

# IMPACT OF MICRO-CLIMATIC VARIATION ON FLORAL DIVERSITY OF GARHWAL HIMALAYA ALONG ALTITUDINAL GRADIENTS

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## ABSTRACT

*The present investigation on the Altitudinal plant diversity of Garhwal Himalaya (North-West) was carried out to obtain the Vegetational zones and altitude of the Garhwal Himalaya and study the climatic effect on their distribution. For study purpose the Garhwal Himalaya is mainly divisible into three major zones on the basis of the type of vegetation and animal distribution Viz, Submontane, Montane, and Alpine zone.*

*The survey represents the salient features of plants. There are several elements which effect the distribution of floral, such as temperature, humidity, and rainfall etc. With respect to altitudinal range, topography, edaphic or climatic features, phytosocial affinities, faces, location etc, mountainous plants have specific preference. In addition to above impacts of biotic or climatic pressures on plant communities, composition, distribution, & change of habitat (Soil & Climate) are obviously pronounced.*

*Occasional aberration in seraphic or climatic cycles such as high wind impacts, thunder storms, cloud burst, continuous drought, floods, excessive hail storms, fog & frost, landslides change in the course of rivers and rivulets, silting of rivers etc influence the distribution of plant vegetation to great extent. The present study reveals that temperature is the main factors, which effect the distribution of plants community in Garhwal Himalaya.*

**Key Words:** Diversity, Flora, temperature, altitudinal variation, High altitude, Climate.

## INTRODUCTION

The temperature and altitudinal gradient induce wide diversity in plant in Uttarakhand. Rich biodiversity is essential for the stability and resilience of mountain ecosystem. Plant diversity is unique in Uttarakhand. One of the most beautiful flowers, the Braham Kamal is the state flower of Uttarakhand. Man has been interested in biodiversity since the dawn of civilization. He used the plant for food and clothing and used the tree and greenish area for the shelter.

In India the idea of protection and preservation of biodiversity has been and integral part of religion and culture since very ancient time. The term and the concept biodiversity have been remarkable events in recent culture evolution. Ten years ago the word did not exists. Today it is one of the most commonly used expression in the biological science and household word. The term biodiversity presence of large number of species of plants and animals.

The diversified physico-climatic condition obtaining in the foot hills region of the Himalaya reflected in a variety of natural vegetation including different types of grass and shrubs and numerous species of wildlife. Diversity of surface relief resulting in to sharp variations in temperature and rain fall mainly controls and conditions the growth, distribution, and density of forest cover in the entire region. Temperature, which is regulated modified by the altitudinal variation particularly in outer Himalayan ranges of the region, is primarily responsible for determining the type pattern and spatial distribution

of vegetation and habitat type through out the area. As one move up form the low lying Tarai belt to Bhabar tract and similar range in the north. Different types of vegetation are generally found. The status of floral diversity in Uttarakhand at Himalaya is much better then other regions of India. But it becomes slowly disappearing due to the human encroachment and over exploitation of plant, animal and other natural resources.

## **MATERIAL AND METHODS**

### **PHYSIOGRAPHY OF GARHWAL HIMALAYA**

The Garhwal Himalaya lies between the latitude 29° 26'-31° 28'N and longitude 77° 4a'-80° 6'E with a total area of about 30,000km. The tom separates it from Himanchal Pradesh in the west and the district boundaries of Nanital Almora and Pithoragarh separate it from the Kumaun in east. Starting from the foothills in South, the region extends up to snow clad peaks making the indo-Tibetan boundary politically. The region incorporates the districts of Uttarkashi, Chamoli Rudraprayag Tehri Pauri & Dehradun, Hardwar the first two being border district.

**Climate and Rainfall:** There are not only variations but also complexities of climate as well as complexities of weather accentuated by the relief of land. The variations of exposure to sunlight and to rain bearing winds have the effect of producing very intricate patterns of local climate. In summer months the valleys experience hot steamy tropical climate, while at a distance of about 75km. the great range bears the highest snowfields of the world. Valley winds in narrow valleys and heavy fog during winter in wide valleys are conspicuous features of the region.

The zone of maximum precipitation during both summer and winter lies between 1,200 and 2,100m. The zone above 2,400m. Experiences smaller amounts of summer rainfall.

