CHAPTER 2

STUDY AREA

2.1  Tons Valley

The study was conducted over the river Tons in western Himalayan region in the state of Uttarakhand, India. The region falls under bio-geographic province 2B zone of the western Himalayas (Rodgers and Panwar, 1988) and sub-region Garhwal Himalayas (Figure 2.1). The Tons valley covers an area of about 4500 sq. km and flows through 2 Indian states i.e., Uttarakhand and Himachal Pradesh and also constitutes political boundary in between these two states. Due to vastness and inaccessibility of the region, biodiversity in numerous areas still remain underexplored or unexplored. The upper catchment of the Tons valley falling in state Uttarakhand was selected for intensive sampling (Figure 2.1). The average elevation in the study area ranges from 900 - 4500 m but few mountain peaks reaches over 6000 m as well (Plate 1 - 3). As very few species occurs at high elevation so, owing to expansive variability in study region, elevation ranging from 900 – 3500 m was considered for sampling.

2.2  Location and Topography

The Tons valley lies between Latitude - 30° 35’ - 31° 20’ North and Longitude - 77° 49’ - 78° 40’ East and entirely composed of hills and high mountains. The valley is bounded in the north and north-east by Shimla district of Himachal Pradesh, in the south-west by the Chakrata forest division of Dehradun district, and in the east by the Yamuna forest division of Uttarkashi district in the state of Uttarakhand. The total area of the Tons valley is ca 4500 sq. km. Its length is 150 km and width is 30 km. The area is composed entirely, of a succession of hills and mountains. The Tons river forms the main drainage system of the valley. Tons river source lies in the 6316 m high Banderpunch glacier zone. The origin of the Tons river is at the convergence of two feeder streams; the Rupin river from the northern part of the Tons catchment near the Himachal Pradesh and the Supin river rises from tributaries from glaciers at north and north-eastern part of Tons catchment. Supin joins Tons at Sankri, which is upstream of confluence of Rupin with Tons at Naitwar (1290 m, asl). These two
feeder streams converge near the mountain hamlet of Naitwar and the channel downstream of Naitwar is known as Tons river. The place is situated in the upstream region of Tuni. The river flow in ‘V’ shaped valley and has an average bed slope of 11m per Km from Naitwar to Tuni.

Pabber is the major tributary of Tons river and merges in tons at Tuni. It originates from Gangdari ranges of great Himalaya in the state of Himachal Pradesh. The river flows in southwest direction down to Rohru town and further downstream of about 20 km in southeast of Rohru and at place Tuni (Uttarakhand), it joins the Tons river.

![Map of the Tons valley (upper catchment) showing major drainage and protected areas (Govind National Park and Govind Wildlife Sanctuary) selected for sampling.](image)

2.3 Geology and Soil

The area forms the knoll belt which extends from Shimla in the northwest upto the Kumaun in the west. In this Himalayan zone, rocks of the area the can be divided into two metamorphic and sedimentary rocks.
Metamorphic rocks are mainly composed of ‘granite and crystalline schist’. Sedimentary rocks are generally of slate, quartzite and conglomerates and include scarlet, green and muddy mica shales, mudstone, silica shales, ferruginous sandstone, brown phyllite and dark coloured slates. These are uncompacted clayey and sandy rocks with bedded structures and ripple marks. The other kinds of rock that are found in the Tons valley are orthoconglomerate, quazrite, grit sandstone. Brown sandy limestone and small amount of phyllite are exposed in the valley. Parallel lamination and ripple marks are common sedimentary structures.

The soil in the valley is fairly deep particularly at the foothills. The soil of this tract can be differentiated into four types; red loam, brown, podsol and meadow soil. The red loams are generally formed along ridges and generally sandy in nature and occurs at sites which received maximum solar radiation. These soils are mostly brownish grey to loamy sand with plenty of undecomposed organic material. The brown forest soil is found in the greater part of the valley and is generally highly organic, finely granular, and clayey and loam, with plenty of undergrowth. The podsol development is met within mils slopes at places in pocket. The meadow soil is usually found near the water streams, cool and low lying shady places. Owing to high ground water table, the soil remains moist and melting of frost covers the soil. These are dark grey, granular, sandy loam, mica sandy soils at greater depth.

