Chapter-1

GENERAL AND PHYSICAL SETTING OF UTTARAKHAND
The Himalayas are the most significant features on the surface of the earth. This mountain chain forms a gigantic arc stretching from the Naga Prabat peak in the North-west to the Brahamputra gap at the base of the Nancha Barwa peak in the east. It extends over a length of about 24,000 kilometres from west to east and varies in width from 150 to 300 kilometres. The Himalayan mountain chain could be divided into six physiographic region

1. Jammu and Kashmir
2. Himachal Pradesh
3. Nepal Himalaya
4. Garhwal Himalaya
5. Kumaun Himalaya
6. Eastern Himalaya (North Bengal, Sikkim, Bhutan and Arunachal Pradesh)

**Historical Background**

The name of Uttarakhand or Kedar Khand is extract from the Puranic literature. Ved Vyas attached so much to it that he wrote an UP Purana about it. It is because of this, the region is regarded as one of the holiest parts of the Bharat, being frequented by great saints and kings from different parts of the country. Every rock and rivulet is dedicated to some deity or saint and has an appropriate legend attached to it. Some of the Himalayan Kingdoms such as Dwigarta, Trigarta, and Madra flourished

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*Presently a new state known as Uttarakhand has been created incorporating the entire area of Uttarakhand and one district (Haridwar) from Uttar Pradesh.*
here. The region had also been under the kingdoms of Brahamputra and Shrughna, lying to the southeast and northwest of the Alaknanda respectively. The kingdoms of Madawar and Govisana were confined to the south of the Brahmaputra covering the bhabar and tarai region as mentioned by Huen Tsang (Cunningham, 1963). The region had also been a part of the Maurya and Gupta empires. In the 3rd century B.C., King Ashoka erected a rock edict on the left bank of the Yamuna at Kalsi in the Chakrata tehsil of Dehradun. During the medieval period (around A.D. 17th century), a number of Rajput princes penetrated into the village of the Himalaya due to the confusion created by Muslim invaders and setup a number of small principalities. Many places have been named after the regions from where they migrated e.g. Ajmer Patti and Udaipur Patti, Katyuris who are known to have a long dynasty lost their stronghold on Kumaon by about A.D. 1400 and split into scattered principalities (Ponde, 1937). Champawat was the residence of the Chand rulers of Kumaun (A.D. 700-1790). In the middle of the 16th century, Rana Balo Kalyan Chand, a successor of the chand dynasty, established his fort at Almora. Raja Udyat Chand was the last successful ruler of Kumaun. In 16th century, Raja Ajaipl integrated 52 fortress (yarns) and their associated territories into Garhwal. The Kiratas, Seythians and Mangoloid elements have also contributed profusely to the culture complex of the Garhkum Himalaya.

In A.D. 1743-44, there was a Rohilla invasion on Kumaon, but they could not establish their foothold. By early 19th century, the Gurkhas in their long sweep of invasion subdued Garhkum and territories beyond up to Kangra. Their territorial ambitions brought them into conflict with the
British, with the result, Nepal lost the territories of Kumaun and Garhwal in 1815. After the British occupation Almora became the administrative seat of Kumaun and Garhwal. The residual state of Tehri was handed over to the Raja of Tehri by Britishers (Painuli, 1959) after retaining the most populous part of Garhwal. During this period there was development of roads, railway lines, education, agriculture and commerce. The latest political boundaries have been made after the re-organisation of the districts in the hill region of Uttar Pradesh in 1960.

**Administrative Characteristics**

Uttarakhand consists of eight districts namely, Nainital, Almora, Pithoragarh of Kumaun and Chamoli, Uttarkashi, Tehri, Pauri and Dehradun of Garhwal division (Fig. 1.1). It extends from 28°43'24" and 31°27'30" N latitude and 77°34'27" and 80°7'22" E longitudes. It encompasses an area of 51,125 square kilometres and account total population of 5.926 millions (According to Census of India, 1991).

This well defined physical region is bounded by the river Kali in the east and river Tons in the west, stretching from the foothills of the Himalayas in the south. This region extends upto Indo-Tibetan international boundary in the north. It measure an average 357 kilometres from east to west and 294 kilometres from North to south. The region is situated centrally in the longsweep of the Himalaya and forms a rather transitional zone between the pre-humid and the rather dry to Himalayas. It was looks like the crown of Uttar Pradesh and stand guard to the upper Ganga plain. The layout of Uttarakhand is mostly uneven, the minimum and maximum
elevations being respectively 1000 metre and 7,817 metre above the mean sea level.

As we know that Uttarakhand is made up of eight administrative districts.

1. Nainital: The Nainital district is situated in the south-eastern part of Uttarakhand (29°24'N lat. & 79°28'E long.). Its border touch those of Pithoragarh, Almora, Pauri, Moradabad, Bareilly and Rampur districts and Nepal in the east. The headquarter of this district are located at Nainital. It is well known for many beautiful lakes and the mountain resorts that have developed around them. The northern part of Nainital district encompasses the lower Himalayan hills. In the south are the Dun valleys, Siwalik hills and the fertile bhabar-tarai tract are along the plains of western Uttar Pradesh.

The Haldwani area is located in the bhabar-tarai tract, many small towns have developed in this area. These includes Kathgodam, Lal Kuan, Bajpur and Rudrapur. The Ramnagar area covers the south-western part of this district. It is situated in the lower hills and bhabar tarai belt, it is fairly large town that lies on the main road leading to Almora and Ranikhet. Kashipur is also large town. The famous Corbett National Park can be reached from Ramnagar.

Agriculture, tourism and industrial activities are the main stay of the economy of this district. The principle crops grown are paddy, wheat, sugarcane, maize, pulse and vegetable. The tarai belt is highly fertile land. Fruits are also cultivated in various parts of Nainital district.
2. **Almora**: Almora district is situated in the east-central part of Uttarakhand (29°3'N and 30°19' N lat. and 79°21' and 80°E long.). Its headquarters are situated at Almora. This district is well known for its rich forests and beautiful hill stations that attract thousands of tourists each year. The economy of Almora district is largely based on agriculture. The main agricultural crops are wheat, maize, paddy, vegetables and potatoes. Apples are other fruits also grown in the hills and valleys.

3. **Pithoragarh**: The district occupies the north-eastern part of Uttarakhand (29°27' N and 30°40' N lat. and long. 79°50' E and 81°3' E long.). Its border touch the International border with Tibet in the north. Pithoragarh also has common borders with Almora, Nainital, and Chamoli districts and Nepal. The headquarters of this district are located at Pithoragarh. Important towns of this district are Berinag, Lohaghat, Dharchula, Garbyang, Champawat and Pithoragarh. The principal crops raised are maize, barley, jowar, ginger and potatoes. Animal husbandry is another important source of livelihood for the residents of northern parts of Pithoragarh district. The traditional route to the holy Mansarover lake passes through Garbyang and Dharchula in the district.

4. **Chamoli**: Chamoli is the largest district of Uttarakhand. It occupies the north-central part of this hilly region. Its northern border touch those of Tibet, Uttarkashi and Tehri in the west, Pauri in the south and Almora district in the east. The temple town of Badrinath, the holy shrine of Kedarnath and the famous valley of flowers/Hemkund are a part of this district. The famous mountain hamlets of Sonprayag, Gaurikund and Kund are a part of this district. The headquarter of Chamoli districts are located
at Gopeshwar, a newly built town. Other important towns of this district are Karanprayag, Nandprayag, Rudraprayag and Gauchar, Alaknanda river and its tributaries drain a large part of Chamoli district. The main tributaries of this river are Mandakini, Dhauliganga, Nandakini and Pindar. Economy is based on agriculture, livestock and tourism.

5. Uttarkashi: This is a second largest district of Uttarakhand (30°28' & 31°28' N lat. & 77°49' E & 79°25' E long.). It lies in the north-western part of region. Its border touch Kinnaur and Shimla district of Himachal Pradesh and Dehradun, Tehri and Chamoli district of the region. In the northern part of this district lie the sources of the Yamuna and Ganga rivers. Important townships of Uttarkashi district are Uttarkashi, Purola and Gangotri. The economy is based on Agriculture and animal husbandary.

6. Tehri-Garhwal District: Tehri district occupies west-central part of Uttarakhand (29°26' & 30° N lat. & 78°12' & 79°14' E long.). Its border touch with Uttarkashi, Chamoli, Pauri and Dharadun district. The headquarters are located at Narendranagar. This district lies in the lower and middle Himalayan ranges. Important townships of this district are Tehri, Chamba, Narendranagar, Muni-Ki-reti, Deoprayag and Kirtinagar. The economy of Tehri district is largely based on agriculture. The crop raised here are rice, wheat, maize, pulses and vegetables.

7. Pauri-Garhwal District: The district occupies the south-central part of Uttarakhand. Its headquarters are located at Pauri a small town located atop a ridge. The border of this district touch Dehradun, Tehri, Chamoli, Hardwar, Bijnor and Nainital districts. Pauri districts encompasses the
Siwalik hills, dun type villages and the lower Himalayan hills. Pauri is situated on a lower Himalayan ridge. Kotdwara is a small town in transition zone between the plains of western Uttar Pradesh and the foothills. Other important townships of this district are Srinagar, Dogadda and Landsdowne. The economy of Pauri district is too based on agriculture.