**Forest resources:** A major part of the Garhwal Himalaya is covered with forests, which constitute an enormous wealth of the region. Despite the strongly marked and after abrupt changes in flora which result from local soil and climatic conditions, there is a degree of uniformity in the vegetation of large areas which allow the country to be divided into distinct vegetation belts:

- Subtropical zone (below 1200m): *Sal, Kanju, Semal, Haldu, Khair, Sisoo*, Cane breaks and *Bamboo* breaks.
- Temperate zone (1200-1800m): *Chir, Pine* with some species of decidious forests.
- Sub-Alpine forest zone (1800-3000m): Lower sub Alpine *Oak, Maruoak, Kharsu oak, Burans*. Upper sub-alpine – *Silver fir, Blue Pine, Cypross, Deodar*.
- Alpine forest zone (3,000-4,500): High level Birch forests, Xerophytic bushes to Alpine pastures.

## **DESCRIPTION OF SITES**

**KOTDWAR :** Altitude – 376m Temp – Max 40<sup>0</sup>c and Min 10<sup>0</sup>c

At the foothills of Shiwalik Mountains, Kotdwar is laterally the gateway to Garhwal enriched with legends and religion fervor.

**SRINAGAR GARHWAL :** Latitude – 30<sup>0</sup>9`W Longitude – 78<sup>0</sup>46`E Altitude – 570m above msl

Srinagar town is one of the most important and biggest town in the hills of Garhwal Himalaya. Srinagar is an important town of the Pauri Garhwal district of Uttaranchal situated in Alaknanda valley on Rishikesh-Badrinath highway.

**UKHIMATH :** Altitude – 1319m

It is at a distance of 1.2km from the district headquarter of Rudraprayag at an elevation of 1311 mt.. On a clear day one can see the beautiful view of Kedarnath Peak, Chaukhamba and other beautiful Valley.

**NEW TEHRI:** Altitude – 1550m to 1950m Temp – Max 30<sup>0</sup>c, Min 4<sup>0</sup>c Rainfall – 500cms annually  
Icon of progressive development and pride of the decision makers. New Tehri is indeed a unique tourist destination. Needing the need of the hour to provide electricity for the Tehri region a huge dam project on the massive Bhagirathi River was envisaged. The ambitious plan could be only having been realized on the water grave of the present Tehri Town. So in order to fulfill this enterprising plan the idea of a muddle town is a reality and is already functioning as regional headquarter.

## **METHODOLOGY**

For studying the Plant diversity, the entire study area was divided into three zones:

**Sub-Montane Zone :** Extends up to 1,200 m above m.s.l.

**Montane Zone:** Extending from 1,200 to 3,000 m above m.s.l.

**Alpine Zone:** Above 3000m from m.s.l.

The information was collected by visiting the study areas at the regular intervals. Description is also based in the collections made by other authors or published literature, to represent complete spectrum of the flora. The plants were given botanical names after identifying them from the published literature.

After botanical nomenclature, wherever possible synonyms of the plant species in local dialect (Vernaculars), Hindi, and common English languages have been included. Vernacular names are collected during the field visits under ethonobotanical investigations of the region, whereas other synonyms are included on the basis of through consultation and matching of names from the published literature. Description of each species includes habit, habitat, and salient features. I have also communicated with persons who have worked in the related fields and also communicate with the officials of the forest department of the study area. The meteorological data were collected with the help of the instruments by visiting personally and also collected form the instruments planted at different places, such as meteorological data recording centre at **G.I.C. Srinagar Garhwal, Navodaya Vidyalaya at Pokhal, Dehradun, G.I.C Ukhimath, G.I.C. Kotdwar**. The temperature is recorded with the help of thermometer; the relative humidity is recorded with the help of hygrometer and rainfall with the help of rain gauge.

## **OBSERVATIONS**

### **CLIMATIC ZONES:**

**Foot hills and Outer Himalaya:** The climate is almost similar to subtropical Genetic plains, except higher annual precipitation (200-250cm per annum) and lower average temperature of 19<sup>0</sup>-21<sup>0</sup>C, covering the elevation 300-900 m.

**Siwalik and Lower montane zone:** This zone covers the elevation range of 900-1800msl, with an average annual temperature of 14-18<sup>0</sup>C and much higher precipitation (250-300 cm. Per annum). This zone represents humid subtropical like climate.

**Central part of montage zone:** This part represents cold temperate like climate and covers the elevation range of 1800-2400m msl with an average annual temperature of 10-14<sup>0</sup>C, and lower annual precipitation as compared to earlier zone. This zone is characterized by more showers and occasional snow fall during winters.

