as well as in the south eastern and the north western parts of the study area mainly parts of Kharagpur I and II, Debra, Sabong, Chandrokona I and II blocks. This older alluvial soil is mainly of Vindhya family and is derived from the alluvium brought down from the Rajmahal hills and the Chhotonagpur plateau. This soil is brown to gray brown or olive brown colour and texture varies from clay-loam to clay and some places sandy-clay-loam.

The newer alluvial soil is found along the valleys of river Silai, Subarnarekha, Keliaghai, Kasai, Tarang and also in the blocks of Daspur I and II, Ghatal, Sabong, Dantan I, Mohanpur, Debra blocks. This soil is mainly developed on newer alluvium of recent origin. The colour of this soil is brown to gray brown and texture varies from sandy-clay-loam to clay-loam.

**NATURAL VEGETATION**

There are few districts in West Bengal in which the varieties of soil and vegetation are so great except the Paschim Medinipur district. The study area displays two distinct physiographic diversities with variation in natural vegetation. Lateritic tract is covered with forest. The tract to the west is lateriferous, undulating and possesses a flora closely approximating to that of Chhotonagpur plateau. Some parts of the study area are entirely waste, while other parts contain jungles of small *sal*, *kusum* and *piasal*. There are no reserved or protected forest in the study area but there are several unclassed forests within the permanently-settled estates. These forests consist mainly of small *sal*, *mahua*, and *palas*. 
The dense forests took place at Nayagram (under Nayagram forest range), Keshiary (under Belda Forest Range) and Narayangarh. The lateritic undulating tract possesses a flora closely approximating to that of Chhotionagpur plateau.

Reference:

- Bengal Gazetteer of Midnapur District by L.S.S.O’ Malley.