8. Dehradun: Dehradun district occupies the south-western part of Uttarakhand. The borders of Dehradun district touch of Saharanpur, Haridwar, Pauri, Tehri and Uttarkashi districts of the region and Sirmur and Shimla districts of Himachal Pradesh. The headquarters of this district are situated at Dehradun. The Jaunsar-Bawar area of Dehradun district lies in the north-west. Chakrata is the main township of this belt. Kalsi and the famous Lakhamandal caves of Mahabharata times are historical places in the Jaunsar-Bawar areas.

The Mussoorie hill station is located in the northern part of the district. It is located at 2000 metres high ridge and attracts many tourists each year. There are a number of places worth visiting in and around Mussoorie, for example, Dhanaulti, Surkhanda temple, Happy valley and Kempty falls. Rishikesh is another important town in this district, it is situated on the banks of the river Ganga. Rishikesh is an important religious town for Hindus and other towns are Doiwala and Raiwala. Agriculture is the backbone (mainstay) of the economy of Dehradun district. A substantial part of the total geographical area of this district is under irrigation. The main crops raised here include rice, wheat, maize, sugarcane, pulses and vegetables. Fruits are also cultivated in some parts
of the Dehradun valley. Tourism also contributes to the economy of Dehradun district in a significant proportion.

Relief

The region has a varied and complex relief features. There are many ranges of mountain running in a general direction from north-west to south-east. The slope is steeper towards the southern side and gentle towards the north. The main rivers of the northern India i.e. the Ganga, the Yamuna, and the Kali rises from this region and constitute three major river systems. The area is studded with lakes which follow the general trend of the range and is studied with their situation form a characteristic features in the area. On the basis of physiographic attributes, this region may be divided into three major physiographic divisions (Fig. 1.2).

1) Himadri (Greater Himalaya)
   i) Himadri Ranges
   ii) Himadri valleys
2) Himanchal (Lower Himalaya)
   i) Himanchal Ranges and Hills
   ii) Himanchal valleys and Lake Basins
3) Siwaliks (sub-Himalayan Tract)
   i) Duns
   ii) Siwalik Ranges

1. Himadri (Greater Himalaya)

   The Himadri ranges run nearly along the international border of the country in this region, where glaciated topography is well preserved.
UTTARAKHAND
PHYSIOGRAPHIC DIVISIONS

I Himadri (Greater Himalaya)
II Himanchal (Lower Himalaya)
III Siwaliks (Sub Himalayan track)

Source: Survey of India maps.

FIG. 1-2
The Himadri is 50 kilometres wide and has the highest elevation, which are approximately more than 4000 metres where several high passes viz. Lemp Lek (4,966 metres), Darma (5,329 metres), Niti (5,579 metres), Mana (5,609 metres) and Jelu Khaga (5,329 metres) are situated joining the region with Tibet. Some Himalayas peaks, famous for their heights, are situated here viz. Nanda Devi (7,817 metres), Kamet (7,756 metres), Trishul (7,120 metres), Nilkhanth (6,597 metres), Dumagiri (7066 metres), Bander Punch (6,315 metres), Gangotri (6,141 metres) and Kedarnath (6,940 metres). These slopes and peaks are covered with several hundreded metres thick ice covers, which make many glaciers like Milam, Gangotri, Pindari and Bhagirathi.

The Greater Himalaya ranges are deeply cut by the head waters of the river Ganga (Bhagirathi and Alaknanda), the Yamuna and the Kali (Sarda). The cross profiles of these valleys show convex form with steep valley walls reflecting the rising phase of the Himalaya and also the younger characteristic of the rivers.

The river Ganga forms the main valley of this region and drains a very large portion. The Ganga (Bhagirathi) rising from the Gomukh Glacier (6,614 metres), which is 30 kilometres long and 2 to 4 kilometres wide, cut a fantastic gorge among the granites of the central axis of the Greater Himalayas. The Yamuna rises from Bander punch range and it has two tributaries i.e. the Tons and the Giri. The valley of Kali (Sarda) form the eastern boundary of the region which ends on the Nepal border. Himadri may be divided into two relief subdivisions - i) Himadri ranges and ii) Himadri valleys.
Himanchal (Lower Himalaya)

The Himanchal is situated between the ranges of Great Himalaya in the north and the Siwaliks in the south. Lower Himalayan ridges have a general elevation of about 1500 metres to 2700 metres and the valleys bottoms between 500 metres to 1500 metres with a width of 75 kilometres. The region is full of a variety of landscape developed in different parts (Fig. 1.3).

The lacustrine basins and river terraces are dominant features of this zone. The valley of the river Ganga and its tributary are in young stage of profile development. They are immature, as they have been subjected to rejuvenation again and again. The main boundary thrust separates this region form Dunes. The ridges of this region, with highly compressed and altered rocks and separated from each other by deep valleys.

There is a lake basin near the outer range of the lower Himalaya which makes a zone of approximately 25 kilometres in length an 4 kilometres in width. The lake region of Kumaun is dotted with big and beautiful lakes. Some important lakes of the region are Nainital, Bhim Tal, Naukuchiya Tal, Sat Tal, Khurpa Tal, Sukha Tal, Sarai Tal.

The Sukha Tal, a lake with no water, is situated near Nainital, while the Gohna lakes is in the Garhwal Himalaya in the valley of a tributary of Alaknanda named Birahi Ganga. The Diuri Tal is another important lake lying 10 kilometres the north-east of Ukhumath. The origin of these lakes is still ambiguous and doubtful. Thomas believes that the frequency of the lakes in this small region may be connected with the
UTTARAKHAND RELIEF

INDEX

ALTITUDE IN METRES

- **ABOVE 4800 METRES**
- **3000 - 4800**
- **1200 - 3000**
- **BELOW 1200**

Source: Survey of India maps

FIG. 1.3
recent movement. The irregularly eroded surface of Siwaliks over which the Krol Nappe has moved must have contributed to the formation of the surface irregularities, consequently upon the breaking up of the thrustmass. Thus the region has two sub divisions - i) Himanchal ranges and hills and ii) Himanchal valleys & lake basins.

The Siwaliks (Sub-Himalayan Tract)

The word Siwaliks derived from Lord Siwa lock, according to Hindu’s mythology. But here the term Siwaliks is used for a range of narrow and low hills which lie almost parallel to major ranges of the Himalayas. It stretches in the north-west to south-east direction and forms the outer range of the Himalayan system. The hills of Siwaliks are broken up and are subjected from the lower Himalayan spurs by a series of structural low lands. The height of the Siwaliks varies roughly from about 550 metres to 1350 metres. Ranges of Siwaliks are intersected by numerous Siwaliks rivers such as Dabka, Baur, Nihar and Bhakra, at several places. These rivers have carved out their deep valleys. These ranges are lithologically quite different from those of lower Himalayan ranges. The southern slopes have steep scarps and the northern slopes descend gently to the flat floored structural valleys called Duns.

The sediments of Duns are brought recently from the upper ranges (Himadri and Himanchal) filled up in this region, which is 350 metres higher than the plain. Many Duns are found in Uttarakhand, such as Dehradun, Kothri Dun, Chaukhamba Dun, Patri Dun and Kota Dun.
Geology

The Uttarakhand hills forms the eastern most part of the western Himalayas. The geology of this region resembles that of Himachal Pradesh in the west and Nepal in the east. The main difference between the Himachal Pradesh and Uttarakhand is that in the former areas, the tethys zone is very well developed. The Himalayas was formed by the mightest thrusting of the earth layers and their rise is analogous to Nappe formation of Alps, a tangential process upheavels and compressions resulting in excessive rock folds, faults and thrust planes, have changed much of their original and primitive structure. They are young with sharp relief features viz. Pyramidal peaks, knife edges, high ridges and deep abyssal valleys. From south to north, the Uttarakhand Himalaya may be divided into the following three parallel zones (Fig. 1.4).

1. Sub Himalaya or the Outer Himalaya or Siwalik range
2. Lesser or Lower Himalaya
3. Great or Inner Himalaya

1. Siwalik

The sub-Himalayan zone of the Siwalik range lies in between the Indo-gangetic plain and the lesser Himalaya. The foothill belt of this region is built entirely of Siwalik sediments. The Siwalik constitutes a great thickness of detrital rocks; clays and conglomerates, rising to an elevation between 5000 and 5,500 metres. These beds of sandstone and shales are separated from the Eocene belts of the lesser Himalayas by "Great Boundary Fault". They are of varying width ranging from 10 to 15
Source: Geological Survey of India

FIG. 1.4
kilometres and form a system of foothills, which have an average height of 900 and 1200 metres. Siwaliks are chiefly composed of tertiary sediments and are related to the latest phase of the Alpine-Himalayan orogeny. Though its upheavals was accompanied by movements of the Himalayan mountains themselves and probably by increasing latters. The Siwalik range is perhaps the most recently formed range of similar magnitudes on the earth. It is still in a primary stage of growth and it may be expected that in future it would rise in altitude and expand in width (Burrard & Hayden, 1907).