**Upper Montane Zone:** Upper montane zone is colder, with average annual temperature of 4.5-10<sup>0</sup>C, and covers the elevation range of 2400-3000m m.s.l. annual precipitation is comparatively low, but the showers are gentle and more frequent. Winter experiences more frequent snow fall.

### **WATER RESOURCES:**

The Garhwal Himalaya serves as the perpetual reservoirs of water for most of the main rivers, which are of immense value to the northern India. Numerous rivers and rivulets, locally known as gad gadera or raulam drain the region. The northern parts of the districts of Chamoli and Uttarkashi most parts of which lie under the snow-covered zone provide the most important reservoir of water. The rivers flow parallel to mountains but at some places, the rivers turn into acute bend resulting in the formation of deep gorges. The Uttaranchal has the following three river sequence:

1. Ganga System
2. The Yamuna System
3. The Ramganga System

### **PLANT DIVERSITY**

#### **SUB MONTANE VEGETATION ADJACENT TO GANGETIC PLAINS**

(1) *Alnus nepalensis* Vern: Utees, Eng. Alder Fl: Oct-Nov. Fr: Oct-Jan

Abundant: along the shady rareness or on landslide zones, 1000-2500m, Binsar, Lansdowne.

Use: Wood used for carpentry & construction, bark used in local medicine, used as soil binder.

(2) *Rumex dentatus*: Vern: Jangli palak. Fl: Feb-May Fr: Feb-May

Common: waste places, road sides of the outer submontane Zones, Kotdwara.

Use: leaves scarcely used as vegetable.

(3) *Rumex hastatus*: Vern: Almora kilmori Fl: Feb-Jun Fr: Jun-Oct

Fairly common: along terraces of fields, exposed slopes, open drier places, 2000m, Kotdwara, Srinagar.

Use: leaf extract applied on cuts and wounds to check bleeding and also believed to relieve from suffering of beetle sting.

(4) *Shorea robeesta*: Vern: Kandar, sal, Eng: Indian dammer Fl: Feb-May Fr: May-Aug.

Common: dominant constituent of miscellaneous forest of sub Himalayan tracts or tropical sal forest to 1000.

Use: High-class timber yielding plant fatty oil from seeds for cooking. Aromatic resin useful in diarrhoea, dysentery and in gonorrhoea.

(5) *Acacia catechu*: Vern: and H. khari, katha Fl: Apr-Aug Fr: Sept.-Feb

Fairly common : dry exposed miscellaneous to forests, Particularly in tarai' bhabar tracts, byasghal, Srinagar.

Use: used for various medicines particularly in digestion and respiratory diseases. Bark used in diarrhoea, dysentery, bronchitis.

(6) *Acacia dealbata*: Hindi: Chikaka Fl: Feb-May Fr: Apr-Aug

Common: planted along road sides or naturalized to 1400m, Pauri

(7) *Acacia intsia*: Hindi : phulai Fl: Apr-Aug Fr: Oct-Dec

Common miscellaneous forests of tarai-bhabar, on exposed slopes, cheela.

(8) *Acacia nilotica*: Vern: Babul, kikar Fl: Mar-Apr Fr: Oct-Nov

Common : outer submontane zones, along the miscellaneous forests, open places, laldhang.

Used: Bark used in bronchitis and asthma, Urinary disorders and dysentery, gum, of tree also medicinal

(9) *Dalbergia lanceolaria*: Vern : Takoli, Bitnea Fl: May-Sep Fr: May-Sep

Common, outer miscellaneous forests, bhabar tracts to 600m, Kotduera

(10) *Dalbergia sericea*: Vern: Bhandir, Gugar Fl: Apr-Aug Fr: Apr-Aug

Common miscellaneous forests of siwalik ranges, usually hear by river banks, Duggadda.

Used: foliage used as fodder, no under plantation to check soil erosion.

#### INTERMIXED VEGETATION: MONOTONE & PLAIN SHARING ELEMENT

(1) *Pinus roxburghii* : Vern: chir Eng: chir Pine. Fl & Fr: Mar-Jun

Abundant in submontane to montane forests, 900-250m, mostly forming pure patches sometime mixed with other trees, Srinagar, Gumkhal, Thailisain.

Use: Wood used for construction, resin in varnishes, paints and truppenine.