Although, the above mentioned soil emerges out of the two parent type rocks, but their development to clear generic types is presumable due to the differences in topographical conditions and weathering agencies like chemical, physical and biochemical and the variation between each of the soil type is numerous.

2.4 Climate

The climate of the area is variable, with subtropical climate in lower part of the valley having hot and more or less humid monsoon season from July to September, pleasant autumn and spring and a cold and dry winter season bracing with clear and bright weather alternating with occasional winter rains and temperate at high elevations. The average rainfall is 1500 mm, with extreme cold and snow during the three to four month winter. Maximum rainfall is experienced during month of July.
and August and minimum rainfall during the months of January and October. A permanent snowline occurs at 5000 m elevation.

In summer, maximum temperature reaches 42 - 43°C in areas below 1600 m and 30 - 32°C at 2000 m elevation. At higher elevations, the weather remain cool and pleasant even in June and the precipitation being high. The winter is long and severe with heavy snowfall above 2000 m. Snowfall down to 1500 m, occasionally lower, but melts away rapidly below 2000 m and even above this altitude, it seldom stays long on sunny slopes except at elevations over 2800 m, snow starts falling in November and continues up to February and sometimes up to March. The period from month of December to February is the coldest period. The months of April, May and June are warm, marked by occasional thunderstorms, often accompanied by hail and raining, at all elevations.

2.5 Vegetation and Protected Areas (PAs) Network

Two protected areas (PAs), the Govind National Park (Govind NP) and the Govind Wildlife Sanctuary (Govind WLS) lies in the upper catchment of the Tons valley (WLS) (Figure 2.1). Govind NP and Govind WLS are part of high Western Himalayan highland situated in Purola Tehsil of the Uttarkashi district in Uttarakhand state and lies between Lat - 31° 02' – 31° 20' N and Long - 77° 55' – 78° 40' E (Figure 2.2). Two major rivers, Rupin and Supin, flow through the Govind NP and Govind WLS and merges at Naitwar village, forming the river Tons. The altitude varies from 1290 - 6323 m. The Govind WLS covers 953.12 km² of which 472.08 km² have been demarcated as National Park encompassing the upper catchment of river Tons.

The forests occur in all aspects and therefore, vary greatly in composition from place to place ranging from river catchments, steep well drained slopes to moist shady ridges and spurs. About 60% of the area of Tons valley is under forest cover. The vegetation of the Tons valley is a mixture of tropical, temperate, sub-alpine, and alpine vegetation. The permanent vegetation is evergreen, intermixed with deciduous species at lower elevations (Champion and Seth, 1968). Following Champion and Seth (1968) forests in study area are classified into six major classes (Figure 2.2) (Appendix 2.1). Detail of groups and subgroups is provided in Appendix 2.1.
The six major types are as follows:

**Group 5. Tropical Dry Deciduous Forest**

**Group 9. Subtropical Pine Forest**

**Group 12. Himalayan Moist Temperate Forest**

**Group 13. Himalayan Dry Temperate Forest**

**Group 14. Sub-alpine Forest**

**Group 15. Moist Alpine Scrub**

The forests in Tons valley are generally dense and the tree height in canopy usually varies from 15 - 30 m. There is an admixture of the species of tropical, temperate and sub-alpine in these forests (Figure 2.2). The deciduous species generally shed their leaves from January to mid March. The forests bordering habitations suffers heavily from lopping and felling. Fortunately, considerable area and parts of the valley forest is not under serious threat and supports luxuriant growth of dense forest. Based on the vegetation composition, Rana et al. (2003) classified the forest of the area into following major types.
(i) Pine Forests

