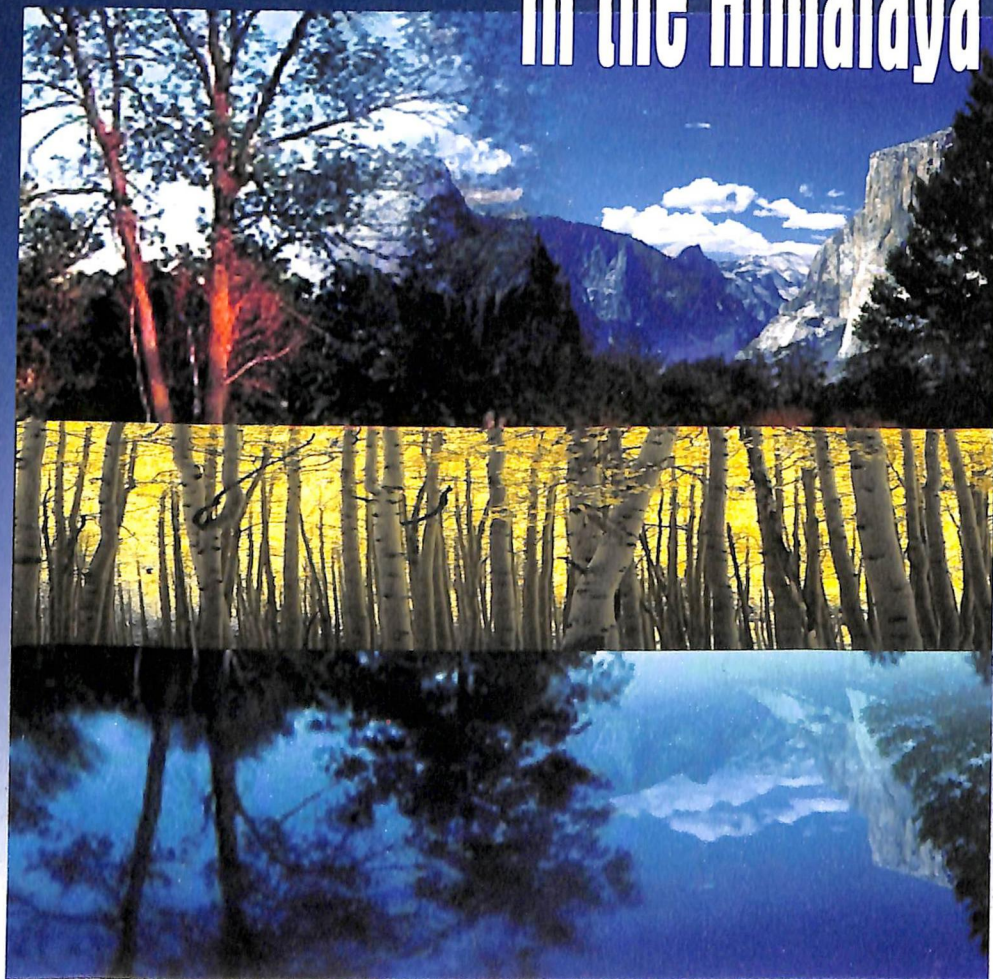


# Natural Resource Management in the Himalaya



**S.S. Negi**

**Forest, Grassland  
and Wildlife Management**



# NATURAL RESOURCE MANAGEMENT IN THE HIMALAYA

VOL. III

FOREST, GRASSLAND AND WILDLIFE  
MANAGEMENT

S.S. NEGI



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# PREFACE

The Himalayan mountain system supports rich and diverse forests and grasslands, which are also the home for a varied assemblage of wild animals. Forests and grasslands play an important role in the lives of the millions of people living in this mountain range and also in the plains of the Indian sub-continent. Wild animals too are vital for the stability of the Himalayan eco-system, thereby enabling it to maintain the delicate environmental balance. Thus, management of forests, grasslands and wildlife is an important part of natural resource management in the Himalaya.

This volume, the third in a series of five, covers forests, grasslands and wildlife and their management. It includes chapters on forest types; forest management practices and working plans; silvicultural systems; forest products; forest regeneration; forest fires; recreational forestry and ecotourism; grasslands; management of grasslands; wild animals; wildlife management and protected areas and biosphere reserves. During the writing of this book, both published and unpublished literature including the author's books were consulted and hence no originality is claimed. It is meant as a handy reference book for natural resource managers, scientists, planners, students, researchers and also the layman interested to know more about natural resource management in the Himalaya.

