CHAPTER II
NATURAL RESOURCES OF UPPER GANGA YAMUNA DOAB

Physiography & physical terrain.
➤ Drainage pattern.
Weather conditions (Climate, Temperature, Rainfall, Humidity).
➤ Soils.
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CHAPTER - 2

NATURAL RESOURCES OF UPPER GANGA-YAMUNA DOAB

A Doab meaning two waters is a term used in India & Pakistan for a tract of land between two confluent rivers. The doab usually refers to a crescent shaped region of Uttar Pradesh in North Central India. The doab designates the flat alluvial tract b/w the Ganges and the Yamuna rivers in western & South western Uttar Pradesh state in India extending from the Shiwalik range to the two river confluence at Allahabad. The region has an area of about 23,360 Sq.miles (60,500 Sq.km.). It is approximately 500 miles (805 km.) in length and 60 miles (97 km.) in width. The following districts/parts form part of the Upper Doab, Muzaffarnagar, Saharanpur, Meerut, Ghaziabad, Gautam Budh Nagar, Baghpat & Bulandshahr. Natural resources of the region are those resources donated to us by the nature. The regional economy of the region in itself dominated & reflected by the availability of natural resources. The type of economy is reflected in the type of natural resources available is the region. The natural resources of the upper Ganga Yamuna Doab includes, physical terrain of the region, drainage, soil, weather condition & what all water resources are available in the region.

PHYSIOGRAPHY & PHYSICAL TERRAIN :

Physiography studies the present relief features of the earth's surface or of natural features in their causal relationship. Ganga Yamuna Doab Segment of the Indo-Gangetic plain in western, south western, U.P. state, India. It lies between Gangas and Yamuna rivers west & upper Ganga plain. The doab (river basin) consists of a wide trough between the great Himalayas to the north & the Deccan plateau to the south. The Ganga along with its tributaries have brought large quantities of alluvium from the mountains and deposited downwards to form the vast plain area. The general slope of the entire plain is to the east & south east.

The Ganga Yamuna Doab is a riverine region being bountifully endowed with the fertile soil, favourable climate, flat surface, rendering possible the construction of roads & railways and slow moving river. An extensing system of irrigation developed
in the tributaries of Ganga & Yamuna & others have turned this region a populous spot of smiling.

The upper part of the Ganga plain is delimited by the 300 m. contour in Shiwaliks in the North, the peninsular boundary in the south and the course of the Yamuna river in the west. Ganga Yamuna Doab is a part of the Great depression. It is a fore-deep formed either by down warp or as a rift valley. It is an alluvium filled trough. These are aggradational plains, composed of the sediments deposited by the river Ganga & Yamuna and thus are literally, "the dust of the mountains." The depth of the plain varies from place to place. The depth of alluvium deposits at Meerut was 1066.8 metres. (Seismic sounding). The variation in thickness of the alluvium largely depends upon the morphological processes. No bed rock is disclosed by the borings exceeding 400m. The uniformity of the level of the plain is due to the deposition of silt in to the water and the absence of any earth movements which did not disturb the flatness even at a later stage. These deposits include great thickness of sand, clay, loam & silt.

Physiographically, the 100m. contour has been accepted by the geographers as the most effective line of demarcation of the Ganga Yamuna region. The Ganga plain is about 550 km. long in the east west direction and nearly 380 km. width in North South direction, covering an approx area of 1.49 lakh sq.km. Its elevation varies from 100 to 300 m above mean sea level. The Upper Ganga plain is drained by Ganga and its tributaries like Yamuna, Ram Ganga, Sarda, Gomti & the Ghaghara rivers. Almost all the rivers follow North west- South east course concomitant with the lie of the land. The average gradient of the land is about 25cm. per km. The gradient is sleep in the northern part. The rivers flow sluggishly in the plain as the gradient decreases. The monotony of this flat & featureless plain is broken by the Tarai-Bhabar submontane belt and on micro levels by the river bluffs, oxbow lakes, meanders, sandy stretches (bhurs) and the river channel themselves. The western part of the plain consists of comparatively higher Ganga Yamuna Doab. East of this doab are the low lying Rohilkhand plains which merge into the Avadh Plains in the east.
THE GANGA YAMUNA DOAB:

The Ganga Yamuna Doab is a geomorphological entity. The surface alluvium has a thickness of 1000 to 2000m. The old bhangar alluvium of the doab has formed flat uplands of the newer alluvium. There are intervening slopes varying form 15 to 30m in relief. These slopes are locally known as Khols. The Khols along the Yamuna have a variation in relative relief. The variation is to the extent of 12 to 20 m in the case of the Ganga Khols.