(2) *Quercus Leucotrichophora*: Fl: Mar-Apr Fr: Oct-Jan

Abundant: On north east slopes or otherwise usually associated with *Rhododendron arboreum* and *Myrica esculenta*, 800-200m khirsu, Binsar.

(3) *Bombax Ceiba* : Vern : Salmali Fl: Jan-May Fr: Apr- May

Common along Alaknanda Valley, Village landscapes, scrub forests to 1200, Srinagar.

(4) *Acacia dealbata*: Fl : Feb- May Fr : Apr- Aug

Common planted road sides or naturalized to 1400m naugaonkhal, Pauri

(5) *Dendrocalamus strictus*: Vern : Bans, Eng, Male Bamboo.

(6) *Poa annua*: Eng: Annual meadow Grass Fl: Jan- June Fr: Jan- June

Common in crop fields, gradens, waste places, Srinagar

(7) *Boehmeria platy phyla*

Vern : Khagsa Fl: Aug- Jun Fr: Aug- Jun

Common terraces of crop fields, edges of forests and river banks to 2000m., Bharsar.

(8) *Prunus Persica*:

Vern & H. Aaru Eng: Peach tree Fl: Mar- Apr Fr: Apr- Jul

Common Cultivated for edible fruits, from sub Himalayan tracts to 2400m., Srinagar.

(9) *Pyraeantha Crenulate*

Vern: Ghingarua Fl: Mar- May Fr: Jan- Oct

Abundant exposed slopes, Forest edges, bank of streams and other miscellaneous localities, often associated with *Berberis* or *Rosa* spp. from submontane tracts to 2650m., Khirsu, Srinagar.

(10) *Pyrus Communis*: Vern & H. Nashpati Eng: Pear. Fl: Mar- Apr. Fr: Jun- Sept

Common cultivated submontane to montane Himalaya, Pauri.

#### MONTANE OR TYPICAL HILLY (TEMPERATE LIKE) VEGETATION

(1) *Ephedra gerardiana*: Vern : Tutgoutha Fl & Fr : Jul- Sept

Rare along the drier slopes, on boulders, on near to Kodyabagarh.

(2) *Taxus Baccata*: Vern : Thuner Fl & Fr : Apr- Nov

Common moist shady montane forests, above 2400m., associated with oak and silver fir forests, Dudhotoli.

(3) *Cupressus torulosa* : Vern : Surai Fl & Fr : Jun- Nov

Common drier montane forests 1800- 3200m. often associated with silver fir or oak trees, Pauri, Dudhatoli Forests.

(4) *Juniperus Communis*: Vern : Jhera, Padmak. Fl & Fr : Sept- Oct

Rare uperraches of montane forests, 250-3100m. Kodyababarh.

(5) *Abies Pindrow*: Vern : Jhilla Dodimma Fl & Fr : Mar- Nov

Common montane ouercus semecarpifolia forests, Bharsar, Kodyabgarh

(6) *Abies spectabilis*: Vern : Morinda Fl & Fr : Mar- Nov

Common montane moist forest 2400- 3000m. associated with Quercus semecarpifolia, Kodyabagrh.

(7) *Pinus Wallichiana*: Vern & H. chilla, Kail

Common montane forests, 2000-3200m. often associated with oak forests, Pauri, Dudhatoli forests.

(8) *Myrica esculnta*: Vern & H. Kaphal, Kaiphal Fl : Aug- Oct Fr : Apr- Jun.

Abundant in oak rhododendron forests, usually in shady localities, adhwani, chelusain.

(9) *Rhododentron arboretum*: Vern : Burans Fl: Mar- May Fr: Apr- Nov

Common oak forests of montane zones, Adhwani, Bharsar, Binsar.

(10) *Cedrus deodar*: Vern: Deodar, Devdar.

Common moist montane forests, 2000-3000m. associated with oaks, Pauri, Binsar.

## **RESULT AND DISCUSSION**

It is of deep concern that flora; which has developed in a life span of millions of years under these specific geometric conditions is vulnerable to extreme stresses. It is not merely a question of millions of year's co evolution or change of vegetation but the sudden breakdown of the diversity in a very short span. Out of several factors, human activity is most dangerous and has reached an alarming state.

The unplanned land use pattern such as urbanization industrialization road network and all commercial exploitation of useful plants and their products are operating at different scales and speed markedly affecting the survival or multiplication of the individual species. Even to the entire floristic composition.