The author is thankful to his well wishers for their encouragement, to his family for their self-denial and also to the publishers for bringing out this volume in a short time.

SHARAD SINGH NEGI

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## CHAPTER 1

# FOREST TYPES

Ranging from sub-tropical pine forests to alpine pastures, the Himalaya support rich and diverse forests whose density, composition, stocking, use and ecological status vary widely. In the Himalaya, forests occur right from the southern fringes along the plains to about the tree line beyond which alpine vegetation grows till the line of perpetual snow. No vegetation grows above the snow line where the land is under a permanent cover of snow.

There is a distinct variation in the forest vegetation with altitude in the Himalayan region. Besides, altitude, climatic is another important variable affecting the forests types found in the Himalayan region. The factors influencing the nature, composition, distribution, ecology and status of Himalayan forests have been listed in the text below:

### 1. Climatic Factors

- a. Solar radiation: Light and temperature.
- b. Frost.
- c. Moisture: Rainfall, its intensity, frequency and distribution; snow, hail, dew and hoarfrost.
- d. Relative humidity and atmospheric pressure.
- e. Wind: its speed and direction of prevailing winds.

## **2. Topographic Factors**

- a. Configuration of the land.
- b. Elevation or altitude.
- c. Slope.
- d. Aspect or exposure.
- e. Drainage characteristics.

## **3. Edaphic Factors**

- a. Geology, rock and genesis of the soil.
- b. Nature and properties of the soil.

## **4. Biotic Factors**

This concerns primarily with the impact of human beings, their animals, wild animals, insect pests and pathogens on forests:

- a. Human beings or man.
- b. Domestic animals.
- c. Wild animals.
- d. Insect pests and pathogens.

## **FOREST TYPES**

The main forest types of the Himalaya have been described in brief in the text below (after Champion and Seth, 1968, Negi 1989, 1992 1996).

### **Western Himalaya**

The forests of the western Himalaya bear affinity with those of the Indo-Ganga plains, Tibetan plateau and also that of the central Himalaya. The total annual precipitation is relatively less than that in the eastern Himalaya, though winter rains are common. In the Kashmir valley, the local climatic conditions have a

profound impact on the forest types. The western Himalaya also have a fairly large tract of cold deserts where conditions are extremely cold and dry.

The main forest types occurring in the western Himalaya are:

### 1. *Sal Forests*

Sal forests occur in the foothills, Shiwalik hills and the dun valleys of Uttaranchal and eastern parts of Himachal Pradesh. The Paonta valley of Himachal Pradesh is considered to be the present western limit of sal though a small patch of sal forest is also found in Kangra area. These forests may be of the following sub-types/types:

- a. Moist Shiwalik sal forest.
- b. Dun sal forest.
- c. Dry sal forest.

*Shorea robusta* or sal is the main tree species of these forests. The others are *Acacia catechu*, *Adina cordifolia*, *Dalbergia sissoo* and *Terminalia tomentosa*.

Amongst these, the moist Shiwalik sal forest and dun sal forests are the most diverse due to higher annual precipitation, good soil conditions and relatively better topographic conditions. It is believed that vast tracts of sal forests once occurred in the dun valleys and Shiwalik hills but were gradually lost due to the ever increasing human population. In the past these forests were extensively found even in the foothills of Himachal Pradesh.

### 2. *Khair-sisham Forest*

The riverine khair-sisham forest occurs along the beds of streams and rivers in the foothills, dun valleys,

Shiwalik tracts and the lower Himalaya, usually under dry and riverine situations, often as one of the first few stages of succession. They develop as a characteristic succession on freshly laid down alluvium, even under exacting conditions, including a long dry spell, which is a characteristic feature before the monsoons.

The main tree species found in the forest are: *Acacia catechu*, *Albizia lebeck*, *Dalbergia sissoo*, *Tamarix diocia* and *Zizyphus mauratiana*.

### 3. *Chir Pine Forest*

Extensive chir pine forests occur in the western Himalaya from Jammu to Uttaranchal, usually between elevations of 900 to 1500 m. Chir pine is a hardy species and grows under exacting conditions. Chir pine forests are found in very extensive patches in the lower hills of the western Himalaya, though they also extend into the lower parts of the main Himalayan valleys, usually along rivers e.g. the Satluj valley in Rampur area. In the Shiwalik hills, they occupy the tops of these ranges.