The Siwalik range is composed of the some little consolidated materials which forms the deposits of the level plains of northern India. It was formerly the northern most belt of the flat alluvial region and has been compressed by lateral forces into a long fold or range. The rocks of the Siwaliks are entirely of fresh water origin and prove that the sea has not washed the base of the Himalaya since the eocene period (Burrard & Hayden, 1907). Geologist believes that Siwalik in the south are buried under the alluviam of the Ganga. The exposed belt, however passes through the northern part of Saharanpur, the southern part of Dehradun, and Garhwal and the middle part of Nainital. To the north, Siwaliks are backed by a discontinuous series of longitudinal valves known as Duns such as Dehra, Kantri, Chaukhamba, Palti and Kata, of them Dehradun (35 kilometres long and 25 kilometres wide) is the biggest and most developed in urban and outdoor facilities. These duns have been filled in only recently from gravels derived from the central Himalaya. They rise to the heights of 350 metres from the plain. On the basis of lithology, the
Siwaliks may be divided into three units.

i. The Lower Siwaliks

ii. The middle Siwaliks

iii. The upper Siwaliks

i) The Lower Siwaliks

Sandstones of the lower Siwaliks are relatively more compact than those of the Middle and upper Siwaliks. It is composed of medium to fine grained compact grey coloured sandstones, interbedded with minor saltstones, shales and some clays.

ii) The middle Siwaliks

The middle Siwalik consist of essentially fine to medium grained salt and pepper sandstones with some saltstones and clay beds. These sandstones are friable due to cementation.

iii) The upper Siwaliks

The upper Siwaliks are embeded with conglomerates and sandstones. The pebbles of the conglomerates, consist of sandstones, quartzites, limestones, shales and phyllite.

2. Lesser Himalaya

This part of the Himalaya lies between the Siwaliks and the great Himalayan zone is not defined features, though its southern contact, a steep thrust against the Siwaliks is generally sharp. It is bounded by the 'main boundary fault' to the south and the 'main central thrust' to the north stretches the zones of lesser Himalayas approximately 75 kilometres. It is
a crystalline zone of unfossiliferous (or poor fossiliferous) sediments with complex tectonics rocks have been compressed and metamorphosed to such an extent that they vary in age from Algankien to the Eocene (Wadia, 1966). Lithological variation present a mosaic of colours buff, cream, white, purple, pink, grey, green, yellow and slaty, presenting a feast to the eye. The variety is pronounced in Uttarkashi region where investigation proved that Dharaser, Surjuni and Uttarkashi Thrust have affected rock variations from highly schistose cericite, quartz, lithostratigraphical variations are pronounced in Almora-Askot and Baijnath reigon in the earth. The contortions of the strata show that the lesser Himalayan region has everywhere compressed horizontally. These mountains are the result of not one but of many movements of the crust and their history is more complex than that of the siwaliks. Here the ranges have been uplifted and later forced to change their alignments. Thus the whole region has been subjected to successive compressions and general wrinkling process is probably still continuing (Burrard & Hayden, 1907). The lower Himalayan zone may be divided into three main structural features.

i) Krol Belt - The Krol belt named after the Krol mountains in Shimla, stretches from the Shimla region in the north-west to Nainital in the south-east. The rocks of this belt includes slates, ppyrites, sandstone and limestones. This region is marked by the presence of clay shales, with quarzites. This Krol thrust override a structural and erosional gap in the Siwaliks (Ganseer, 1964).
ii) Deoban-Tejam Belt - It lies south of the main thrust of the greater Himalaya and forms mainly the inner sedimentary belt of the Lower Himalaya, stretches from the Shimla area in the north-west to the Kali valley in the south-east. It is mainly belt of enormously thick limestones and dolomites tapped by thick quartzites (Gansee, 1964). To the south is the Badolisera-Pithoragarh zone which runs just north along the north thrust border of the Almora-Dudatoli crystalline means. To the north of Askot-Baijnath crystalline thrust lies the Chamoli-Tejam zone, in which the sedimentary sectors are thicker than the southern belt and the tectonic picture somewhat less complicated by secondary disturbances.

Askot-Baijnath, which west of the Kapkot, are nearly connected to the main thrust zone of the higher Himalayas forming the northern border. The deepest outcrop of this is met between Tejam and Kapkot in the Sarju and the Ramganga valleys. The great thickness and rather constant development of practically unfossiliferous and only slightly metamorphic sediments, where the metamorphic seems to increase from the topographically lowest exposures to the top Horizons, is a unique feature in the inner part of the lower Himalayas. It has been suggested that the age of this part vary from pre-Cambrian to Mesozoic (Gansee, 1964).

iii) The Almora-Dudatoli Crystalline mass - The inner sedimentary zone of the lower Kumaun Himalaya is separated by the large Almora-Dudatoli thrust sheet from the Król thrust of Nainital and is subdivided by two smaller thrust remnants the Almora and the Baijnath thrust.

The Almora thrust forms a huge crystalline syncline. A marked change in the crystalline composition outcrops are met at bhowali with
some quartz, conglomerates, highly crushed quartzites and conspicuous green doloidal epidote diabases, near ranikhet region an increase of alkali feldspar lead to granite geneisses, south of Almora, then is a coarse to medium granites of muscovites, biotite, granite. The Almora granite which dominates the champawat region (Ganseer, 1964).

3. Great Himalayas

The higher or Great Himalayan region lies to the north of the Main central thrust. It spreads over 50 kilometres. It is a region of huge glaciers, huge U-shaped valley, horns, and the glacial lakes. The main central thrust separating the higher Himalayan zone form the lower Himalayan zone is well outlined by the Kali valleys and valleys of Goriganga and the Pindar rivers. The crystalline sheet of the higher Himalayan zone is made of old metamorphic rocks and is composed of a series of highly fossiliferous sediments. The main rocks of this zone are quartzites, magnetites, gneiss, granites, schists, diorite, amphiboles (Singh, 1993). It is however a difficult and unaccessible area with an average relief between 4800 and 6000 metres, culminating into some of the highest peaks of Asia, viz. Bander Punch (6,315 metres), Kamet (7756 metres), Nanda Devi(7,817 metres), Dunagiri (7066 metres) and Trishul (7,120 metres). Some of the giant glaciers such as Gangotri, Milan and Kedarnath (largest after Karakoram glaciers) can be seen here (Wadia, 1966).
Drainage

The Uttarakhand is drained by short consequent tributary streams which flow obliquely in the valleys and then join the main streams. The great Himalayan ranges along with its major branch the Zaskar range forms the general divide between the two major river system, the Ganga system and the Indus system (Singh, 1983). The region is well drained by the numerous rivers and the rivulets (locally known as Gad and Gadhera). The drainage can be divided into three main system which is shown in Fig. 1.5.

1. The Ganga system
2. The Yamuna system
3. The Kali system

1. The Ganga System

Major parts of the region is drained by the Ganga system and its tributaries, covering the whole of the Garhwal, except western portion of Uttarkashi districts and western parts of Almora and Nainital districts (Singh, 1993). The name Ganga is applied to the river below Devprayag where the river Alaknanda and Bhagirathi meet. After the confluence at Devprayag the river continues to flow down in torrents and cascades for a distance of approximately 160 kilometres, and after cutting through the Siwalik ranges of hills, its emerges into the plains at Hardwar in Uttar Pradesh (Report, 1972). Its important tributaries are Alaknanda, Bhagirathi, Bhillganga and Nayar rivers.

i) The Alaknanda: It is the most important river of the basin as well as the region. The river derives its name from Alkapuri, the town where
according to Hindu mythology "Kuvera" the God of wealth resides. Alaknanda enters the Garhwal region where its joins with Mandakini rivers. It flows to south-west and makes the boundary between the districts of Tehri-Garhwal and Pauri-Garhwal. The Alaknanda flowing with a smooth surface gently winds around the point of confluence. It is 44 metres in breadth and rises 14 metres at the same point. The width of the united stream is 75 metres. The Alaknanda marks the great central line of lowest elevation receiving rivers as either side which in turn receives minor streams that got water through numerous rills and rivulets until the great dividing ridge is met which forms the watershed between the headwaters of the Kali or Sarda on the east and the Ganga system on the west.

From Rudraprayag upto Devprayag Alaknanda flows in the westerly direction and receives a large number of stream on both banks, main stream joining Alaknanda on the right banks are Bhardarigad, Bariargad, Odiargad and Takaligad. The other branches have their sources at the Maniknath peak and Gopalpur Dong region. The stream which join Alaknanda on the left bank are Baohangad, Gewatigad and Kalhunsyungad.

ii) The Mandakini - It is the major tributary of Alaknanda, Mandakini drains the districts of Chamoli, and Garhwal making boundary between them and then its joins Alaknanda near Rudraprayag at a height of 1000 metres. Its main streams in the region are Lastargad, Helaungad, Lastergad descends from Latkhanar (2718 metres). An interesting point to note about the Mandakini in the break in its thalweg at Sonprayag where it first meet its major tributary Basaltic Ganga. The waterfall is about 100 metres high, possibly it is a rock step in the longitudinal profile of previously glaciated
valley occurring at its should at the junction of tributary (Bose, 1968).

iii) The Bhagirathi - River Bhagirathi is regarded to be the main source of the Ganga river, between Tehri and Bhatwari, the river generally flows in a comparatively broad open form except above Dharasu where it cuts a deep gorges through quartzites. Bhagirathi flows towards the south and cuts across the Himalayan axis in the granite gorges. It again turns at right angles and flows towards the southeast just opposite in direction to its upper course (Bose, 1968). The actual source of the Bhagirathi is in the gangotri glaciers (25 kilometres long), some distance north of Kedarnath at a point called Gaumukh (30°65' & 79°40'N). The gangotri is a few kilometers down the streams from Gaumukh. The Bhagirathi joins the western tributary called the Jahnavi, some distance to the north of main Himalayan range between Banderpunch (6315 metres) and Srikanta (6133 metres) through a gorge in which the river bed is 3960 metres below the peaks on either sides. This region is said to be silt like opening in the rocks with practically vertical side reaching down 180 metres, to the bed of the river (Krishna, 1968). Bhagirathi enters the Garhwal region near Pratap Nagar. Before coming at Pratapnagar it has made boundary between Uttarkashi and Tehri garhwal districts. It runs in south-easterly direction and meet Ganga in Devprayag at the height of 449 metres. Its main contributary rivers and streams are Bhilganga rivers, Sirkandagad and Chandbhangad.

iv) The Bhilganga : Bhilganga descends from Kedarnath in the northern Tehri-Garhwal. It flows in the south-westerly direction and meets Bhagirathi near Tehri at the height of 672 metres.
v) The Ramganga basin: The Ramganga (also called Ruhut or Ruput in its upper course) rises in Lower Himalaya at an altitude of about 3110 metres above sea level at latitudes 30°5' N and longitude 70°16'E near the village of Lahba in the Garhwal districts of the Uttarakhand. Initially the river flows in a south-easterly direction successively through Almora and Garhwal districts for about 112 kilometres (Report, 1972). It flows with a very rapid fall, first through Garhwal, again it debouches on the plains near the Kalagarh fort in Bijnor districts. It is now a large river and 24 Kms lower down receives on its right bank, the Khoh which also rises in Garhwal (Mishra, 1970). After flowing in south-westerly direction Ramganga make the boundary of the two districts, Nainital and Garhwal. Then its makes its way to the west and drains the southern Garhwal. Monda, Sona and Mandalti are the important tributaries of Ramganga.