The initial level if the impact is of lower intensity. It affects phonological abnormalities as well as seed production and regeneration often not so noticeable. However high intensity impact interact more vigorously with the plants as well as habitats resulting in depletion of lent population and if continuous for a long period plant species reduced to the category of threatened nature. Eventually rarity or extinction of plants is due to excessive stresses rendering the change of the habitat unfit to the original species. Furthermore, with respect to altitudinal range, topography edaphic or climatic features, phytosocial affinities, facies, locations etc, mountains

plants have specific preference. Therefore the original vegetation of the Himalaya is more prone to the disturbances and as compared to any other phytogeographical regions. The actual number of threatened category of plants is much larger. As per current estimates more than 10 % of the plants fall in the threatened category and due to absence of any spurious exploratory work, we still do not exactly know about the plants of extinct category.

Conclusively, the vegetation is under extreme stress and of the several natural processes of evolution and changes human activities are more responsible to the degradation of quality and quantity of the plant life and communities in the Himalayan. As such distributional range along with the density fluctuates with respect to plant or habitat. The most important aspect of the dynamics of vegetation is the degradation of habitat due to several natural or biotic stresses, which creates favorable grounds to some advanced or invading species and limitations to primitive or original ones. Therefore, traditionally known or hitherto described characteristic vegetation is in danger as a whole and somewhat more adaptive plants of dry exposed, adjacent localities or exotics are causing serious concern for their wide invasion in the Himalayan ecosystem.

Based on general survey, the variation in floral species of high altitudinal area of Garhwal Himalaya, following species were observed and identifying with their botanical name and altitudinal range.

**Table 1: Showing variation of Plant Diversity and their distribution range in meters above m.s.l. (Garhwal Himalaya)**

| S.No.           | Name of the shrubs                              | Distribution in Garhwal Himalaya  | Altitudinal range (m. above m.s.l.) |
|-----------------|---|---|-------------------------------------|
| 1               | <i>Berberis anistata</i><br>Vern :Kingor        | Lansadon, Pauri, Srinagar   | 1,8000-2,700m                       |
| 2               | <i>Zizphus matuntiana</i><br>Vern: Ber          | Sub Himalayan tract, Srinager, Satupuli<br>Kotdawara, Tropical Asia                   | 300-1,000m                          |
| 3               | <i>Juniperus communis</i><br>Vern: Jhora        | Rara, upper montane forest Kodiabgarh,<br>Montane Himalaya                            | 2,500-3,100                         |
| 4               | <i>Rumex dentatus</i><br>Vern Jangali palak     | Sub Monate zone, Kotdawara, South India,<br>Myanmar, China                            | 300-500                             |
| 5               | <i>Zanthoxylum armaltum</i><br>Vern: Timroo     | Sub Himalayan belt, Kotwara, Philipines,<br>China                                     | 2,000                               |
| 6               | <i>Murraya koenigill</i><br>Vern: Karri patta   | Sub Himalayan tracts  | 1,500                               |
| 7               | <i>Carissa opaca</i><br>Vern: Karonda           | Sub Himalayan tract frequent, Open exposed<br>place, Scurb jungles, Dugadda, Srinagar | 1,200                               |
| <b>Herbs:</b>   |   |   |                                     |
| 1               | <i>Saussurea obvallata</i><br>Vern: Brahm kamal | Rare upper montane Himalaya, Alpine herb  | 4000-4800m                          |
| 2               | <i>Saussurea gossypium</i><br>Vern: Phen kamal  | Montane Himalaya, Alpine herb   | 4,000- 4,800m                       |
| 3               | <i>Primula denticulata</i>                      | Alpine herb   | 4,000-4,800m                        |
| <b>Grasses:</b> |   |   |                                     |
| 1               | <i>Poa annua</i> , Eng: annual<br>meadow grass  | Srinagar, Throughout India  | Cosmopolitan                        |
| 2               | <i>Cynodon dactylon</i><br>Vern: Ddubla, Doob   | Wast Places, Srinagar Throught India  | 1,800m                              |