The chir pine forests of the western Himalaya may be divided into the following two sub-types:

- a. Upper or Himalayan chir pine forest.
- b. Lower or Shiwalik chir pine forest.

*Pinus roxburghii* or chir pine is the dominant tree species of this forest with the other species being *Acacia catechu*, *Cedrus deodara*, *Lyonia ovalifolia*, *Quercus leucotricophora* and *Rhododendron arboreum*. There is a variation in the associated species with climatic conditions, altitude and topography.

### 4. *Sub-tropical Mixed Deciduous Forests*

Mixed deciduous forests occur in the sub-tropical belt



of the western Himalaya, in the foothills, Shiwalik hills, dun valleys and the lower and middle Himalaya. The conditions under which these forests grow vary from moist to dry and accordingly, they may be of the following sub-types:

- a. Moist mixed deciduous forest.
- b. Dry mixed deciduous forest.

The main species are: *Acacia catechu*, *Adina cordifolia*, *Bauhinia retusa*, *Bombax ceiba*, *Dalbergia sissoo*, *Madhuca indica* and *Terminalia* sp. The dry mixed deciduous forests are more open than the moist forests.

### 5. Oak Forests

Oak forests occur in many parts of the western Himalaya, usually under relatively moister conditions, with the dominant species varying with elevation. They develop either as pure forests or in moist shady depressions within the coniferous forests. These forests develop well under extremely favorable conditions of moisture and good soils. The composition of oak forests varies with altitude. Different oak forests of the western Himalaya are listed below, though often, there is a transition zone between them.

- a. Ban oak forest found between 1700 to 2200 m with the dominant species being ban oak or *Quercus leucotricophora*. Other tree species are *Carpinus viminea*, *Lyonia ovalifolia* and *Rhododendron arboreum*.
- b. Moru oak forest occurring between 2200 to 2400 metres with the main species being *Quercus himalayana*. Other tree species are *Aesculus indica*, *Betula alnoides*, *Quercus leucotricophora* and *Quercus semecarpifolia*.

- c. Kharsu oak forest occurring between 2500 to 3500 metres with the main species being *Acer caesium*, *Betula alnoides*, *Pyrus lanata*, *Quercus himalayana* and *Quercus semecarpifolia*.

## 6. Moist Temperate Forests

Moist temperate forests occur in the moist temperate region of the western Himalaya, usually between elevations of 1800 to 2500 m. Bulk of the total annual precipitation is received from the monsoons while the upper tracts also experience snowfall in the winter months. The different types/sub-types are:

- a. *Moist deodar forest*: This forest is dominated by *Cedrus deodara*, with the other species being *Abies pindrow*, *Picea smithiana*, *Pinus roxburghii*, *Pinus wallichiana*, *Quercus* sp and *Rhododendron arboreum*.
- b. *Mixed coniferous forest*: The main species are *Abies pindrow*, *Acer acuminatum*, *Betula alnoides*, *Cedrus deodara*, *Picea smithiana*, *Pinus wallichiana*, *Quercus* sp and *Taxus baccata*.
- c. *Blue pine forest*: Blue pine or *Pinus wallichiana* is the main tree species with the others being *Abies pindrow*, *Aesculus indica*, *Cedrus deodara*, *Picea smithiana*, *Pinus wallichiana*, *Pyrus lanata*, *Quercus* sp and *Rhododendron* sp.
- d. *Mixed deciduous forest*: This forest comprises of broad-leaved species like *Acer acuminatum*, *Aesculus indica*, *Betula alnoides*, *Juglans regia*, *Pyrus lanata*, *Quercus* sp. and *Rhododendron* sp.

## 7. Dry Temperate Forests

These forests occur in the inner dry valleys and the cold desert tracts of the western Himalaya, mainly in

the areas, which lie in the rain shadow of the high mountains and receive very little rainfall. Most of the total annual precipitation is received in the form of snow. These forests are open and often of a poor quality. The trees may be malformed and stunted due to the unfavorable growth conditions like poor soils, low moisture, high elevation and sub zero temperatures. They comprise of the following forest types/sub-types:

- a. *Dry deodar forest*: This forest is dominated by *Cedrus deodara* with the other species being *Corylus colurna* and *Pinus gerardiana*.
- b. *Dry mixed forest*: The main species are: *Acer pentapomicium*, *Cedrus deodara*, *Celtis australis*, *Fraxinus* sp. *Pinus gerardiana* and *Quercus ilex*.
- c. *Chilgoza pine forest*: This is an open forest dominated by *Pinus gerardiana* with occasional trees of *Cedrus deodara*. It is restricted in occurrence to parts of Kinnaur district and in isolated patches in Chamba district of Himachal Pradesh.