These forests are most widely distributed, occupying the lower slopes in all river catchments, chiefly at the altitudes between 750 – 800 m, occasionally extending above and below this zone. The pine forests go down to about 600 m where these gradually pass into scrub and thorn forests. Towards upper limit these forests extended up to 2300 m, confining to warm exposed aspect, like ridges and spurs. In all pine forests *Pinus roxburghii*, the sole dominant species attains optimum growth in the area. Generally, the pine forests are almost pure, however, at some places *Pinus roxburghii* is associated with trees like *Lyonia ovalifolia*, *Phyllanthus emblica*, *Ougeinia oojeinensis*, *Pyrus pashia*, and in drier rocky places with *Euphorbia royleana*. In shady and moist pockets *Quercus leucotrichophora* and *Alnus nepalensis* are typical associates of pine, however, in upper zone there is an admixture of *Cedrus deodara* and *Pinus wallichiana*.

There is a discontinuous undergrowth of shrubs often so widely scattered that at a very short distance their presence is scarcely observed. Among these are *Rubus ellipticus*, *Rhus parviflora*, *Coriaria nepalensis*, *Berberis lyceum*, *Indigofera cassiodes* and *Woodfordia fruticosa*.

The ground vegetation is almost negligible, except few species like *Imperata cylindrical*, *Heteropogon contortus*, *Anaphalis triplinervis*, *Lespedeza gerardiana*, *Conyza candensis*, *Reinwardtia indica*, *Archyranthes aspera* and *Artemisia nilagirica*.

(ii) Oak Forests

There are three major species of oak in the Tons Valley viz. banj (*Quercus leucotrichophora*), moru (*Q. dilatata*) and kharshu (*Q. semecarpifolia*) which occupy more or less distinct altitudinal zones. The chief characteristic feature of the oak forests are that, soil is usually moist due to high degree of atmospheric humidity throughout the monsoon period, which results in the rich epiphytic flora of mosses, ferns and lichens. The oak forests are dominated by *Quercus leucotrichophora*.

There are few common tree species associated with banj forests such as *Lyonia ovalifolia*, *Neolitsea umbrosa*, *Ilex dipyrena*, *Cornus capitata*, *Phoebe lanceolata* and *Rhododendron arboretum* are locally common. Among shrub species,
there is altogether a different composition, and the numbers of common shrub species are very large. The commonest among them are Berberis chitri, Desmodium elegans, Indigofera heterantha, Daphne papyracea, Myrsine africana, Pricepia utilis, Leptodermis lanceolata etc. The herbs are Boehmeria macrophyllaa, Geranium mascatense, Artimisia nilagrica and grasses like Chrysopogon sp., Drepanostachyum sp. and Bromus ramosus are common.

The moru (Quercus dilatata) oak forests are sporadically found between 2000 – 2500 m elevations and occupy an intermediate zone between the Quercus leucotrichophora and Q. semecarpifolia. Other species in these forests are Acer caesium, Ilex dipyrena, Neolitsea sp. and Symplocos paniculata. The kharsu (Q. semecarpifolia) occupies highest zone amongst the oaks and generally found between 2200 – 3500 m elevations. Other competing species are Abies pindrow, Quercus dilatata, Taxus baccata, Ilex dipyrena, Acer caesium. Common shrubs are Rosa macrophylla, Cotoneaster sp., Lonicera sp., and Wikstroemia canescens.

(iii) Deodar Forests

The dominating tree in the deodar forests is Cedrus deodara, which forms more or less pure formations between 2000 – 3000 m. A few species like Pinus wallichiana, Abies pindrow, Quercus leucotrichophora, Q. dilatata are scattered in deodar forests and the undergrowth is usually scanty consisting of Lonicaera spp., Mahonia borealis, Princepia utilis, Sarcococca saligna, Spiraea canescens, Daphne papyracea, Boehmeria macrophylla and Rosa brunonii. Common herbs are Justicia spp., Plectranthus spp., Polygonum capitatum, Anaphalis spp., Salvia nubicola, Conyza spp., Anisomeles indica and several species of ferns are also dominant on the floor of deodar forest.