The Upper Ganga - Yamuna Doab is formed by the alluvial deposits brought down by rivers Ganga & Yamuna. The general slope of the land is north to south and towards the south east. The slope is approx. 29 cm per Sq.km. and the height of the region is 207.4 m above mean sea level. The maximum height of the region is 225 m and it decreases to 193 m in the southern region. The entire area is a flat, featureless plain area. The districts which are in the North Western part of the region Baghpat, Meerut & Ghaziabad and in the north are Muzaffarnagar & Saharanpur districts and in the south is Bulandshar district. The land which lies in west of Kali river is more fertile. Various sandy uplands are found in areas of Khadar belt and sometimes floods occur in Khadar belt. Bhangar area is free from floods. The Khadar present in Hindan river is very thin and becomes strong after the addition of Yamuna water into it. The narrow fertile belt is found in the South west part of this river. The Khadar belt of Ganga is wide & more stronger and affected areas like Mawana, Garhmukteshwar and Anpshahr of the region. It can be divided into:

1. **Yamuna - Hindan Doab**: This tract is found in between the west of Yamuna & east of Hindan river. The districts of Meerut and Ghaziabad occupies this belt. It is 25 Km wide in the north and the river Yamuna and Hindan met each other in South of Dankaur. This area is more fertile especially the northern part formed by alluvial soil. Small tracts of fertile area are found in the southern part. Small riverlets or stream divide this area into two parts, namely uplands of Yamuna Hindan Khadar and Yamuna Hindan Khadar.

**Uplands of Yamuna - Hindan Khader**: This are stretches from east of Hindan river upto west of Yamuna Khadar area. The area adjacent to Yamuna Khadar is
characterised by sandy uplands. The soil of this region is weak and small streams are flowing in this region.

Yamuna Hindan Khadar: It lies in the west of upland of Yamuna - Hindan Khadar where many depressions are found. This tract is narrow in the north and wide in the south. There is no tributary joining the Yamuna river but Hindan river has two tributaries, Krishna and Ban- Ganga. They joined the Hindan river in the North east of the area. In the entire area, many Bhoor dunes are found along the banks of both the rivers. Along them, many areas are densely populated, Chhaprauli, Baghpat & Kottana of Baghpat district along the Yamuna banks and Barnawa and Balani along the Hindan river banks.

2. Central Depression:

This area is found between the Hindan river and district of Meerut, Bulandshahr and along the Aligarh state highway no. SH-22 & SH-18. It includes the western area of Sardhana Tehsil, Meerut Tehsil, Hapur, Sikandarabad and Khurja. The soil is more fertile in areas adjacent to river Hindan and Upper Ganga Canal. Some sandy and weak soil is found along the banks of Hindan river. The slope of upper Ganga canal is gentle towards the east. The slope towards Sardhana and Bulandshahr is steep and many depressions are found in this area. In the lower parts, many artificial drains are constructed to save peoples from water filled depressions. The soil of the region is free from reh or Kallar due to presence of high moisture in the soil.

3. Eastern Upland:

These uplands are found between the central depressions and the Ganga Khadar belt. It includes the maximum area of Mawana, some parts of Meerut and Sardhana, Some part of Hapur, Bulandshahr, Khurja and Shikarpur Tehsil. Kali river and its tributaries form the eastern boundary of this upland. The tracts of Bhur soil and many sandy uplands are found along it. Bhur soils are formed due to accumulation of wind- blown sands during the hot dry months of the year and are found along the banks of the Ganga river especially in the upper- Ganga - Yamuna Doab.
4. **Ganga Khadar** :

The Khadar is composed of river alluvium and forms the flood plains along the river banks. These deposits are normally confined to the vicinity of the present river channels. The khadar is found in the far east region of the Ganga - Yamuna Doab. They are called as Ganga Khadar or flood plain of Ganga river. This area comprised of many depressions and stream that are connected to the river. The Ganga Khadar is approx. 10 km wide in the northern part and it decreases in the South of Bulandshahr district. This belt comprises of weak and light soil, many suitable for long grasses. Wherever, alluival deposits are found along the river banks, there are series of villages and tehsils like Mawana, Garhmukteshwar and Anupshahr are found along it.