**Table 2: Showing variation of Plant Diversity and their distribution range in meters above m.s.l. (Garhwal Himalaya)**

| Sl No. | Name of the Trees                 | Distribution in Garhwal Himalaya | Altitudinal range (m. above m.s.l.) |
|--------|-----------------------------------|----------------------------------|-------------------------------------|
| 1      | <i>Shorea robusta</i> , Vern: Sal | Sub Himalayan tracts             | 350-1,070m                          |

|    |  |   |               |
|----|--|---|---------------|
| 2  | <i>Dalbrzia siso</i> , Vern: Shissaham               |   | 350-1,070m    |
| 3  | <i>Acacia catehu</i> Vern:khair,Kata                 | Ttarai-bhabar tracts, Byasghat, Srinagar  | 350-1,070m    |
| 4  | <i>Aezle marmelos</i> , Vern: Bel                    | Tarai-bhabar , Srinagar   | up to 12,00m  |
| 5  | <i>Pinus roxburghi</i> , Vern: Chir                  | Common in all Uttarakhand Himalayan   | 600-2,300m    |
| 6  | <i>Rhododendron arborium</i><br>Vern: Burans         | Adhwani, Bharsar, Binsar  | 600-2,400m    |
| 7  | <i>Quercus leucotrichophora</i> Vern:<br>Banj        | Khirsu, Binsar  | 800- 2,400m   |
| 8  | <i>Pinus excelra</i> , Vern: Kail                    | Montane Himalayan zones, Dudhatoli forests  | 2,100-2,400m  |
| 9  | <i>Abies pindro</i> , Vern: Raga                     | Bharsar, Kodiabzarh   | 2,740-3,350m  |
| 10 | <i>Rhododendron amilhoprogen</i><br>Vern: Bhotiachai | Montane zones, Associated with Bugyals  | 2,740-3,350m  |
| 11 | <i>Cedrus deodara</i> Vern:Ddeodar,                  | Pauri, Binsar, Western Montane Himalaya   | 2,000-3,000m  |
| 12 | <i>Aegle marnelos</i> Vern: bel                      | Tarai- bhabhar, Sinagar, Throught India   | from 1,200m   |
| 13 | <i>Aesculus Indica</i><br>Vern: Pangar               | Common in moist Oak forest Rhododendrun forests of motane Himalaya, Pauri Khirsu, | 1,500-2,500 m |
| 14 | <i>Myrica esculenta</i><br>Vern: Kaphal              | Abundant in Oak Rhododendron forests, Adhwani, Montane Himalaya                   | 2,500-3,300 m |
| 15 | <i>Quercus Horibunda</i><br>Vern:Tilong, Moru        | Moist shaddy revenes, Champeshwar, Submontane and montane Himalaya                | 8,00-2,000 m  |
| 16 | <i>Pinus Willichiana</i> ,<br>Vern:Chilla, Kail      | Associated with Oak forests, Pauri, Dudhatol forests, Montane Himalaya            | 2,000-3,200 m |
| 17 | <i>Rhododendron companutalum</i>                     | Montane Himalaya  | 2,800-5,000 m |

Table 3: Showing forests types, distributional range & dominant components of different forests of Garhwal Himalaya

| S.No | Main Forest                            | Type of Forest                            | Altitude (m) above m.s.l | Dominant sps. Composition   |
|------|--|---|--------------------------|---|
| 1    | Nortnen tropical Dry Deciduous forests | (i) Dry Siwalik Sal Forest                | 350-1,070                | <i>Shorea robusta</i> , <i>Dalbergia siso</i> , <i>Acadia catechu</i> (Khair)                                   |
|      |  | (ii) Nortnen dry mixed deciduous forest   | 400-1,780                | <i>Toona ciliata</i> (toon), <i>dendrocalamus sbrctus</i> , <i>Adina cordifolia</i>                             |
|      |  | (iii) Pine forest                         | 600-2,300                | <i>Pinus roxburghii</i> (chir), <i>Rhododendron arborium</i> (Burans)   |
|      |  | (iv) Alder forest                         | 1,370-2,300              | <i>Alnus nepaluisis</i> , <i>Quercus Leucotrischophora</i> (Banj), <i>Betula alriorides</i>                     |
|      |  | (v) Oak forest                            | 1,830-2,350              | <i>Q.leucotricho -phora</i> (Banj), <i>Rhododendrun arborium</i> (Burans),                                      |
|      |  | (vi) Moist Temperate Deciduous forest     | 1,830-3,050              | <i>Q.leucotrichophora</i> (Banj), <i>Oak Q. semicarpitolia</i> (Kharsu oak), <i>Abies pindrow</i> (Silver fir), |
|      |  | (vii) Oak Scrub                           | 1,400-2,400              | <i>Q.leueotrichophora</i> (Banj), <i>Rhododendron arborium</i> (Burans)   |
|      |  | (viii) Kharsu Oak                         | 2,740-3,350              | <i>Q.Seme carpitolia</i> (Khassu Oak), <i>Abies pindrow</i> (Jhilla)  |
|      |  | (ix) West Himalayan upper Oak/ Fir Forest | 2,740-3,350              | <i>R. anthopogen</i> (Bhotiachai), <i>Abies pindrow</i> (silver fir, raga), <i>Cupressus species</i>            |