(iv) Mixed Forests

The mixed forests being invariably found in the moist depressions upto 1800 m and rarely occur over large continuous areas. The tree species are usually deciduous and found mixed, but at some places Aesculus indica, Acer caesium and Toona serrata, dominate the vegetation. Other common species found in these forests are Continus coggygria, Celtis australis, Albizia julibrissin, Olea ferruginea, Symplocos paniculata, Mallotus philippensis, Ougeinia ooeinensis, Viburnum spp., Rhus
parviflora, Lyonia ovalifolia, Hovenia acerba, Phoebe lanceolata, Cinnamomum tamala, Trema politoria, Euonymus tingens, Alnus nepalensis, Prinsepia utilis, Rubus ellipticus. Toona serrata is observed at shady depressions on way to Sankri area.

Common climbers are Cissampelos pareira, Vitis lanata, Cryptolepis buchananii, Rubia manjith, Clematis monatana, Pueraria tuberosa and Aspidopterys willichii. The ground floor is well covered with the annuals and perennials like Cyathula tomentosa, Boehmeria macrophylla, Crotalaria prostrate, Euphorbia hirta, Verbacum thapsus, Capsella bursa-pastoris, Solanum surattense, S. nigrum, Justicia spp. and Ajuga bracteosa.

(v) Scrub and Thorn Forests

These forests, being a successional community, resulted due to indiscriminate exploitation of the natural forests, uncontrolled felling and cutting of trees and over-grazing. These forests are found upto 1500 m, due to frequent grazing and biotic disturbances, regeneration of species is very poor and hence vegetation is very sparse.

These forests are characterized by bushy or thorny stunted trees and shrubs with crooked stems. They are usually scattered over the rocky and exposed hill slopes. Euphorbia royleana forms the pure patches over rocky hill slopes, it seldom occurs in association with other species. The common species of the scurb and thorny forests are Rhus parviflora, Zanthoxylum armatum, Murraya koenigii, Rhamnus virgatus, R. procumbens, Vitex negundo, Berberis asiatica, Prinsepia utilis, Abelila triflora, Achyranthes bidentata, Plectranthus rugosus, Holmskioldia sanguine, Adhatoda zeylancia, Elsholtzia fruticosa, Artemisia nilagirica, Eriophorum comosum, Flemingia semialata, etc., and grasses like Phragmites karka, Heteropogon contortus, Apluda mutica and Arundinella nepalensis, are very common in the scrub forests.

2.5.1 Seasonal Vegetation

The seasonal vegetation of the valley has been mainly distinguished into rainy, winter and summer vegetations (Rana et. al., 2003).
(i) Rainy Season

During June and July almost all the dried patches begin to green. The species like Euphorbia prostrata, E. hirta, E. hypericifolia, Cyperus difformis, Phyllanthus fraternus, Arthraxon lancifolius and Cynodon dactylon start appearing in the fallow fields and wastelands. About two or three weeks later, a variety of grasses are sprouted up and the whole ground appears like green carpet. By the end of July and first week of August, several species of other groups are also found growing with grasses. Some of the common species are: Origanum vulgare, Alysicarpus spp., Cassia occidentalis, C. pumila, C. tora, Nasturtium officinale, Kickxia ramosissima, Inula spp., Commelina benghalensis, Corchorus aestuans, Portulaca oleracea, Parthenium hysterophorus, Arabidopsis himalaica, A. stricta, Arisaema spp. and Cleome viscose. During the rainy season, optimum temperature and moisture provides the ideal conditions for the plant growth in this area. Most of the species of this season complete their flowering and fruiting by the end of October or November. The bulk of the rainy season vegetation disappears towards the end of November with the same rapidity as it came up during the rains.

