Assessement of Forest communities and dependence of local people on NTFPs in Askot Landscape, Uttarakhand

Phase – 1 Report

Biodiversity Conservation and Rural Livelihood Improvement Project (BCRLIP)

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Executive Summary

The Askot landscape represents a great diversity of ecosystems within a very short altitudinal range ie. from 600-7000 m. The assessment of vegetation was done during October, 2012 - October, 2014 covering the entire Gori sub-watershed between 600-2300 m in Askot Landscape in Pithoragarh district of Uttarakhand under Biodiversity Conservation and Rural Livelihood Improvement Project (BCRLIP). A checklist of 573 species of plants was prepared including some rare and endangered species, of which 124 trees, 112 shrubs, 24 climbers, 35 orchids and 278 herbs were recorded after carrying out a reconnaissance of the valley. The data collected for vegetation was analysed and forest communities were identified based on TWINSPAN analysis and various village surveys were conducted to find out the use of various Non Timber Forest Products such as fuelwood, fodder, timber, medicinal plants etc. in the study area.

A total of 11 forest communities were identified in the Gori valley, viz. Macaranga pustulata, Shorea robusta, Engelhardtia spicata, Diploknema butyracea, Pinus roxburghii, Alnus nepalensis, Quercus leucotrichophora, Litsea umbrosa, Quercus lanuginosa, Q. leucotrichophora-Neolitsea cuipala and Sorbus foliolosa along an elevational gradient between 600-2300m. It was observed that the total basal area of Q. lanuginosa forest was highest (38.8 m^2 ha^{-1}) followed by Q. leucotrichophora (32.7 m^2 ha^{-1}) and Pinus roxburghii (31.8 m^2 ha^{-1}) and minimum for Q. leucotrichophora-Neolitsea cuipala forest (10.8 m^2 ha^{-1}) and Sorbus foliolosa forest (9.2 m^2 ha^{-1}).

Among Non Timber Forest Products 24, 26, 16 and 24 species were being used as fodder, fuelwood, timber and medicinal plants, respectively. Q. leucotrichophora has the highest preference among fodder followed by Bauhinia vahlii, Boehmeria rugulosa and Ougeinia oogenensis. Lyonia ovalifolia followed by Rhododendron arboreum, Q. leucotrichophora and Woodfordia fructicosa among fuelwood; Shorea robusta followed by Alnus nepalensis, Pinus roxburgii and Q. leucotrichophora among timber; and

Eupatorium adenophorum followed by *Terminalia chebula, Zanthoxylum alatum* and *Pleurospermum angelicoides* among medicinal plants.

Lopping, forest fire and weed infestation were among major cause of disturbance to forest resources. Impact of lopping on *Quercus lanuginosa, Rhododendron arboreum* and *Q. leucotrichophora*, forest fire in W and NW aspects due to the dominance of Chir pine forests and infestation of *Cannabis sativa, Eupatorium adenophorum, Urtica dioica* and *Impatience edgeworthii* was highest in NW aspect. The common species used for medicinal purposes by the villagers were *Emblica officinalis, Terminalia chebula, Litsea monopetala, Celtis australis, Bauhinia vahlii, Syzygium cumini, Myrica esculenta, Berginia ciliata, Oxalis corniculata, Eupatorium adenophorum, Adhatoda zeylanica, Terminalia chebula, Cissampelos pareira, Viola canescens, Fragaria nubicola, Tinospora cordifolia* and different orchid species in Gori valley.

Twelve potential plant indicator species viz., *Chimnobambusa falcata, Eupatorium adenophorum, Alnus nepalensis, Quercus leucotrichophora, Quercus lanuginosa, Macaranga pustulata, Rhododendron arboreum, Pinus roxburghii, Aconitum heterophyllum, Dactylorhiza hatagirea Picrorhiza kurrooa* and *Pleurospermum angelicoides* were identified based on the information collected during the surveys as well as through secondary information. The distribution map of each species was generated according to climatic zone in ArcGIS software along with their potential distribution range. Finally, a species richness map was prepared to show the high species richness zone in the study area.

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Chapter 1. Askot Landscape - Background

1.1 Introduction

The Askot landscape presents a great diversity of ecosystems because of the great compression of life-zones in a small geographical area. To add to the diverse conditions that such a range of altitudes produce is the landscape's special biogeographic location on east-to-west transition of flora of Himalaya, and its proximity to Tibet, that enables it to share characteristic elements and affinities. The landscape is the converging point of the Western Himalaya, the Central (Nepal) Himalaya, and the Trans-Himalaya (Tibetan-Palearctic) transitions.