Kosi: The Kosi or Kaushalya, which is the third most important rivers of Uttarakhand is the principal affluent of the river Ramganga. It rises on the outer Himalaya in patti Borarau of Pargana Baramandal of Almora and does not join the Ramganga until they have escaped from the mountains and entered the plains, from its sources the Kosi flows in southerly direction upto someswar. In this section of its course the river is fed by streams coming down the eastern slopes of the high chain of hills in that Patti-Birchuwa (2568 metres), Gopal Kat (2763 metres), Bhat Kat (2774 metres) and Bhura Pirmath on the east forms the intershed between Kosi and Gomti, a tributary of the river Sarju. From its junctions with soal upto Kairna, it forms the boundary between the districts of Almora and Nainital from Khairena, it flows north wards upto Bujan, then it takes a
north westerly course as far as Mohan, where it turns abruptly to the south east and then south to Ramnagar, where it enters the plains at an elevation of 366 metres above sea level. Between Kumaria and Ramnagar it is fed by numerous torrents with very steep beds in which the rain water runs with great velocity, occassionally causing great damage. The Kosi is a most erratic and treacherous river in its behaviour, which cause huge damage to cultivations on its bank and to the irrigation work (Neville, 1922).

The Kosi is the only river which has a very great effect on the agriculture of the hills, until the floods of 1800 A.D., the village along the Kosi had some of the finest irrigated lowlying canals in the hills, but they suffered greatly in that year from diluvian (Neville, 1922).

Pinder : The river rises in the Pindari glacier which lies between Nandakot and Nandadevi, at an elevation of 3684 metres above the sea-level, its course is generally toward south from the foot of the glaciers. At Dwali, it is joined by Kushini river, thence it bends to the south-west by Khati to Wachham where it receives on the right bank, the Sundardhunga on the same side. The rest of its course is in the district of Chamoli, where it meets the Alaknanda at Karnprayag and Ultimately the Ganga.

Gola : The Gola river rises on the southern slopes of the ridge to the south of Dal in Dalpat in Almora. Its course is southwards from its source to Khamsyany, then it turns westward upto a point where it receives a stream from Malwa-Tal. It then turns south for about 3 kilometres and then again towards north west. It receives on its right bank the Borakheri stream which takes the flow of Bhim Tal at Ranibagh receives Ballia which takes
the surplus of water of Sal Tal and Nainital. The river leaves the hills at Kathgodam and flows through Haldwani to the Terai and Join the Ramganga on its left banks. The river is largely utilized for irrigation. In times of flood, it becomes a violent and dangerous torrent, changing its channel through a wide bed (Neville, 1922).

2. Yamuna System

The river yamuna rises at Yamunotri glaciers in Uttarkashi district at an elevation of about 6320 metres, lying on the South-western slope of the Bandarpunch peak. The Yamuna covers about 1/2 of the western parts of Uttarkashi, a small western parts of Tehri-Garhwal and about 2/3rd western parts of Dehradun. Asan is an important river of the Dun valley as well as tributary of the Yamuna system. The Tons is the biggest tributary of the river Yamuna. The volume of water brought by this river becomes nearly doubles to that of the river Yamuna. The river Yamuna and the Tons separately cutting Mussoorie ranges in to deep valleys and meet together at Kalsi. The Giri, another important tributary of the river Yamuna comes farther north-west of the Tons, bringing water from south-east Himachal Pradesh, the Giri Joins the river Yamuna in Kirada Dun valleys.

3. The Kali River System

The Kali river system is depicted by the name of the river Kali, this is the most important river of this system. This river system covers the eastern portion of the Uttrakhand region, in which the river Kali flows for a distance of 195 kilometres from the point of origin to the point exist from this region. The river Kali which rises near the Indo-Nepal Tibet,
trijunction follows a south-westerly course and runs almost at right angle to the lower Himalayan and Siwalik ranges. The Kali system covers the district of Pithoragarh and the eastern parts of Almora & Nainital districts. The Kali system drains near about 1/4 portion of the region. It has two main head streams i.e. Khuti-Yankti and the Kalapani. The former is generally regarded as the true source of the Kali, The Kalapani is a collection of perennial springs while Khuti-Yankti takes its origin from the snowfield of Himadri, receiving water from the headwaters, the river Kali flows in a south-west direction upto jauljebi (120 kilometres away) where it is joined another tributary Goriganga. Another important tributary of Kali is Sarju, which brings a large amount of water and flowing 105 kilometres from the origin. The place where Sarju meets Kali is known as Pancheswar. The course from Romeswar to Pancheswar is about 20 kilometres. The full length of the Sarju river from its source to its confluence with Kali is estimated to be about 132 kilometres (Walton, 1910). The Kali (United stream) takes a south-eastern course from Pancheswar and about 16 kilometres. Further, down streams receives the largest river on its western bank, Further south, it receives the Ladhiya river which rises in Nainital District, its important affulents are the Ratiyagadh and Kuirala which join it near chaura in Talti-Rau and Pal-Belon respectively, Lower down the Ladhiya is joined by the Babkala river. With all these accessions, Kali becomes a great river before entering Nainital district at Barmer, Hence onward is marks the boundary between Nainital and the Kingdom of Nepal. It enters the plains at a heights of 243 metres above sea level. Hence further it is known as Sarda.
Climate

Uttarakhand experiences a wide range of climatic conditions. In the terai and bhabar tract adjoining the plains of western Uttar Pradesh, a typical tropical climate prevails. Sub-tropical climate conditions are found in the Siwalik hills, Dun valleys and upto an elevation of 800 metres in the lower Himalayas, temperate upto about 2,400 metres and sub-arctic and arctic at higher elevations. Thus while the mercury may rise to more than 40°C in the terai and bhabar tract, icy winds may be lashing the Nanda Devi Peak.

Most parts of Uttarakhand receive very heavy rainfall from the south-west monsoon from early July to the end of September. However the areas lying in the rainshadow of the main Himalayas, for example, the upper Darma valley, receive very little rain. Both the south-west and north-east monsoon systems of the Asian continental mass played vital role in the climatic and weather conditions of this hilly region. The south-west monsoons are gigantic land and sea breezes that blow across the Indian subcontinent each year from July to September. In May and June, western and central India and the adjoining parts of Pakistan are heated to atmospheric temperatures of over 42°C. This results in a low pressure belt in this area, there is a high pressure zone over the sea and as a result, winds begin to move in towards the heartland of the Indian sub-continent.

As the wind pass over the mass of water, they pickup moisture and becomes saturated with it. These winds, laden with moisture are known as the south-west monsoon. They strike the Himalayan mountain chain and...
cause heavy and widespread rains in most part of India. In winter, this cycle is reversed. There occurs a zone of high pressure over central Asia and a low pressure over the seas in the south. These winds are known as the north-east or winter monsoon. They cause rains in January and February in many parts of Kumaun, are not as heavy as those by the south-west monsoons. A fairly long and moderately severe winter is the chief characteristics of the climate of the region. However in the valleys and comparatively lower elevated areas in the region, tropical heat may be experienced during April to May and first half of June. Local population of the region, however divided the climatic year into three seasons.

1. **Purior Kharso : (Hot Weather Season)**
   **(From March to Mid-June)**

   The hot weather season commence from March when the temperature rises sharply resulting in a relative fall in pressure and humidity. The heat is intense, though less severe than that experienced in the Gangetic plain i.e. Zaid crops.

   This period can be divided into two parts i.e.

   a) Spring season (March-June)
   b) Hot summer season (May-June)

   By the month of March, temperature begin to rise rapidly everywhere and reaches its maximum in the month of May. In this month, mean monthly temperature recorded as 17.7°C and 16.1°C in Dehradun and Uttarkashi respectively (Fig. 1.6). From April, the heat further increases rapidly, while the air becomes dry. During spring season, the night in Tarai and Bhabar are tolerably cool, though day temperature is somewhat higher, Generally humidity is low with a marked clear sky.
Fig. 1.6
April records a further increase in temperature when the mean maximum temperature of Dehradun and Uttarkashi rises to 38.2°C and 35.4°C respectively. During May and June, the temperature continue to increase, though much less rapidly than in March and April until the south-west monsoon commences when the temperature is higher. In summer season, low valleys and foot-hill zones are very hot and hot days are experienced even upto 1600 metres above sea-level but the higher ridges are cool even in the hottest month. May is even more hot with a mean maximum temperature of 35.5°C and 35.0°C and mean minimum temperature of 16.5°C and 9.2°C in Dehradun and Uttarkashi respectively. Obviously, June is the hottest month of the year and mean monthly temperature of this month is recorded 29.3°C and 24.9°C at Dehradun and Uttarkashi.