The Ganga Yamuna Doab region is a riverine region endowed with fertile soil, favorable climate, flat surface and slow moving river. This region with its deep, fertile, stoneless, alluvial soil and its many rivers is the most favourable and most desirable part of India.

**Drainage Pattern** :

The drainage pattern of any state depends on the slopes and gradient of that area. The slope of the entire area of Upper Ganga - Yamuna Doab is gentle from north to south and south east. The gradient is steep in the northern part. The slope gradient is two feet per sq.mile is found in the region. It is featureless and flat plane area. Many rivers like Ganga, Yamuna, Hindan and Kali river and their various tributaries are flowing in this region. Also, the drains that flows into these rivers are the major flowing streams of the region. The major flowing streams of the region which flows north south and then towards eastwards , These are —

1. **Ganga River Drainage Pattern** :

Ganga river is the major river of this region. This river while flowing from North to South reaches the boundary of a village Bela of Meerut district and it forms the eastern boundary of the region. This river separates the Mawana Tehsil of Meerut district, Garhmukhteshwara Tehsil of Ghaziabad, Sayana tehsil of Bulandshahr
district and Pragana and Debai of Anupshahr tehsil from district of Bijnor, Moradabad and Badaun. The surface area of this river is made of thick sand. Various cities and town like Hastinapur (Mawana Tehsil), Garhmukhteshwar, Ahar, Karanhas and Ramghat (Bulandshahar district) are located along the banks of Ganga. In Meerut district, these two tributaries : Burhi Ganga and Soti river are found, but these rivers at present are of no use.

(a) **Burhi Ganga** : This small tributary of Ganga river flows through Muzaffarnagar and enter Saifpur, Firozpur village of Meerut district. It is believed that Burhi ganga is ancient Ganga and in the past, present Ganga flows along the banks of this river.

(b) **Soti River** : This river also is of no use. It is a seasonal river. It jomed the main Ganga river near Jalalpur Village of Mawana Tehsil.

2. **Hindan River Drainage Pattern** :

   It flows from Muzaffarnagar (North- South) district and enters into Pilokkhar village of Sardhana Tehsil and from South to Westwards, it enter into Baghpat district and forms a boundary of Meerut district, enters into Makanpur village of Ghaziabad district and passes through Dadri Pargana (Gautambudh Nagar) before finally enters into Yamuna river. The towns which are located along the river banks of Hindan river are Budhana, Ghaziabad, and Kasna. The following are its tributaries-

(a) **Krishna River** : This river is also known by the name of 'Karsuni'. This river passes through Tikri village of Barnawa, covers almost 18km. of route and finally joins the Hindan river. This river is also of no use.

3. **Kali River Drainage Pattern** :

   This river is also known as 'Nagin' river as it crawls and flows like a snake. This is a tributary of Hindan River. It flows through Muzaffarnagar and enters into Meerut district near Sardhana. The cities and towns located along this river are Pahasu, Malagarh and Chaundera of Bulandshahar district. It is a seasonal river and these drains are also connected to it, named as chhoiya and Abu drain.
4. **Yamuna River Drainage Pattern**:

The Yamuna is the largest and the most important tributary of the river Ganga. It originates from the Yamnautri Glacier in the Bandarpunch peak in Garhwal in Uttranchal at an elevation of 6,330m a source which is very close to the source of Ganga itself. The Yamuna river is also called as Yamraj's sister. After entering the Baghpat district near Tada village of Chaprauli, this river flows southwards and it forms the boundary of the Baghpat and Gautambudh Nagar and separates them from Haryana and Delhi. This river is the lifeline of Delhi, capital of our country. The town located on this are Chaprauli, Baghpat, Kotana, Dankaur, and Jewar. Its main tributaries are:

(a) **Bhuria River**: This river flows parallel to Hindan River up to 3-4 km. This river received water from oagal and choiya drains. It covers an area of about 38 km and finally joins the Yamuna river.