The landscape shows a predominance of typical west Himalayan forest communities (Chir pine and west Himalayan oaks), it also represents the western most limit for the occurrence of East Himalayan communities like *Tsuga* and *Macaranga*. Habitats range from sub-tropical Sal to alpine meadows locally called bugyals.

The varied combination of altitude and aspect of each mountain slope, also expose it to different number of hours of sunlight and intensity of solar radiation. Unique combinations of these, and other factors such as severity of slope, varying soil depth and moisture regimes, produce very diverse habitats within a small geographic area, for plant species that have specialized to occupy specific niches. There is great diversity of forests along an elevational gradient in Askot Landscape from the valley bottom *Macaranga pustulata* forest followed by Sal (*Shorea robusta*), broadleaved lauraceous forest, Chir pine (*Pinus roxburghii*), Oaks (occupy different habitats at a successive altitudes), viz. *Q. glauca* (<1500 m on moist slopes); *Q. leucotrichophora* (1100-2200 m on gentle south facing slopes); *Q. lanuginosa* (1500-2000 m on drier slopes); *Q. floribunda* (2200-3300 m on shady and moist slopes) and *Q. semecarpifolia* (2800-3500 m on gentle, drier and south-facing slopes often forms timberline), Fir (*Abies pindrow*), Birch (*Betula utilis*), Hemlock (*Tsuga dumosa*), Noble Cypress (*Cupressus torulosa*) and Blue Pine (*Pinus wallichiana*; Rawat *et al.* 1997, KSLCI 2010).

1.2 Ecological studies in Western Himalaya

Composition of forest in lower altitude region mainly in Gaula catchment was studied by Tiwari (1982), while in Pindar catchment by Adhikari *et al.* (1989, 1991) and in Saryu catchment at higher altitude region of Kumaon Himalaya by Rawal (1990). The studies on structural aspects (biomass) were conducted by Chaturvedi & Singh (1987) on *Pinus roxburghii*, Rawat & Singh (1988) on different oak species, Rana *et al*. (1989) on various forests along altitudinal gradient in Kumaon Himalaya in low altitude region, while Adhikari *et al*. (1995), Garkoti & Singh (1994) and Joshi (2002) in high altitude region of Kumaon Himalaya, Adhikari & Rawat (2004) and Rai (2012) worked in high altitude region of Garhwal Himalaya. Most of the workers who worked on structural aspects of the forest also studied the functional aspects (productivity, litter fall, decomposition and phenology) of various forests. Mehra & Singh (1985) worked on litter fall patterns of various forest types along altitudinal gradient in Kumaon Himalaya. The qualitative study in high altitude region and quantitative study in low altitude region of Kumaon Himalaya on phenology were conducted by Negi (1989). Rawat (1984) worked on phenology of alpine plants of Pithoragarh district as well as alpine region of Uttarakhand state, respectively. The floral wealth of Pithoragarh district was studied by Samant (1988) while structural and functional aspects were studied by Sundriyal (1987) in Tungnath and Ram *et al.* (1988) in Rudranath. Uniyal *et al*. (2002), Garbyal *et al.* (2005) and Negi (2012) studied the Non Timber Forest Products in different valleys of Uttarakhand Himalaya.

1.2.1 *Ecological studies in Askot Landscape*

We have relied on an enumeration and description of the biodiversity values in the Askot Wildlife Sanctuary by Dhar *et al.* (1997), as a base to describe some of the biodiversity values of the project landscape. Rawat (1984) and Samant (1987) worked on floral richness in alpine region of Pithoragarh District. Dhar *et al.* (1997) worked mainly on composition of forests; Samant *et al.* (1998) worked on diversity of orchids in Gori valley and Adhikari (2009) on coarse woody debris. Uniyal *et al*. (2002) and Bhatt *et al*. (2009) worked on ethnomedicinal plants. Samant et al. (1995) and Jalal (2008) worked on

orchids, while Garbyal *et al.* (2005) worked on Livelihoods and lifestyle of Askot Landscape.