(ii) Winter Season

With the commencement of winter season from October to the first week of March, temperature goes down and the top soil as well as the atmosphere becomes dry. By this time, most of the species of temperate regions make their appearance. The common among them are: Anagallis arvensis, Fumaria indica, Gnaphalium spp., Ajuga bracteosa, Anisomeles indica, Verbascum trhapsus, Cyathula tomentosa, Capsella bursa-pastoris, Anemone obtusiloba, Thalictrum foliolosum, Campanula colorata, Conyza aegyptiaca, C. canadensis, Cotula anthemoides, Polygonum capitatum, Rumex dentatus, Euphorbia thymifolia, Setaria pumila and Themeda arundinacea (Rana et al., 2003).

(iii) Summer Season

The summer is very short starting from April to May or first week of June. The decreasing moisture content and increasing temperature during April and May result in the disappearance of most of herbaceous species except those found in the
moist habitats. The seeds of several annual herbs lie dormant in soil throughout the rainy and winter season.

Major plants in the season are *Argemone mexicana*, *Stellaria media*, *Hypericum* spp., *Juncus bufonius*, *Plumbago zeylanica*, *Boerhavia diffusa*, *Geranium nepalense*, *Conyza japonica*, *Launaea* spp., *Myriactis nepalensis*, *Saussurea heteromalla*, *Senecio nudicaulis*, *Taraxacum officinale* and *Tridax procumbens*. Besides this there are lots of herbaceous species associated with the vegetation.

### 2.5.2 Aquatic and Marshy Vegetation

The aquatic and marshy plants normally grow and develop in water and complete at least a part of their life cycle in water. The common habitats for aquatic and marshland species are rivers, ponds, streams, pools, ditches and depressions along the road and villages, formed during rainy seasons. The maximum diversity in the aquatic flora is noticed during monsoon season.

With the onset of cold weather, coupled with gradual drying up of marshy habitats, a green cover appears on the dried up muddy depressions and monsoonal ponds. Some of the common species inhabiting such areas are: *Veronica anagallis-aquatica*, *Houttuynia cordata*, *Acorus calamus*, *Spirodela polyrhiza*, *Typha angustifolia*, *Ranunculus sphaerospermus*, *Mentha arvensis*, *Nasturtium officinale*, *Lecanthes penduncularis*, *Paspalum scrobiculatum*, *Fimbristylis dichotoma*, *Cyperus difformis*, *C. iria* and *C. exaltatus*.

### 2.5.3 Weeds and Aliens

It is sometimes difficult to distinguish between wild plants and aliens, as wild plants comprise both indigenous species and aliens that have become naturalized. The aliens appear as wild plants but behave as weeds. They are generally found along roadsides, waste places, agricultural fields, gardens etc. Among the common weeds are: *Anagallis arvensis*, *Asclepias curassavica*, *Capsella bursa-pastoris*, *Cannabis sativa*, *Chenopodium album*, *C. ambrosioides*, *Cleome viscosa*, *Commelina benghalensis*, *Cyperus iria*, *Euphorbia hirta*, *Fimbristylis dichotoma*, *Fumaria indica*, *Lathyrus sphaericus*, *Oxalis corniculata*, *Panicum psilopodium*, *Stellaria media*, *Tagetes minuta*, *Triumfetta rhomboidea*, *Vicia hirsuta*, *Xanthium indicum*, *Bedens*.
pilosa, Gnaphalium luteo-album, Tridax procumbens, Ageratum conyzoides, Solanum viarum, S. torvum, Physalis minima, Argemone mexicana, Martynia annua, Malvastrum coromandelianum, Parthenium hysterophorus and Lantana camara.