(b) **Karwan River**: It flows between the Kali river and middle canal. It is also known as Kharo river. It is born near parpa village of Dadri pargana and passes through Sikandarabad and Khurja and covers an area of about 145 km. and finally joins Yamuna river. Lakes are found in this river.

5. **Neem River**:

This river flows in between Kali river and Ganga river. This river borns near Sayana and ensembled various lakes and Jheels, flows southward. There is one chhoiya drain near Debai and then join this river and it passes through Aurangabad chandrok. It flows upto Ahar and Shikarpur tehsil.

6. **Canals and Lakes**:

This region comprises of these canals-

(i) Upper Ganga Anupshahar branch.

(ii) Upper Ganga Kanpur branch.

(iii) Upper Ganga- Mut branch.
Many drains like Abu Nala, Kirdhar nala, Khandala drain, Aliyar drain and Albal drain flows in this region.

Many small lakes (Jheels) are found in this region, locally, they are called as Dahar or Soti.

**CLIMATE :** The climate of upper Ganga Yamuna Doab region is characterised by dry continental climate. As a result of which there is extreme hot in summer and extreme cold in winters. South west monsoon arrives in this region in summers. That is why this region is called as Monsoonal climatic region. In summers, maximum temperature rises to 41°C but sometimes in June it reaches upto 46°C. In the entire area fast and hot winds blow from the western sides which are locally called as 'Loo'. This region is divided into four climatic periods.

1. **Winter Season :** The cold weather season commences in November and continues till March. Clear sky, pleasant weather, low temperature and humidity, high range of temperature, cool and slow northerm winds are the chief characteristics of this season. Local winds blow in this region. Sometimes, the cold winds from mountainous area blow towards the plain areas and the temperature reaches upto 3-4°C. Average temperature of 10°C is found in this region.

2. **Summer season :** The hot weather season commences from April end to June. This season is extremely hot and dry. Average temperature during this season varies from 20°C- 41°C. In summers hot winds blows from the western sides called as Loo winds increases the temperature upto 46°C in the month of June.

3. **Rainy Season :** The rainy season starts with the onset of the South- west monsoon in June and continues till middle of September. This is also called as monsoon season, the south-west monsoon season. High heat, high humidity, extensive clouding and several spells of moderate to heavy rain with strong surface winds are the chief characteristics of this season. The south - west monsoon covers the entire area and spells heavy rain. Rainfall occurs in summer month. Average annual rainfall reaches upto 720 cm. during this period. There is no rainfall in winters but sometimes rainfalls occurs due to western disturbances. This region do not receive any rainfall due to North- East monsoon in winters.
4. **Cool season**: The cool season starts from the middle of September and continues up to November after which the winter season starts. Due to retreat of the monsoon this season is called the season of retreating monsoon. No severity of temperature (hot & cold) is found during this season. Pleasant weather conditions prevails over the entire region.

**TEMPERATURE**: There is one research centre at Meerut which depicts the weather forecasting of the area around. In the month of June average annual temperature upto 41°C is found. Day temperature is 20°C and night temperature is 8°C. Sometimes temperature reaches upto 45-46°C. In the month of May hot winds blows in the entire region locally known as 'Loo' winds. December & January are the coldest months of the year. During winter season, the average annual temperature reaches upto 10°C but due to blow of westerlies and cold spells from the Himalayas, the temperature falls down to 3-4°C. Sometimes, the temperature reaches upto freezing point. Distribution of temperature in the Upper Ganga- Yamuna Doab is shown below in the following table.
Table No. 2.1

Distribution of temperature in Upper Ganga- Yamuna Doab region.