2. Chaumas Or Baskat (The Rainy Season) (From Mid-June to October)

The season of general rains or the rainy season in Uttarakhand generally commence by the middle of June. The begining of rainy season being a complete change in the weather condition with the advent of rains, experiences heavy and prolonged rainfall i.e. Kharif crops. In this period, a diminished range of temperature is found throughout the year. The mean monthly temperature in mountaneous region in July is 26.9°C in Dehradun, and 24.2°C in Uttarkashi (Fig. 1.6). July and August have the smallest range of temperature and these months having higher commodity, receives 80 per cent of the annual rainfall from the south-west monsoon. The monsoon is weakened by September, though sky is not always clear. The rain is
received intermittently and due to low temperature, little change in humidity is observed. The distribution of temperature in the month of October shows a slight fluctuation. The temperature condition show that though, there is a definite increase in the mean maximum temperature in the month of October, the mean temperature is less than that of September. This is on account of decrease cloudiness and the influence of the mechanism of mountain and valley breezes. During this month, the velocity of wind is generally minimum due to little range in pressure.

3. **Hyund or Sheetkal (Cold Weather Season)**  
   *(From November to February)*

   By the end of October, the skies clear, rain stop and there is a further fall in temperature. Significantly the beginning of a cold weather season from November and last upto February. The season experience heavy and bracing, with only a moderate degree of variation between the day and night, snowfall is rare, though in exceptional year, it has been recorded even at on elevation of 900 metres (Walton, 1910).

   The cold is comfortable above 1600 metres except during the middle of day. By December the cold weather season fully set in. January is the coldest months recording a temperature of 13.8°C at Dehradun and 12.6°C at Uttarkashi. During the same month, *tarai* and *habhar* zone enjoys a breaching climate, while the mountaineous part is severe. Nights are usually heavy and clouds particularly in low lying areas and severe frost occasionally occur. Clouds often interfere in mild winter and some rain usually falls in this season, which on the higher elevation occur in the form of snow, occasionally the snow, falls down to 1600 metres but melt
rapidly below 1200 metres and it seldom stays long on sunny slopes. It may be seen from the Fig. 1.6, the mean minimum temperature in the month of November range from 6.3°C at Dehradun and 7.4°C at Uttarkashi, but the mean maximum temperature ranges between 22.1°C and 26.6°C for the same station. The month of December record a further decrease both in the mean maximum and minimum temperature. The mean minimum temperature ranges between 3.9°C and -4.2°C at Dehradun and Uttarkashi respectively. The lowest temperature is recorded in the month of January when the mean minimum temperature at Dehradun, and Uttarkashi is 1.7°C, and 1.0°C respectively. By February temperature begin to rise but still remain relatively low as compared to that of November. A significant climatic features of this season is the occurrence of frost as well as snowfall in the early hours of morning, which adversely effect crops like, Arhar, peas, gram and rapeseeds & mustard.

Rainfall Rhythm

The monsoon sets in towards the end of June and last till the later half of September, occasionally prolonging in to October (Mason, 1936). The period from October to about middle of November is regarded as the post-monsoon period and thereafter the winter season sets in lasting till about the middle of march followed by the summer or pre-monsoon season (middle of march to middle of June).

The rainfall generally increases in the valleys from south-west to north-east direction and decreases beyond the highest ranges while the plains of Uttar Pradesh receives 80 per cent of their annual rainfall during
the south-west monsoon from June to September. There are however, a few occasions in the monsoon season, when the rainfall in the plain districts may be lower but there are heavy rains in the hills causing floods in the river. In the outer Himalayas, rainfall is heavy, varying between 157.78 cm (Dehradun) and 169.73 cm (Nainital). Rainfall decreases beyond the outer Himalayas (Fig. 1.7).

July and August are generally rainiest months, accounting for about 50 to 60 per cent of the total rainfall. November is the least rainy months, sometimes October is also a fine as November. The month of October and November are characterised not only by clear skies and calms but also by a great range of temperature and heavy dews at nights (Walton, 1910). With the exception of monsoon, most of the rain during the remaining parts of the year occurs in winter and early summer, in association with the western disturbances across North India. During this period as much as 30 per cent of the rainfall occurs over these hilly districts.

It may be seen from the table 1.1 that the average annual rainfall received in the months from June to September varies from 63.00 per cent to 88.87 per cent of the total average rainfall in the districts of Uttarakhand.

The distribution of rainfall in the Uttarakhand follows a contrast pattern. Guided by relief the Bay of Bengal currents of south-west monsoon after striking against Himalayas moves westward close to Himalaya ranges, therefore the region receives heavy rainfall from these
Table 1.1

Seasonal Quinquennial Average Rainfall and its Percentage from Total Average Rainfall district of Uttarakhand

(Rainfall in cm.)

<table>
<thead>
<tr>
<th>District</th>
<th>Total Average Rainfall</th>
<th>June-September</th>
<th>% of the Total</th>
<th>October-December</th>
<th>% of the Total</th>
<th>January-February</th>
<th>% of the Total</th>
<th>March-April</th>
<th>% of the Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nainital</td>
<td>169.73</td>
<td>150.84</td>
<td>88.87</td>
<td>3.33</td>
<td>1.97</td>
<td>5.32</td>
<td>3.13</td>
<td>10.24</td>
<td>6.03</td>
</tr>
<tr>
<td>Almora</td>
<td>119.09</td>
<td>87.88</td>
<td>73.80</td>
<td>7.32</td>
<td>6.14</td>
<td>8.94</td>
<td>7.50</td>
<td>14.95</td>
<td>12.56</td>
</tr>
<tr>
<td>Pithoragarh</td>
<td>151.40</td>
<td>107.94</td>
<td>71.30</td>
<td>8.68</td>
<td>5.73</td>
<td>8.80</td>
<td>5.81</td>
<td>25.98</td>
<td>17.16</td>
</tr>
<tr>
<td>Chamoli</td>
<td>152.75</td>
<td>105.03</td>
<td>68.76</td>
<td>10.42</td>
<td>6.82</td>
<td>9.68</td>
<td>6.33</td>
<td>27.63</td>
<td>18.09</td>
</tr>
<tr>
<td>Uttarkashi</td>
<td>115.32</td>
<td>72.65</td>
<td>63.00</td>
<td>8.43</td>
<td>7.31</td>
<td>10.92</td>
<td>9.47</td>
<td>23.32</td>
<td>20.22</td>
</tr>
<tr>
<td>Tehri-Garhwal</td>
<td>130.36</td>
<td>100.51</td>
<td>77.10</td>
<td>7.26</td>
<td>5.57</td>
<td>10.60</td>
<td>8.13</td>
<td>11.99</td>
<td>9.22</td>
</tr>
<tr>
<td>Pauri-Gahrwal</td>
<td>109.87</td>
<td>79.14</td>
<td>72.03</td>
<td>5.16</td>
<td>4.70</td>
<td>6.91</td>
<td>6.29</td>
<td>18.66</td>
<td>16.98</td>
</tr>
<tr>
<td>Dehradun</td>
<td>157.78</td>
<td>130.76</td>
<td>82.87</td>
<td>8.74</td>
<td>5.55</td>
<td>7.42</td>
<td>4.70</td>
<td>10.86</td>
<td>6.88</td>
</tr>
</tbody>
</table>

Source: Board of Revenue, Lucknow, Uttar Pradesh.
UTTARAKHAND
MONTHLY QUINQUENNIAL AVERAGE RAINFALL.
currents in the south-eastern, north-eastern, south-western and north central part comprising the district of Nainital, Dehradun, Chamoli and Pithoragarh where the average rainfall is 169.73 cm, 157.78 cm, 152.75 cm and 151.40 cm respectively. Similarly the average rainfall in Tehri Garhwal, Almora, Uttarkashi and Pauri Garhwal is 130.36 cm, 119.09 cm, 115.32 cm, and 109.87 cm respectively.

**Pressure**: Like temperature, pressure is also inversely proportional to altitude, decreasing with the increase of height. The pressure conditions, according to altitudes, are given below" (Kendrew, 1949).

### Table 1.2

<table>
<thead>
<tr>
<th>Height from sea level in metres</th>
<th>Pressure in millibar (mb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00 sea level</td>
<td>1013</td>
</tr>
<tr>
<td>609.60 or (2000 feet)</td>
<td>942</td>
</tr>
<tr>
<td>1219.20 or (4000 feet)</td>
<td>875</td>
</tr>
<tr>
<td>1828.80 or (6000 feet)</td>
<td>812</td>
</tr>
<tr>
<td>2438.40 or (8000 feet)</td>
<td>753</td>
</tr>
<tr>
<td>3048.00 or (10,000 feet)</td>
<td>697</td>
</tr>
<tr>
<td>3657.60 or (12,000 feet)</td>
<td>465</td>
</tr>
<tr>
<td>4267.20 or (14000 feet)</td>
<td>301</td>
</tr>
</tbody>
</table>

**Humidity**: Summer (March to May) is the driest part of the year, with relative humidity ranges between 30 to 60 percent. During monsoon season (June to September), the humidity attains a value of about 70 to 90 percent, while it remains between 50 to 60 percent during the remaining parts of the year.
Clouds: In this part of the Himalayas wet days with the exceptions of monsoon are extremely rare. In the monsoon months of July to September, skies are generally heavily clouded. Heavy clouding also persists in short spells during winter months when the district is affected by western disturbances.