### 8. Sub-alpine Forests

The sub-alpine forests of the western Himalaya occur at elevations of over 2500 m and extend till the upper limit of tree growth, often up to the line of perpetual snow. They comprise of mixed deciduous and coniferous vegetation, with the former developing under relatively moister conditions. The crown density may vary depending on the site conditions. There may occur sub-alpine pastures in between these forests. They consist of the following forest types/sub-types:

- a. *High-level fir forest*: The main species is *Abies spectabilis* with other species being *Picea smithiana*, *Pinus gerardiana*, *Pinus wallichiana*

and *Prunus padus*.

- b. *Birch fir forest*: The main species are *Abies spectabilis*, *Betula utilis*, *Quercus semecarpifolia*, *Rhododendron anthopogon*, *Rhododendron lepidotum* and *Sorbus foliolosa*.
- c. *Birch-Rhododendron scrub forest*: The main species are *Betula utilis*, *Rhododendron campanulatum* and *Rhododendron lepidotum*.

## 9. Alpine Vegetation

Alpine vegetation is found near the snow line in the higher and trans-Himalayan tracts of the western Himalaya. Sub-zero temperatures are experienced in this tract in the winter season, with snow covering the ground for several weeks at a stretch. Trees are few, stunted, malformed and scattered. Alpine grasses and some shrubs form the main species in this vegetation. Alpine vegetation consists of the following vegetation types/sub-types:

- a. *Moist alpine scrub*: This vegetation comprises of alpine pastures near the snow line in the moister parts of the higher Himalaya. The main species are *Aconitum* sp., *Berberis* sp., *Betula utilis*, *Juniperus* sp., *Rhododendron campanulatum*, *Syringa emodi* and *Trolis* sp. They extend from the sub-alpine tract to the snowline.
- b. *Dry alpine scrub*: The dry alpine scrub is found in the cold and arid tracts of the trans-Himalaya. The main species are: *Artemisia maritima*, *Artemisia sacorurum*, *Caragana* sp., *Draba gracillima*, *Juniperus communis*, *Juniperus wallichiana*, *Potentilla fruticosa* and *Sedum crenulatum*. They extend till the line of perpetual snow.

## Central Himalaya

The forests of the central Himalaya bear affinity with those of the western and eastern Himalayan regions, Tibetan plateau and the Ganga plains. In fact, there is a gradually change in the vegetation characteristics from the western to the central Himalaya and then to that of the eastern Himalaya. Rainfall is heavier in the central Himalaya, than in the western part of this mountain chain. The main forests types found in the central Himalaya are:

### 1. Sal Forests

These forests are dominated by *Shorea robusta* and they occur in the Shiwalik hills, foothills, dun valleys and lower Himalaya up to an elevation of about 800 m. The main sub-types are:

- a. Shiwalik sal forest.
- b. Dun sal forest.
- c. Bhabar-terai sal forest.
- d. Hill sal forest.

Besides sal, the principal tree species of these forests are: *Adina cordifolia*, *Amoora decandra*, *Anogeissus latifolia*, *Eugenia oojenensis*, *Sterculia urens*, *Terminalia arjuna* and *Terminalia tomentosa*.

### 2. Tropical Riverine Forest

This forest is found along the beds of rivers and streams in the foothills, Shiwalik hills, dun valleys and the lower Himalayan tracts, usually as a successional stage. The principal tree species are: *Acacia catechu*, *Adina cordifolia*, *Bombax ceiba*, *Dabergia sissoo*, *Lannea grandis* and *Trewia nudiflora*.

### 3. Evergreen and Semi-evergreen Forests

Evergreen and semi-evergreen forests occur in the moister tracts of central Himalaya, mainly in the eastern parts of Nepal, usually up to an elevation of about 1600 m. The main species are: *Albizzia procera*, *Cedrela toona*, *Cornus macrophylla*, *Mallotus nepalensis*, *Phoebe lanceolata*, *Quercus leucotricophora*, *Randia tetrasperma* and *Sarauja nepalensis*.