<table>
<thead>
<tr>
<th>Months</th>
<th>Temperature Daily Max. (°C)</th>
<th>Temperature Daily Min. (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>20.9</td>
<td>8.1</td>
</tr>
<tr>
<td>Feb.</td>
<td>23.9</td>
<td>9.5</td>
</tr>
<tr>
<td>March</td>
<td>29.8</td>
<td>15.0</td>
</tr>
<tr>
<td>April</td>
<td>36.2</td>
<td>20.2</td>
</tr>
<tr>
<td>May</td>
<td>40.0</td>
<td>25.3</td>
</tr>
<tr>
<td>June</td>
<td>39.6</td>
<td>27.5</td>
</tr>
<tr>
<td>July</td>
<td>34.2</td>
<td>26.2</td>
</tr>
<tr>
<td>Aug.</td>
<td>32.5</td>
<td>25.6</td>
</tr>
<tr>
<td>Sept.</td>
<td>33.3</td>
<td>24.4</td>
</tr>
<tr>
<td>Oct.</td>
<td>31.9</td>
<td>18.2</td>
</tr>
<tr>
<td>Nov.</td>
<td>27.9</td>
<td>10.8</td>
</tr>
<tr>
<td>Dec.</td>
<td>22.9</td>
<td>7.8</td>
</tr>
<tr>
<td>Annual Average</td>
<td>31.0</td>
<td>18.2</td>
</tr>
</tbody>
</table>

Source; U.P. District Gazetteers : Meerut, Baghpat, Ghaziabad, Muzaffarnagar, Saharanpur, Gautambudh Nagar and Bulandshahar.

RAINFALL:

Rainfall in Upper Ganga- Yamuna Doab region is caused by the South- west monsoon coming from the Bay of Bengal & Arabian Sea. The maximum rainfall occurs in this region due to south-west monsoon winds. The quantity of rainfall
increases towards the north eastern part & decreases towards the South west part. This region receives 72% of rainfall by South west monsoon. Maximum rainfall occurs in the month of July. Average annual rainfall in Meerut reaches upto 720 mm. and in Anupshahar, it reaches upto 743mm & in Khurja, it is measured as 630 mm. The distribution of rainfall in the upper Ganga Yamuna doab region is shown below:

**Table No. 2.2**

**Distribution of rainfall in Upper Ganga Yamuna Doab.**

<table>
<thead>
<tr>
<th>Months</th>
<th>Rainfall in (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>30.2</td>
</tr>
<tr>
<td>February</td>
<td>29.7</td>
</tr>
<tr>
<td>March</td>
<td>14.5</td>
</tr>
<tr>
<td>April</td>
<td>11.7</td>
</tr>
<tr>
<td>May</td>
<td>15.2</td>
</tr>
<tr>
<td>June</td>
<td>78.2</td>
</tr>
<tr>
<td>July</td>
<td>229.9</td>
</tr>
<tr>
<td>August</td>
<td>212.6</td>
</tr>
<tr>
<td>September</td>
<td>151.6</td>
</tr>
<tr>
<td>October</td>
<td>23.9</td>
</tr>
<tr>
<td>November</td>
<td>2.5</td>
</tr>
<tr>
<td>December</td>
<td>11.4</td>
</tr>
<tr>
<td>Annual</td>
<td>810.9</td>
</tr>
</tbody>
</table>

HUMIDITY:

Humidity & temperature are universally proportional to each other. When temperature of an area increases, humidity decreases & vice versa. During summer days, air is dry and low humidity is present in the air. April & May months are the driest months of the year & during this time, humidity reduces to 20 percent. In the months of July & August when the entire region is covered by the South west monsoon winds, the humidity percentage increases. Relative humidity reaches upto 70% to 100%. As the humidity reaches 100%, rainfall begins. June & July months have a highest humidity and the sky is fully covered with clouds. Relative humidity of the region (month wise) is shown below in the table.
Table No.2.3
Distribution of humidity (in percent) in the upper Ganga Yamuna Doab reason.

<table>
<thead>
<tr>
<th>Months</th>
<th>Humidity at 8.30am. (in%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>80</td>
</tr>
<tr>
<td>February</td>
<td>67</td>
</tr>
<tr>
<td>March</td>
<td>57</td>
</tr>
<tr>
<td>April</td>
<td>41</td>
</tr>
<tr>
<td>May</td>
<td>39</td>
</tr>
<tr>
<td>June</td>
<td>54</td>
</tr>
<tr>
<td>July</td>
<td>79</td>
</tr>
<tr>
<td>August</td>
<td>82</td>
</tr>
<tr>
<td>September</td>
<td>77</td>
</tr>
<tr>
<td>October</td>
<td>69</td>
</tr>
<tr>
<td>November</td>
<td>63</td>
</tr>
<tr>
<td>December</td>
<td>74</td>
</tr>
<tr>
<td>Annual Average</td>
<td>62</td>
</tr>
</tbody>
</table>


SOILS:

Soil is the thin surface layer on the earth, comprising mineral particles formed by the break down of rocks, decayed organic materials, living organisms, water & air. Soil is a very important natural resource of India because agricultural production is
basically dependent on the fertility of soil. The rich, deep fertile soils of the Ganga plains supports high density of population through agricultural prosperity.