Winds: Winds are generally light with 3 to 4 kilometres per hour in the valleys and 5 to 8 kilometres per hour at local elevation of 2000 metres, increasing further with higher altitudes. In the wake of western disturbances and in associated with thunder storm, the winds may become quite strong. Katabatic winds may also be experienced during night as a result of local effects produced by nature of terrain.

Climatic Zones

Convective activity is essential for the occurrence of thunderstorm, with the advance of the summer the activity becomes pronounced due to ground heating. Thunderstorm occurs throughout the year. Frequency being least in November and December and generally greatest during the May and September. During winter and pre-monsoon months thunderstorm are sometimes accompanied by hail. Dust storms are rare and occur, if at all, in the valleys in summer. Hill fog is common during the monsoon months. Fog may also occur in association with western disturbances. In the valleys, morning fog may occur frequently in winter. Due to its complicated relief the area has been divided into micro-climatic region by Kausic S.D. The micro-climatic conditions usually differ from valley to valley and locality to locality, according to the i) Direction of
the ridge, ii) degree of slope, iii) Sunny or shady aspect of slope; iv) Intensity of forest cover and v) nearness to glaciers. The region can be divided into seven broad climatic zones, primarily based on altitude.

i) **Subtropical Zone (300-900 metres)**: This zone covers the whole of Bhabar and parts of the siwalik over the southern slope of the outer Himalaya. The mean annual temperature varies between 17°C to 24°C. The rain comes mostly from the summer monsoons, the annual figures ranging between 157 to 170 cm. About 85 per cent of the annual precipitation occurs in four months from June to September, winter depressions give about 12 to 25 cm of rain from the beginning of December to April. In May there is a little convective precipitation, about 3 cm in the whole months.

ii) **Warm Temperature Zone (900-1800 metres)**: The mean annual temperature varies between 13.9°C and 18.9°C in this zone. Summer season begins from the end of April. In May and June the temperature varies between 26.7°C and 32.2°C in the day time. In the sunshine, the temperatures are 12°C to 16°C higher than those under shade. The night experience a fall of 13°C to 17°C. In higher localities two or three nights even in May, experience a snowfall from the western depression on the right tops.

Local temperatures are affected by the forest on the ridges and slopes of the spurs. The temperatures of the forested ridges and valleys bottom differ by 5°C to 12°C even on the same slope. In winter snow descends to about 1370 metres, However, it melts more rapidly on sunnier
slopes. The slopes are clear by snow by the beginning of June. Monsoon commence towards the end of June and ceases by the middle of September. The heaviest precipitation is experienced along the outer ridges, which form a barriers to check and exhaust the force of the monsoon. Heaviest rainfall occurs between June 22 and September 21. It is accompanied by moist and thunder. The streamlets and rivulets swell in floods.

Winter depression cause snowfall on seven or eight day in each of the three months from January to March. Average number of snowfall days is four in April and two in May. The amount of winter rain is also controlled by local topography. The months of April and May are rather marked by thunder and occasional hailstorms at all elevation. In May and first half of June, before the break of the monsoon, convectional rain occurs in the afternoon, in small amounts (12 to 25 cm) practically every 3rd or 4th day.

iii) Cool temperate zone (1800-2400 metres) : In this zone, the mean annual temperature ranges between 10°C to 13.3°C, rising to 17.2°C to 21.1°C in the warmest month and falling to 6.1°C to 2.9°C in January. In May and June, the daily range of temperature is 15°C to 20°C due to radiation in the night and dry air. From July onwards, the dialy range decreases till March, when it again begins to increase. The rainfall from summer monsoon varies between 125 cm to 150 cm, according to the local topography, winter rainfall from the western depressions, mostly in the form of snowfall is 25 to 30 cm. The full force of the monsoon is felt in August, which has heavier rainfall than July in all the climatic zones of
Uttarakhand, irrespective of altitudes. Monsoon generally get exhausted by mid-September. In November wet days are extremely rare and the mountains standout for the greater part of the month clear of cloud.

iv) Cold Zone (2400-3000 metres): The mean annual temperature of this zone ranges between 4.4°C to 10°C. there prevails a large cold winter of more than 5 months with temperatures below 6.1°C. The daily range of temperatures in June and July is observed to be more than 25°C. This zone experiences much lesser amount of summer rainfall than any of the southern zones. Before reaching the great Himalayan zone, the monsoon have to cross the Dhaula Dhar range, which checks their advance, only some clouds are able to cross this range and further the main ridge. Therefore there are marked differences in the amount of rainfall in the front and rear of this main range. From June to September, the rainfall ranges between 37 cm to 50 cm in the frontal zone and 20 to 25 cm in the rear. Winter depressions cause 3 to 5 metres of snowfall from November to May and sometimes snowfalls continue upto the mid of June.

v) Alpine Zone (3000-4000 metres): In this zone, the temperature for 7 months in the year remains below 6.1°C and in this months of January it falls below -6°C, springs, summer and Autumn occur only for five months i.e. from May to September, but snowfall occur even in June. Night temperatures even during the summer remains below 4.4°C. The summer rains are not only monsoonal but also convectional. The effect of great snow ranges is two fold. Acting directly on the air in contact with them they cool it and make it sink to the valleys are drawn up and dynamically expanded so that if moisture is present in sufficient quantity, rain is
deposited. In April and May, showers occur nearly every day in these parts. After rainfall, the temperature falls usually below 4°C and it becomes extremely cold even in July. Snow melts in this zone between June and September. From November to mid May the zone remains under snow ice. In this zone, the diurnal and nocturnal winds have reverse directions. In the day time, winds blow up the valleys and in the night they blow down the valley.

vi) Glacial and Perpetually Frozen Zone: This area is limited to the altitudes 4000 meters and above. In this zone, the temperatures remains below zero for ten months and between 2.2°C and 3.9°C for two months of summer. Snow melts during monsoon in July and August. Here the alpive forests undergo a gradual transition through xerophytic bush land to the Alpine pastures (bugyab). Sometimes alpine forests may be seen upto about 4200 metres, but above 4,800 metres, the landscape is a cold desert with no vegetation, wide variations in the amount of rainfall are observed depending upon the location and altitude of the recording station. Stations in the interior in general experience lower rainfall than the station on the edge of the area. About 90 per cent of the rain fall is recorded in the four months from June to September.

Soils

Soil is the natural body derive from the parent materials. It is said that soil is the mother of agriculture. Therefore, all plant kingdoms directly or indirectly depend on the soil. As a matter of fact the Human civilization is depend on the soil for its well being. This is true for
Uttarakhand as well as all parts of the country (Negi, 1975). It is very difficult to give classification of soils of Uttarakhand so far no authentic soil survey has been carried out for this region. There is wide variation in soil types. These soils differ from valley to valley, slope to slope and even on the same slope from place to place, the writer could however obtain some information regarding soils from settlement reports and from some studies by soil scientist. The land classification in Uttarakhand is based on altitude and irrigation facilities. According to Pant, the quality of soil is a minor factor in determine the hill cultivation (Pant, 1935). Based on this principle, the Agricultural land of Uttarakhand can be divided into the following three categories:

1. Talaon or irrigated land
2. Upraon or unirrigated land
3. Katil land

**Talaon Land**: These are found near rivers or perennial streams in the high land valleys. The soil is usually composed of fine alluvium and deposited by the rivers. These are two types

a) **Sera**: These are first class irrigated lands with perennial supply of water and often lying on the river bed. These fields are used for high grade rice production. The best seras are situated in Bamsali near Ranikhet, Mandel in Bageshwar and Khasporja basin near Pithoragarh.

b) **Pancher**: These are second class of this category and are less fertile, being composed of coarse detritus. These lands are capable of easy irrigation, especially during the rain, but in dry years, they are difficult to be irrigate and are no better than upraon.
2. Upraon Land: These are permanently terraced and comparatively dry. They always depend upon the monsoon for water supply. Usually the upraon fields possess the following characteristics. They are situated at a high level, are unirrigated and are sown with dry crops. The value of the upraon land depend upon such factors as the moisture retention capacity, accessibility of the slope and the position with reference to the aspect of the hills. If these factors are favourable, the uproar will be regarded as a better class land and is termed Talliya. This is generally occupy an intermediate position between the talaon and the upraon lands.