2.6 People and Livelihood

About 47 villages are scattered throughout the Govind NP and Govind WLS (Anonymous, 1986). The people subsist mainly on livestock, cultivation, and forest products. The Tons valley is home hold of several tribal communities like Jaunsaris, Parvatis and Gujjars. Although Parvatis are more or less similar to Jaunsaris but they are not legally notified as tribes. They are economically weaker than Jaunsaris. Gujjars in the area are nomads and they perform transhumance. They move towards high elevation with their livestock during the summer and move back before the onset of the winter. The Rajputs of the valley are called Khasas. The Khasas have always been referred to as a very powerful race, which are supposed to migrate at a very early period from Central Asia and are supposed to have left their name in Kashgar, Kashkara, the Hindukush, Kashmir and Nepal. The poet Kalhan’s chronicle of the Kashmir, the “Rajtaringini” to the ruler of Kashmir is full of references to the Khasas, who were always a continuous source of trouble to the ruler of Kashmir. The “Mahabharata” the “Harivansa” and the epic “Puranas” all mentioned the Khasas as a tribe inhabiting the northwest Himalaya (Saksena, 1962). Grieson in ‘Linguistic Survey of India’ has traced the origin of western Pahari and conclude that earliest Aryan-speaking inhabitants of this region were Khasas.

Despite primitive way of life, the people of the valley have maintained a balance in the agro-ecosystem with major components comprising crop plants (in terrace farming), the forests and rearing of animals, which they have acquired through age-old traditions. Introduction of apple cultivation is a recent change that has altered the socio-economics of the society. Living close to the forest the people have an understanding of the properties of the flora and fauna, functioning of the ecosystems and ways of using them sustainably. But the recent changes in the global economy has influenced the basic lifestyle of the people of the valley, so they are forced to adopt according to the demand of the recent socioeconomic changes in the society like, social pressure to use electronic devices.
2.7 Wildlife

The fauna of the study area is poorly known and represented in literature other than a few scattered references on the mammals, birds, reptiles, butterflies, dragonflies and damselflies, hymenopterans and chilopods. Dang (1968) published a report on the preliminary survey of Har-ki-dun and adjacent valleys, with special reference to blue sheep and brown bear. A report from Wildlife Institute of India (Anonymous, 1986) reported 11 species of mammals from the study area. Later Sathyakumar (1994) reported about 20 species of large mammals from the Govind Pashu Vihar. Kumar et.al. (2004) published a list of 257 taxa belonging to nine faunal groups (viz. Odonata, Lepidoptera, Hymenoptera, Chilopoda, Amphibia, Reptilia, Aves and Mammals.

A total of 115 species of birds and 32 species of mammals have been recorded so far from the area. Major wildlife species are Asiatic Jackal (*Canis aureus*), Red Fox (*Vulpes bengalensis*), Leopard Cat (*Prionailurus bengalensis*), Leopard (*Panthera pardus*), Snow Leopard (*Uncia uncia*), Yellow Throated Marten (*Marets flavigula*), Mountain Weasel (*Mustela altaica*), Brown Bear (*Ursus arctos*), Asiatic Black Bear (*Ursus thibetanus*), Musk Deer (*Moschus chrysogator*), Sambar (*Cervus unicolor*), Barking Deer (*Muntiacus muntjak*), Himalayan Tahr (*Hemitragus jemlahicus*), Bharal (*Pseudois nayaur*), Royale’s Pika (*Ochotona roylei*), Red Giant Flying Squirrel (*Petaurista petaurista*) and Indian Crested Porcupine (*Hystrix indica*). The most important avifauna of the area is Himalayan Bearded Vulture (*Gypaetus barbatus*), Western Tragopan (*Tragopan melanocephalus*), Satyr Tragopan (*Tragopan satyra*), Himalayan Monal (*Lophophorus impejanus*), Koklass (*Pucrasia macrolopha*) and Cheer Pheasant (*Catreus wallichii*), which are also scheduled species in Indian Wildlife (Protection) Act, 1972 (Anonymous, 2006).