Soil display a wide variety of physical & chemical characteristics. In India, soil formation is mainly related to the parent rock material, surface relief, climate, natural vegetation, animals, insects & man.

According to Dr. H.M. Bunnet, "Soil is a layer of unconsolidated material of the earth's surface which has been derived from rocks & organic matter through agencies of decay disintegration.

According to Agriculture department of USA "Soil is the connection of natural bodies occupying properties of the earth's surface that support plants and that have properties due to the integrated effect of climate and living matter, acting upon parent materials as conditioned by relief over periods of time".

The upper Ganga- Yamuna Doab region is of almost uniform topography & lithology, the soils are by & large homogenous. The alluvial soil with the variants, the Usar & Bhur, depending on the drainage conditions, mechanical & chemical constituents. Most of the alluvial soils are derived from the sediments deposited by rivers. The alluvial soils in this region are as yet immature and have weak profiles. They differ in consistency from drift sand to rich loams and from silts to stiff clays. The proportion of nitrogen is generally low, but potash, phosphoric acid & alkalies are adequate, while iron oxide and lime vary within a wide range. The porosity and texture provide good drainage & other conditions favourable for bumper crops. These soils are easily replenished by the recurrent river floods and support uninterrupted crop growth.

The alluvium soils of the region is divided in to newer or younger khadar & older bhangar soils. The khadar soils relatively rich in plant nutrients, occupy the narrow frequent siltation tracts in the flood plains of the rivers. These are deficient in organic materials specially phosphorus and are sandy to loamy in texture. The Ganga khadar soils have immature profiles with sandy to silty loam texture, lack of concretion, fair proportion of lime and other soluble salts and are alkaline in reaction (PH8) with imperfect drainage, while the Yamuna khadar soils have sub-mature
profiles with predominance of clay and concretion and very high lime and other soluble salts contents under the poor drainage condition.

The bhangar soils are more extensive in areal spread, occupying the interfluvial zones. The soluble salts & lime are low and show neutral to slightly acidic reaction except pH 6 to 7.5 in the low lying areas. Prone to water logging. In the proximity of the Ganga these are loamy to sandy loam in texture while near the Yamuna, the silt content decreases giving sandy to sandy loam texture possibly due to the excessive drainage.

Slightly, different from the khadar & the bhangar is the submontane soil where two physiographic units, the bhabar & the terai, are bedded in the texturally different soils. The bhabar soil is sandy to gravelly, highly porous and aerated, and has lower moisture retaining capacity while the terai soils one rich in nitrogen & organic matter but are deficient in phosphate. The terai zone is provided with rich clayey soil, with some proportion of lime sand, moisture & rich humus. These two zones are thickly forested. The terai soils are generally covered by tall grasses and forests but are suitable for a number of crops such as wheat, rice, sugarcane, jute & soyabean under reclaimed conditions.

Due to their softness of the strata & fertility of the alluvial soil are best suited for irrigation and respond is well to canal & well/tube well irrigation. The alluvial soils yield splendid crops of rice, wheat, sugarcane, tobacco, cotton, jute, maize, oilseeds, vegetables & fruits.

The soil of the region were classified in to 6 parts for the first time in 1876 as follows:

(1) Danker (Bulai)  (2) Matiar  (3) Seweta  (4) Rasli (Bulai)

(5) Bhoor  (6) Sand.

Again in 1940, soils were classified into six parts:

(a) Matiar or Kachhiana soil
(a) **Matiar Soil**: In some parts of Bulandshahar district, this soil is known by names as Bara Bhumi or Ameta Bhumi. This type of soil is generally found adjacent to villages. This soil is also called as Bara Bhumi or Goin Bhumi. Vegetables, fruits, flowers & tobacco are grown in this soil. This soil is divided into two grades, grade-I & grade-II; these are distinguished on the types & grade of vegetables grown in the region. Grade-II type of soil is used for growing vegetables around Meerut city. Grade-II type of soil is also found around the Hapur town. In some places, this soil is also called as Rasali.