3. Katil Land: These Katil, khill, Irjan or Kalabanga are the names applied to unterraced cultivation on virgin soils. The hill tops are cleared and brought under cultivation after the shrubs have been burnt. They are generally left fallow by years. After sometimes, they are finally brought under terraced cultivations. In the Bhabar zone, the soil is mainly alluvium deposits on a mass of boulders and gravel. In Terai and Kashipur it resembles the soil of the plains further south. The upper portion of the Terai, the soil is dark consistant loam, but the east, it is light. The soils of the Uttarakhahand have developed from rocks with biotic schists and phyllite material under a cool and moist climate with rainfall extending to more than 150 cms. The soils are shallow, gravelly impregnated with unweathered fragments of stone with parent rocks occuring within a few centimetres at elevated spot to about 2 metres in valleys or depressions. Here generally the soils are not calcareous, and neutral to slightly acidic in reaction. Moderately acidic soils are only met with or higher elevation where rainfall is high strong enough to leach down the bases from the soil minerals under temperate climatic conditions.
Altitude is the main factor in determining the productivity of soils of Uttarakhand. The northern slopes in comparison to southern slopes are usually less denuded. So in the northern slopes, the task of cultivation is easier due to thicker soils than the southern slopes where the soil is granular. Uttarakhand has a wide variety of soil. The parameters listed below have been used to delineate the soils of this region into various types.

a) Structural, textural and chemical composition of the soil.
b) Soil fertility
c) Geographical distribution and extent
d) Soil horizons and their composition

The important soil types of Uttarakhand have been discussed below (Fig. 1.8):

1) Tarai soils
2) Bhabar soils
3) Gray-Brown forest soils
4) Podzolic soils
5) Mountain Medow soils
6) Skeletal soil
7) Red sandy-loam soils
8) Snow and snow field

1. Tarai Soils: Away from terraced and unterraced soils of the hills, a good amount of land lies in tarai. In 1948, a large tract of forests was cleared for reclamation and colonisation in the Nainital Tarai. In 1955, a soil survey was made and tarai soils were divided into fine textural cum calcimorphic soil associations.
UTTARAKHAND SOILS

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- TARAI SOILS
- BHABAR SOILS
- GRAY BROWN FOREST SOILS
- PODZOLIC SOILS
- MOUNTAIN MEADOW SOILS
- SNOW FIELD
- SKEL TAL SOILS


FIG. 1.8
i) Matkota clay loam:

Mildly calcareous, it is a textural clayey loam tending to be silty clay loam. It is rich in organic matter and the colour is dark grey at surface. The next layer is of light yellowish brown material with a silty loam texture, the organic matter is low, the water holding capacity is high because the sand content (fine and coarse) is low. It is poorly drained and is mildly alkaline, deficient in phosphoric acid but rich in nitrogen.

ii) Matkota Loam - High calcareous:

These are highly calcareous throughout the depths. The depth of upper layer is 23 cms. colour is dark grey, brown and rich in organic matter. The next layer is grey brown with comparatively contain less organic matter. The coarse sand content is high. The organic carbon and total nitrogen content are high but diminishes in subsoil. Total phosphorus is high but phosphoric acid is less, the soils are mildly alkaline.

iii) Matkota Loam - Slightly calcareous:

The soil is poor in lime content due to its comparatively elevated situation. Loam to silty loam in texture and grey brown in colour at surface. The depth of this layer is 60 cms. with adequate quantity of organic matter. The next layer is 80 cms deep with pale brown blue colour. The texture of middle and the lower layer is loam and silty clay loam. There are coarse sand particles. The nutrients status is poor. The soil is mildly alkaline which contains low phosphoric acid.
iv) Matkota Loam - Non-calcareous

The texture is loam to sandy loam at surface. The colour of the soil is greyish brown, darker in shade in lower layers. The intermediate bottom layers are dark brown and yellowish brown. These are not good soils for crops without irrigation, because the water retaining capacity is poor. The plant nutrients is average, organic matter is slightly high in the case with total nitrogen. The available phosphoric content are medium. The texture of the soil is light.

v) Matkota sandy loam:

This soil is dark brown to reddish brown in colour and the texture is sandy loam to sandy. The whole profile is sandy in nature. It is not a good soil. The percolation is excessive and therefore suffers from droughty conditions. The soil has a very low water holding capacity. The nutritional status of the soil is very poor. These soils have medium to high contents of available phosphates. These soils are not fit for agricultural crops.

2. Bhabar Soils: These soils occur in the form of a narrow belt in the foothill region of Garhwal Himalayas. These soils have developed under a sub-humid and moist climate which becomes dry during summer months.

These soils are found in the form of small pebbles, coarse gravels, detritus and mechanically transported from adjoining hills. The texture of soil is gravelly fine, silly, and invariably calcareous in nature. The soils are of dark grey to black colour and a moderately alkaline in reaction. They are rich in plant nutrients but inspite of this, they fail to
support normal cultivation, especially due to the scarcity of moisture due to rapid percolation and underground drainage. This excessive percolation results from the presence of the boulder substratum below the surface, which drains out all the water underground and which ultimately emerges into the adjoining tarai tracts.

The soils supports only inferior crops of shorter maturity whose water requirements are not high. Lighter dressing of fertilizers are better manuring practices for these soils.

3. Grey Brown Forest Soil

These soils are found generally in sub-tropical regions between 610 to 915 metres. These soils, generally support deciduous forests. These soils are rich in plant food because in this region both rainfall and temperature are higher resulting in this vegetation growth. Decaying leaves of the trees play an important role in soil formation of organic matter. These soil supports a thick and dense vegetation which is not only responsible for the comparatively high fertility but also prevents soils from being washed away during torrential rain. In cultivated areas some layers of the soils are washed away every years. Generally this is compensated by a new soil formation. Madua (Ragi), paddy, wheat and barley are the dominant crops of this soils groups, where pH value ranges between 6.0 to 6.5. The main properties of different horizons of forest soils are given below:
<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth (cms)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-10</td>
<td>Dark brown to brown, sandy loam, fine subangular blocky, fine roots abundant</td>
</tr>
<tr>
<td>A₁</td>
<td>10-30</td>
<td>Yellowish red to reddish yellow, clay loam, subangular blocky, roots abundant</td>
</tr>
<tr>
<td>B</td>
<td>30-45</td>
<td>Yellowish red to reddish yellow, clay loam, subangular blocky, thin clay skin, occasional quartzite, gravels, slightly sticky but nonplastic when wet, roots abundant.</td>
</tr>
<tr>
<td>B₁</td>
<td>45-60</td>
<td>Yellowish red to reddish yellow, clay loam, thin clay skin, coarse root abundant</td>
</tr>
<tr>
<td>B₂</td>
<td>60-90</td>
<td>Yellowish red to reddish yellow, clay moderates to abundant.</td>
</tr>
<tr>
<td>B₃</td>
<td>90-120</td>
<td>Yellowish red to reddish yellow, clay moderate to abundant</td>
</tr>
<tr>
<td>C</td>
<td>Below 120</td>
<td>Yellowish red to reddish yellow, gravelly clay, subangular blocky, slightly sticky when wet.</td>
</tr>
</tbody>
</table>

4. Podzolic Soils: Podzolic soils are found in the cool temperate zone at a height of 916 to 1830 metres. These are leached and acid soils with pH value below 6 with low fertility. This type of soil is generally suitable for coniferous forests, fruits and potato cultivation. The main properties of different horizons of podzolic soils are given below.

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depths (cms)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-10</td>
<td>Black, sandy to clayey loam, rich in under composed organic matter</td>
</tr>
<tr>
<td>A₁</td>
<td>10-30</td>
<td>Black, sandy to clayey loam, loose, rich in humus, acidic</td>
</tr>
<tr>
<td>B</td>
<td>30-50</td>
<td>Black, though of a relatively higher shade, sandy to clay loam, acidic</td>
</tr>
</tbody>
</table>
B₁  50-70  Brownish black, sandy to clay loam, more compact than the other horizons acidic.

B₂  70-90  Brownish, sandy loam, large pockets of parental materials may be found in this horizon, acidic

C      Below 90  Brownish, parental rocks may be found in the lower layers.

5. Mountain Medow Soils: This type is usually met near streams cool and low lying shady places, due to very high ground water level, the soil always remain moist and the organic matter is not completely decomposed into humus. The morphology of typical soil type is given below.

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth (cms)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-15</td>
<td>Darkgrey, granular with brown spots, sandy loam, micaceous, more dark when wet</td>
</tr>
<tr>
<td>A₁</td>
<td>15-35</td>
<td>Granular, dark grey, sandy loam, darker than A, bluish and brown spots at dirty brown spots round mica piece. This horizon contains mica stores.</td>
</tr>
<tr>
<td>B+C</td>
<td>35-45</td>
<td>Yellowish micaceous, sandy soils, brownish yellow when wet.</td>
</tr>
</tbody>
</table>

6. Skeletal soils: These shallow skeletal soils have their genesis over sloping land of high plateaux and small valleys. They are formed from variety of parent materials. This lithic and light textured soils are rich in humus and have mobile form of sesquioxides. The other peculiarity of these soils is an altered "B" horizon. These soils are found in Uttarkashi, Chamoli and Pithoragarh. These soils are suitable for wildlife, forestry and grazing.
7. Red Sandy loam soils: This soil type is usually sandy in nature and mostly found along slopes of the hills and ridges. It occurs at places which receive maximum solar radiation and is dry due to their situation on slope. The analysis and morphology of a typical red loam, soil profile is as follows:

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth (cms)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-15</td>
<td>Brownish grey, slightly organic loamy soil with plenty of undecomposed orgnaic matter, darkens slightly in colour, when wet</td>
</tr>
<tr>
<td>B</td>
<td>15-50</td>
<td>Loamy, reddish brown soil containing little humus, deep red brown when wet</td>
</tr>
<tr>
<td></td>
<td>50-115</td>
<td>Loamy, sand, yellowish, brown soil, more yellow when wet</td>
</tr>
<tr>
<td>C</td>
<td>115-150</td>
<td>Loamy, ash grey, micaceous, soil of hydrogenic nature, more green when wet.</td>
</tr>
</tbody>
</table>

8. Snow and snow field: The perpetual snow fields are not actually soils, but barren areas of the Himalayas, the present glacier zone in the Himalayas lies approximately between 3350 metres and 7000 metres above mean sea level and found in districts of Pithoragarh, Chamoli and Uttarkashi.

Soil Erosion and Soil Conservation

The soils of Uttarakhand have very thin alluvium, as described above and hence are highly susceptible to sheet erosion and gully erosion. Landslides are common here due to heavy rainfall.