|   |                       |                                      |             |  |
|---|-----------------------|--------------------------------------|-------------|--|
|   |                       | (x) Himalayan temperate pasture land | 2740-3350   | <i>R. anthopozen (Bhotiachai), grasses of higher elevation</i> |
| 2 | Sub. Alpine Forest    | Sub alpine Pasture                   | 2,700-3,350 | <i>Befula utilis (Bhojpatra), Cupressus species</i>            |
| 3 | Moist Himalayan Scrub | Alpine Pasture                       | 3,350-3,650 | <i>R. anthopozen (Bhotiachai), Alpine measons</i>              |

**Table 4: Forest area dominated by various tree species in hill districts**

| Sl. No.      | Type           | Hectare          | Percentage    |
|--------------|----------------|------------------|---------------|
| 1.           | Pine           | 415,447          | 17.56         |
| 2.           | Cedar          | 15,528           | 0.66          |
| 3.           | Fir and Spruce | 99,295           | 4.50          |
| 4.           | Blue Pine      | 19,089           | 0.80          |
| 5.           | Cypress        | 1,621            | 0.07          |
| 6.           | Sal            | 245,839          | 10.39         |
| 7.           | Teak           | 8,952            | 0.38          |
| 8.           | Khair          | 7,333            | 0.31          |
| 9.           | Sisham         | 5,513            | 0.23          |
| 10.          | Oak            | 266,436          | 11.56         |
| 11.          | Eucalyptus     | 21,527           | 0.91          |
| 12.          | Others/ mixed  | 578,506          | 24.45         |
| 13.          | Non-productive | 681,167          | 28.79         |
| <b>Total</b> |                | <b>23,66,283</b> | <b>100.00</b> |

Source: Forest Department, Uttarakhand.

**Table: 5 District wise rarest cover in Uttaranchal assessed by forest survey of India**

| District    | Geographical area | Dense forest cover | Open forest cover | Total forest cover | %of geo. Area |
|-------------|-------------------|--------------------|-------------------|--------------------|---------------|
| Almora      | 5385              | 2095               |                   |                    |               |
| Chamoli     | 9125              | 2519               | 632               | 3151               | 34.53         |
| Dehradun    | 3088              | 1243               | 327               | 1570               | 50.84         |
| Pithoragarh | 8856              | 2178               | 805               | 2983               | 33.68         |
| Pauri       | 5440              | 2156               | 993               | 3143               | 57.89         |
| Tehri       | 4421              | 1734               | 748               | 2482               | 56.14         |
| Uttarkashi  | 8016              | 2586               | 461               | 3047               | 38.01         |

**Table : 6 (status of forest area in Garhwal)**

| Particulars   | D.dun | Pauri | Tehri | Uttarkashi | Chamoli | Total |
|---|-------|-------|-------|------------|---------|-------|
| total Geographical area in 1990-91 sq(km <sup>2</sup> ) | 3088  | 5440  | 4421  | 8016       | 9125    | 30090 |
| Total forestry area in 1991 sq (km <sup>2</sup> )       | 2198  | 4496  | 3972  | 7103       | 5204    | 22973 |
| Population in 1991                                      | 1026  | 683   | 580   | 240        | 455     | 2984  |
| % age forest to geographical area                       | 71.2  | 82.6  | 89.8  | 88.6       | 57.0    | 76.3  |
| % age of District Geog area to region                   | 10.3  | 18.1  | 14.7  | 26.6       | 30.3    | 100   |
| % age of forest area to region                          | 9.6   | 19.6  | 17.3  | 30.9       | 22.6    | 100   |
| % age of district population to region                  | 34.4  | 22.9  | 19.4  | 8.0        | 15.3    | 100   |
| forest area per capital (Hectare)                       | 0.214 | 0.658 | 0.658 | 2.960      | 1.144   | 0.770 |

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