(b) **Bara Bhumi**: This soil is also of two types: Grade-I & Grade-II. Grade-I soil is found near the villages, where manures & irrigation facilities are available. The soil in which the slope is not gentle and shortage of irrigation facilities is considered as Grade-II soil. In Grade-I soil, vegetables and fruits are grown. This is also called as Goin Bhumi.

(c) **Seweta**: This soil is also divided into many types. This soil is better than other soils due to availability of manures, irrigation facilities & overall fertility of the soil. The upper surface of the soil is covered with domat soil and other facilities of manures & irrigation are available. Seweta II type of soil is far away from the village and have less domat soil on the surface. Undulating surface & shortage of irrigation facilities make this soil of Grade II. The third grade sewata soil is devoid of fertility, manures & irrigation facilities. This is also called as Reh or Kallar type of soil.

(d) **Bhoor**: High sandy uplands are called as Bhoor. It is also called as Pilora in Bulandshahr district. The colour of this soil in yellowish in nature (tamarind yellowish colour). This soil comprises of sand, easily cultivable and absorbs the water
immediately. This soil is found in Dadri, Dankaur, Mawana, Garh, Pooth, Sikandarabad & Barwana. This soil is less fertile & production of crops is low in this soil. This type of soil is also found in river basin.

(e) **Dankar**: This soil is hard in nature and found in lakes & Jheels depressions. This soil is fertile & suitable for rice crop. This soil is also found in Bulandshahr & Gautambudh Nagar & It is suitable for rabi crops calcium quality is more in this soil. The crops grown in this soil are damaged due to floods in the rainy season.

(f) **Khadar**: This soil is found in the valleys of Ganga, Yamuna & Hindan rivers. This soil is formed due to deposition of alluvium and are more fertile. This soil is suitable for growing crops like wheat, rice, sugarcane etc. At some places, sandy uplands are also found. At some Places alluvial soil is also affected by floods & water logging problems. This soil is largely meant for rice cultivation. This type of soil is found in Ganga khadar of Mawana Tehsil & Garh Tensil of Gaziabad district.

According to planning communion, 2000, the soils of this region are dense, fertile, loamy, & domat in nature. Sandy uplands are found at various places in Khurja & Bulandshahr district. They are not used for cultivation. Old alluvial soils is found in districts of Meerut & Ghaziabad. At some places, this soil comprises salt & reh composition. The soil adjacent to Ganga & Yamuna rivers are sandy in nature. After intense study of soil of this region the planning commission divided the soil of the region into four parts.

1. Old Alluvial plain
2. Old alluvial plain with sand dunes.
3. Recent flood plain.
4. Active flood plain.
WATER RESOURCES:

Water is one of the most precious natural resources and a key element in the socio-economic development of a country. Water is the essential part of the modern day life. It is used for drinking, irrigation, industries & a host of other purposes. About 71% of the earth's surface is covered by water but only a small fraction of total water available on the earth is useful for human consumption. The distribution & use of water on earth is shown in the table.

Table No.2.4
Earth's water resources:

<table>
<thead>
<tr>
<th>Distribution of water on earth</th>
<th>%</th>
<th>Use of water</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceans, saline lakes</td>
<td>97.20</td>
<td>Agriculture</td>
<td>93.37</td>
</tr>
<tr>
<td>Ice caps, glaciers</td>
<td>2.15</td>
<td>Municipal &amp; Rural water supplies</td>
<td>3.73</td>
</tr>
<tr>
<td>Lakes, rivers, streams</td>
<td>.0085</td>
<td>Industries &amp; power generation</td>
<td>1.26</td>
</tr>
<tr>
<td>Atmosphere, biosphere</td>
<td>.00015</td>
<td>Livestock</td>
<td>1.08</td>
</tr>
<tr>
<td>Ground water</td>
<td>0.64</td>
<td>Others</td>
<td>0.56</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>