### 4. Chir Pine Forest

Chir pine forest occurs in the sub-tropical belt up to an elevation of about 1000 m. It consists primarily of almost pure forest of chir pine with few associates. The main species are: *Cedrela toona*, *Pinus roxburghii* and *Quercus leucotricophora*.

### 5. Oak Forests

Oak forests are found at different elevations in the central Himalaya, mainly in moister localities with higher rainfall, sheltered aspects and good edaphic conditions. Oak trees may also be associated with coniferous forests. These forests may be of the following sub-types:

- a. *Ban oak forest*: Found between elevations of 1800 and 2800 m and dominated by *Quercus leucotricophora*.
- b. *Moru oak forest*: Occurring between elevations of 2800 to 3200 m with *Quercus himalayana* being the main species.
- c. *Kharsu oak forest*: Found above an elevation of 3200 m and dominated by *Quercus semecarpifoila*.
- d. *Buk oak forest*: Occurring between elevations of 2500 to 3500 m in eastern Nepal and dominated by *Quercus lamellosa*.

## 6. Temperate Forests

The temperate forests of central Nepal occur at elevations of over 2300 m and may extend to about 3300 m. They are comprised of both coniferous as well as deciduous forests. The main types/sub-types are:

- a. *Moist temperate deciduous forest* in which the main species are: *Acer caesium*, *Aesculus indica*, *Alnus nepalensis*, *Betula alnoides*, *Juglans regia*, *Quercus* sp and *Rhododendron* sp.
- b. *Rhododendron forest* which consists of different species of *Rhododendron*.
- c. *Blue pine forest* dominated by *Pinus wallichiana*.
- d. *Fir and Spruce forest* in which the main species are: *Abies pindrow*, *Abies spectabilis*, *Acer caesium*, *Juglans regia*, *Populus ciliata*, *Picea smithiana* and *Rhododendron* sp.
- e. *Tsuga dumosa forest* in which the main species are *Abies spectabilis*, *Betula utilis* and *Tsuga dumosa*.
- f. *Moist temperate coniferous forest* in which various coniferous species like fir, spruce, deodar and blue pine dominate

## 7. Sub-alpine Forests

The sub-alpine forests occur at elevations of over 3300 m in the central Himalaya. They extend till the tree line or even to the upper limit of tree growth. There occur sub-alpine grasslands or pastures within these forests. The different forest types/sub-types are:

- a. *Juniperus forest*.
- b. *Alnus forest*.
- c. *Hippophae scrub*.

## 8. Alpine Vegetation

Alpine vegetation occurs near the snow line on the main and trans-Himalayan ranges of central Nepal. These are primarily alpine pastures with few shrubs and occasional stunted trees. Their different sub-types are:

- a. *Moist alpine scrub*: The main species in this pasture are *Berberis* sp., *Juniperus recurva*, *Juniperus wallichiana*, *Potentialla fruticosa*, *Rhododendron* sp and *Salix sikkimensis*.
- b. *Dry alpine scrub*: The main species of this pasture are *Artemisia* sp., *Clematis phlebantha*, *Ephedra gerardiana*, *Hippophae thibetana*, *Juniperus* sp. *Rhododendron* sp and *Rosa serica*.

## Eastern Himalaya

The eastern Himalayan forests resemble those of the central Himalaya, Myanmar, Tibet and the Brahmaputra plains. There is a gradual transition in the forest vegetation from the central to the eastern Himalaya. The specific conditions of growth experienced in the eastern Himalaya are listed below:

- a. Rainfall is higher in the eastern Himalaya than in other parts of the Himalayan mountain chain. Most of this is received from the SW monsoons, which arrive earlier in this region.
- b. Summer temperatures are relatively milder than in the foothills on the western Himalaya, where the mercury may soar to over 40°C.
- c. The plant diversity of these forests is more.
- d. Soil conditions are largely favorable for forest growth.



- e. The snowline is at a higher elevation in the eastern Himalaya, than in the western parts of the Himalayan mountain chain.

The forest vegetation found in the eastern Himalaya have been described in brief below:

### 1. Sal Forests

Sal forests occur in the foothills, terai and *bhabar* tracts of the eastern Himalaya. The main types/sub-types are:

- a. Lower and Upper *bhabar* sal forest.
- b. *Terai* sal forest.
- c. Lower Himalayan sal forest.