Kumaun is subjected to widespread and extensive soil erosion, But the problem has not attracted much notice and adequate measures to
combat it are tacking. In the lower hills excessive erosion has led to increased setting of the rivers and ruining the agriculture of the hill areas. One major factor responsible for this state of affairs is the upsetting of the balance of nature, especially removal of the forests and overgrazing, where the natural vegetation has not been tempered with, there is little erosion, but in areas where the vegetal cover has been removed and the rainfalls occurred on bare grounds, extensive erosion is caused. Similarly the result of grazing and lopping is the disappearance of the forest and pastures and wholesale erosion of the soil (Hamilton, 1953). These methods play a three-fold role in soil conservation namely.

a) by reducing and controlling the surface runoff.
b) by enabling the moisture to be retained in the soil for a longer period
c) by protecting the soil from erosion etc.

For the conservation of soil, crops production and following slope is most important and have been suggested following indicator for Uttarakhand (Roychaudhari).

1. The land with slope gradient not exceeding 15 feet per mile is fit for agricultural purposes without any particular conservation method.
2. The land with a slope gradient of 15 to 50 feet per mile is fit for cultivation only after the application of some soil conservation measures.
3. The land with a gradient between 50 to 100 feet per mile is not fit for Agricultural purposes, but can be used as pastures with control
grazing. It can be used for agriculture only after very intensive soil conservation measures have been taken.

4. The land with a gradient of over 200 feet per mile and above is only fit for afforestation purposes.

5. Unclassified slopes, such as ravines etc. should remain permanently under forests and never to be allowed to be grazed.

Natural Vegetation

Forest plays an important role in economy of our country. A major part of the Uttarakhand is covered with forest (about more than 60 per cent area) and also constitute enormous wealths of the region. There are four main factors which determine the broad features of vegetation of the region.

i) Climate
ii) Soils
iii) Relief and
iv) Biotic factors

Geonomically, the natural vegetation of the region can be divided into three broad groups (Mathur, 1980).

i) Broad leaves forests
ii) Coniferous forests
iii) Scrub and other similar flora

Hooker (1909) and Champian (1909) have presented a very comprehensive material on the vegetation types of Himalayas for the first time.
Champian and Seth (1968) have studied the complicated structure of the region and divided the Himalayan region into six vegetation belt according to height above sea level.

1. Upto 3000 feet - Tropical moist deciduous forest (Sal trees)
2. 3000-6000 feet - Sub-tropical pine trees (often upto 7500 ft on the southern slope)
3. 6000-11,000 feet - Moist temperate: mainly conifers, some oak trees
4. 6500-8000 feet - Dry temperate, often conifers, (mainly in drier inner valleys)
5. 9500-11500 feet - Alpine: dense, small crooked trees, fern and rhododendrons
6. Above 11500 feet - Alpine, dry shrubs

Rautela (1963) classified the natural vegetation of Uttarakhand into four types, according to climate and altitude of the region (Fig. 1.9):

1. Sub-tropical forest zone (300-1200 meter)
2. Temperate forest zone (1200-1800 meter)
3. Sub-Alpine forest zone (1800-3000 meter)
4. The Alpine zone forest zone (3000-4500 meter)

1. Sub-tropical Forest Zone

This zone is characterized by greater rainfall (170 cm or more annually) with fairly warm temperature. The climatic condition of this zone make the soil rich with humus for the growth of vegetation. This zone
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NATURAL VEGETATION

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\[\text{SUB TROPICAL}\]

\[\text{TEMPERATE}\]

\[\text{SUB ALPINE}\]

\[\text{ALPINE}\]

\[\text{SNOW CAPEO AREA WITH GLACIER}\]

Source: National Atlas Maps, Forest Survey of India

FIG.1.9
extending from north-west to south-east, almost covers the sub-Himalayan tract of the region. It occurs upto height of 750 metres towards northern slope and upto the height of 1200 metres towards the southern slope. Sal (Shera robusta) is the most important species of this zone, it is found upto the height of 11,525 metres, it attains a height of usually 25 metres and sometimes 35 metres. These trees (sub-deciduous forest) shed their leaves with the beginning of dry season. Sal trees are of great commercial value as they fulfill the needs of households purpose. Sal trees are quite prominent along the coarse of rivers. Besides, sal, the other species are also found in this zone are Haldu (Adina cordifolia), Dhuari (larger stromia purviflora), Sain (Terminalia lomentosa) and Tun (Cedrelaloona), Bhyunal is another important tree of this region which usually grows in the valleys and lower hillslopes. Mango, pipal and Banyan trees of plains are also found on the lower slopes of the hills. In the low and high rainfall region, dry deciduous and moist deciduous trees appear. The floristic composition in dry is "angle marmelos", dry bamboo break (Dindrocalamus strictus) and in the moist forest is Kamja (Halentela integrifolia), Kuri (Nyelanth esarbottrists), Semal (Samila malabasica), Amaltas and Dhundi.

2. Temperate Forest Zone

The temperate forests are found between sub-tropical and sub-Alpine zone from 1500 metres to 1800 metres. The temperate forest appears upto 1900 metres on the southern slopes and upto 1800 metres towards the northern slopes (Osmaston, 1987). The dominant tree of this zone is "chir" which is light green in colour and forms a open forests of 20-30 metres height. There are a few shrubs and undergrowth grass which
appear during the monsoon. The chir produces useful timber for furniture, boxes, building and railways sleepers. Resin is extracted from these forest from which tarpentine oil is obtained. The valleys of Gori and the Tons rivers are full of chir trees. They are also found in the Yamuna, Bhagirathi, and Alaknanda river valleys. Extensive forest appears around Ranikhet and Almora.

3. Sub-Alpine Forest Zone:

This vegetation starts from 1800 metres and continues up to 3000 metres. The forest of this zone covers a considerable area of the region. It can be divided into two parts

i) The lower sub-Alpine zone

ii) The higher sub-Alpine zone

The lower sub-Alpine zone is dominated by oak trees. There are various varieties of oak trees are found in this zone such as Banj oak (Quercus income), Maru oak (Quercus dilata) and Bruns oak (Quercus semicarpifolia) (Singh, 1993). Banoak is used for making agricultural implements due to its hardened wood, it is also used as fuel.

In the higher Alpine zone, the varieties of trees differ according to the elevations as follows

i) Silver fir (Albies pundrow) | 1900-3100 metres

ii) Blue pine (Pinies excelsa) | 2950-3600 metres

iii) Sprunce (Picea morinda) | 2000-3000 metres

iv) Birch (Betula utilis) | 2400-3050 metres

v) Cypress (Cupressus torulesa) | 2400-3050 metres

vi) Deodar (Cedrus deodara)
Cyprus is the most dominant trees found at the height of 2000 to 3000 metres. Its fine durable wood is commonly used in construction and also as timber and railway sleeper (Spate, 1967). The tree attains a height of 20 meters. Blue pine, silver fir, and spruce may be seen from the height of 1900 metres to 3000 metres. Blue pine frequently grow in poor soil and an steep slopes. Birch is found from 2950 metres to 3600 metres in Bhagirathi valley. Its bark is used as substitute for paper. Some undergrowth and Alpine herbs are also found, walnut and chestnut also grows in the Bhagirathi, Alaknanda, and Pindar valleys. Thin Bamboo called Ningola are found in the area specially around Almora, all types of conifers provide huge quantity of wood for different purposes.

4. The Alpine Forest Zone

The birch of higher sub-Alpine zone continues to grow in the Alpine zone also. The vegetation makes the upper most unit of the tree line i.e. 4200 metres and sometimes may be seen in small patches even on higher elevation. Above this line, there exists temperate grassland upto the snowline (4500 metres). The environmental aspects generally gives way to shrubs in the northern part and grasses in the southern part. Alpine grasses provide highly nutritive grazing grasses. Some medicinal and plenty of Gaggl a scented shrub grow in Pindari and NIlkanth valleys. It is collected to produce incense. There are a number of varieties of medicinal shrubs available in higher Himalayas, which are get to be explored and put to use. Mamiri a kind of root, is also collected in Uttarakhand, it is used in making surma, an ash like material applied in the eyes. Ratan-Jyot another shrub is collected in Yamunotri region. There is a large variety of flowers
in alpine meadows as in the valley of flowers. A good number of herbs
found in the region are getiana, prunula, saifraga, geranium and astem.
Pulsatillum, aconitum are important medicinal plants.

**Fauna and Flora**

Wild animals are integral part of natural heritage, some of our
best known animals are threatened with extinction. Earlier the killing of
wild animal was regarded as a sports. Flora has usually associated
with fauna but human interference either directly or indirectly through
deforestation, hunting, recreation and development has caused a great
depletion of wild life, creating ecological imbalances on the whole.
Attempts have been made by the government to preserve and enrich the
various species by maintaining their natural habit. A number of parks and
sanctuaries have been established and maintained e.g. Kedarnath sanctuary,
valley of Flowers National Park, Corbett National Park (extensive in area
and has a wide valley of fauna), Govind wildlife sanctuary, Nanda-Devi
National Park and Rajaji National Park (Singh, 1983). The representative
of these regions are Elephants, Tigers, Panthers, Slath bear, Swam deer,
Spotted deer, hogdeer, four horn antelope and many colourful birds. In the
Alpine zone, there are some rarest animal found in India, Manal Pheasant,
(one of the most beautiful bird) brown beer, snow leopard, musk deer, and
thar are rare animals, lake in Nainital district, the Ramganga and Kosi
rivers invite Mahasheer anglers.
References