Rainfall is the main source of fresh water in India. From precipitation alone (including snowfall), India receives 4,000 km³ (billion cubic water) water. India has one of the largest supplies of water in the world. Due to various constraints of topography, and uneven distribution of water resources over space & time, the total utilisable water resource is assessed as 1,122 km³, out of which 690 km³ is surface water and 432 km³ is ground water. Water is available in two forms:

1. Surface water
2. Ground water
Surface water is available on the surface of the earth in the form of rivers, lakes, ponds, canals etc. Rivers comprises the most important source of surface water. Ganga basin average annual run off is 501 km$^3$, utilisable flow of Ganga is 250 km$^3$ & storage completed of Ganga water is 37.4 km$^3$. The assessment of total ground water resources in India according to the National commission on Agriculture (1976) was estimated as 67m. hac.m excluding soil mixture. The usable ground water resource was assessed as 35 m, hac m of which 26m. hac m. was considered as available for irrigation. The total replenisable ground water resource of Ganga basin is 17.17 million hectares meter per year. The total utilizable ground water of Ganga for irrigation is 14.59 m.hac.m. per year & the level of ground water development of Ganga basin is 30.79 percent.

The rain water & availability of water is necessary for sustainable agricultural development in Upper Ganga Yamuna Doab region. Water is available to crops in the natural form or supplied by artificial means. The process of supplying water to crops by artificial means such as canals, wells, tube wells, tanks etc. The upper Ganga-Yamuna Doab region receives rainfall in summer months from south west monsoon. This region often suffers from high variability of rainfall. The rainfall in India is uncertain, unreliable, irregular, variable, seasonal & unevenly distributed. In India, only 30.2 % of the cultivated area receives sufficient rainfall and about two third of the total cropped area needs irrigation facilities. Irrigation in Upper Ganga- Yamuna Doab is necessary to increase the farm productivity. With the introduction of High yielding varieties of seeds & heavy doses of chemical fertilizers, since from 1960's, irrigation from artificial means has become a very important ingredient of Indian agriculture.

The upper Ganga Yamuna Doab region is located in a monsoon climatic zone of a country. This regions economy is largely influenced by agriculture and allied activities. In India, Indian economy is considered as a gamble of monsoon. This region suffers from high variability of rainfall & this is reason why this region needs artificial irrigation facilities to increase the crop productivity. Considering the importance of water as a resource, National water policy was adopted in 2002, Central Water Commission, central ground water Board authority & National water development agency were formed by the central government. Their main aim is to
regulate, planned, development & management of water & priority is given to drinking water, irrigation, hydropower, ecology, agro-industrial & non-agricultural industries.

The farmers of the upper Ganga Yamuna Doab region are taking the full advantage of the various schemes initiated by the government agencies. Farmers are making full utilization of government & private sources of irrigation. The net irrigated area of the region in 2005-06 was 1341878 hectares and the gross irrigated area of the region in the same year was 2198622 hectares. Out of the total net irrigated area of 1341878 hectares and gross irrigated area of 2198622, under Meerut district irrigated area is 191793 hectares, Baghpat area 110190 hectares, Ghaziabad 139526 hectares, Gautambudh Nagar 120937 hectares, Bulandshahr 250187, Muzaffarnagar 323782 hec. & Saharanpur area was 248509 hectares.

The various sources of irrigation of the region are canals, tubewells (Govt. / Private), wells, Lakes and others. The total area irrigated by canals in the region in 2005-06 was 228566 hec., by Govt. tubewells 63354 hec. and Private tubewells 1013614 hec. by wells 31474 and by others was 2060 hec. The total irrigated area by various sources of irrigation in the region (2005-06) was 1357428 hec. In Meerut district irrigation by canals in 2005-06 was 34936 hec., Baghpat 3179 hec., Ghaziabad 22250 hec., Gautambudh Nagar 15158 hec., Bulandshahr 31982 hec., Muzaffarnagar 76161 hec. and Saharanpur was 44781 hec.

In Ganga- Yamuna Doab region in the year 2005-06 maximum irrigation was done by tubewells (Govt./Private). The total area of the region irrigated by tubewells was 1057693 hec. (year 2005-06). Govt. tubewells irrigated an area in the same year was 31474 hec. and by private tube wells the irrigated area was 1026219 hectares.