*Shorea robusta*, which forms more than 90% of the crop dominates these forests. Other tree species are: *Amoora wallichii*, *Cedrela microcarpa*, *Cedrela toona*, *Duabanga grandiflora*, *Elaeocarpus aristatus*, *Salmalia malabarica* and *Terminalia* sp.

### 2. Semi-evergreen Forest

Semi-evergreen forests have developed along the foothills in the transition zone between the hills and the plains, which receive very heavy rainfall. They are comprised of a mixture of semi-evergreen and evergreen species with a dominance of the former. Different semi-evergreen forests of the eastern Himalaya are:

- a. Alluvial plains semi-evergreen forest.
- b. Sub-montane semi-evergreen forest.
- c. Secondary semi-evergreen forest.

The principal tree species occurring in these semi-evergreen forests are: *Castanopsis indica*, *Duabanga grandiflora*, *Eugenia formosa*, *Gmelina arborea*, *Michelia*

*Natural Resource Management in the Himalaya*  
*champaca*, *Phoebe attenuata*, *Schima wallichii*,  
*Tetrameles nudiflora* and *Terminalia* sp.

### **3. Sub-tropical Forest**

These forests occur in the sub-tropical regions of the eastern Himalaya, usually in the foothills and lower Himalayan tracts, up to elevations of about 2000 m. The principal species forming a part of these forests are *Betula cylindrostachya*, *Engelharditia spiciata*, *Phoebe attenuata* and *Schima wallichii*.

### **4. Oak Forests**

Almost pure forests of oak are developed at different elevations in the eastern Himalaya, usually under favorable conditions of growth like soil and moisture. The composition of oak forests varies with altitude in the following manner:

- a. *Lower oak forest*: The main species are: *Acer campbellii*, *Quercus fenestrata* and *Symplocos* sp.
- b. *Buk oak forest*: Its main constituents are: *Michelia doltsopa*, *Prunus nepalensis* and *Quercus lammelosa*.
- c. *Upper oak forest*: The main species forming a part of this forest are: *Acer campbellii*, *Betula alnoides*, *Quercus lamellosa* and *Quercus pachyphylla*.

### **5. Temperate Forests**

In the eastern Himalaya, temperate forests occur at elevations of more than 2200 m. They are comprised of both coniferous and deciduous species. Snowfall occurs only in the upper parts of the temperate belt. The temperate forests of the eastern Himalaya have been described in brief below:

- a. *Wet temperate mixed forest*: Occur at altitudes of over 2300 m with the main species being *Abies densa*, *Quercus lineata*, *Taxus baccata* and *Tsuga dumosa*.
- b. *Moist temperate forest*: A mixture of coniferous and broad-leaved trees occurring in the moist temperate zone.
- c. *Fir forest*: Occur at elevations of more than 2500 m. The principal species forming a part of this forest are *Abies delavayi*, *Abies densa*, *Picea spinulosa* and *Pinus wallichiana*.
- d. *Dry temperate forest*: Occur between elevations of 2800 to 3400 m with the main constituents being *Abies delavayi*, *Abies densa*, *Juniperus* sp., *Picea spinulosa* and *Tusga dumosa*.

## 6. Sub-alpine Forests

Sub-alpine forests are found at elevations of over 3000 m and may extend till the snow line or tree line. Snowfall is received in the sub-alpine tracts with the ground being covered under a blanket of snow for several weeks. There occur pastures within the sub-alpine forests. The main sub-alpine forests of the eastern Himalaya are listed below:

- a. Larch forest.
- b. Sub-alpine birch/fir forest.
- c. Dry Juniper-birch forest.
- d. Sub-alpine scrub.

## 7. Alpine Vegetation

Alpine vegetation occurs near the snow line, usually extending from just below the upper limit of tree growth to the line of perpetual snow. It is made up of alpine

pastures dominated by grasses and a few shrubs with scattered and stunted tree growth. The main vegetation types comprises of the following:

- a. *Moist alpine scrub*: Occurs near the snow line in the moister tracts with the main species being *Berberis*, *Quercus* and *Rhododendron*.
- b. *Dry alpine scrub*: Occurs near the snow line in the drier tracts. The main species are Junipers.