1.3 The study Area- Askot landscape

The Askot landscape is located in Eastern Kumaon of Western Himalaya in the state of Uttarakhand and lies between the coordinates 80° to 81° 5’ E Longitude, and 29° 5’ to 30° N Latitude (Fig. 1). It encompasses an area of 4463 square kilometers. There is a great altitudinal range within the landscape from 560 m at Jauljibi to 7434 m at the summit of Nandadevi East. The location of the landscape is where the bio-geographic elements of the Western Himalaya, the Central Himalaya and the Tibetan Plateu converge. (Peace, 2007).

The landscape consists of steep to very steep high mountains and deep narrow valleys. The valleys widen as they approach lower elevations. The following pictures depict the nature of vegetation distribution and human settlements in the landscape.

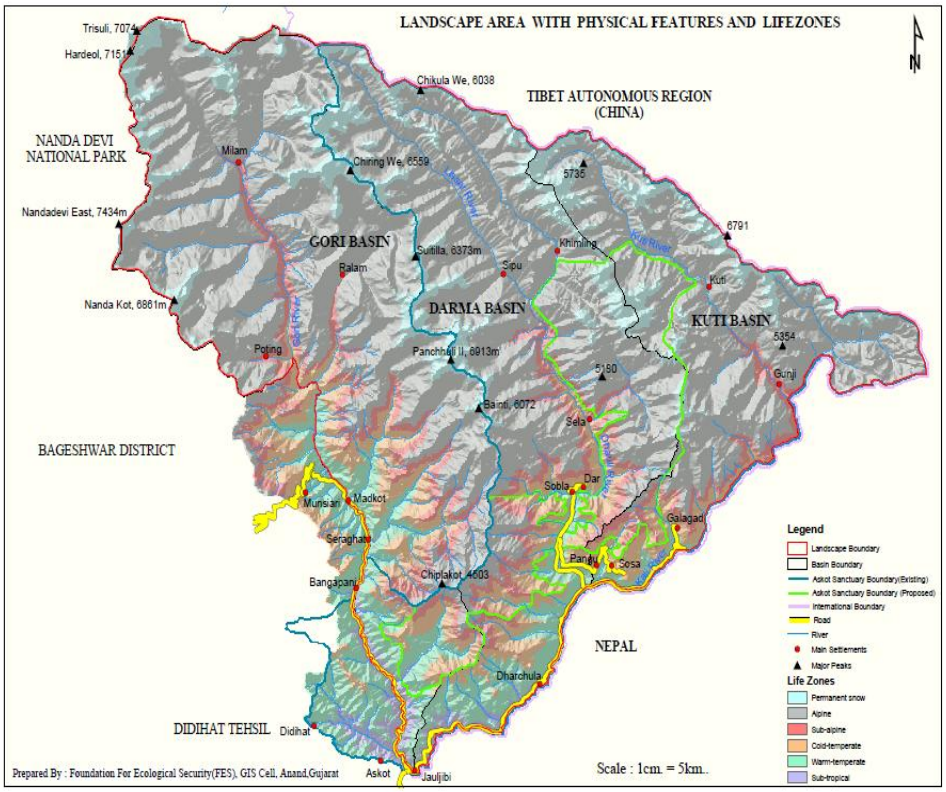


Fig. 1. Physical map of Study Area: The Askot Landscape

1.3.1 Climate

Rainfall is quite variable in this area. Averaging below 200 cm annually in the lower reaches of these valleys, the areas in the Greater Himalaya zone here, for example the Panchachuli basin on the western flanks receives as much as 300 cm of torrential rain. The upper Trans-Himalaya reaches of these valleys, on the other hand, are in the rain-shadows, and comprise an arid cold-desert area that receives less than 15 cm of rain annually. This is excluding the precipitation in the form of snow in winter. Snow at the high altitudes is heavy and wet, and unlike othr places in the trans-Himalaya where dry snow is blown away by strong winds, it accumulates up to the roofs of the alpine habitations, making it necessary for people to migrate with their livestock to lower villages in the montane belt in early October. Avalanches are a regular phenomenon, as witnessed by the huge compacted cones of avalanches debris along many gorges, forming snow bridges across the rivers at many points that can sometimes remain un-melted till the following winter (Peace, 2007).

With every successive ascent of 1000 metres elevation there is a significant drop in air pressure, availability and tension of oxygen and in temperature. In higher elevations humidity drops as well. The mean temperature is known to drop at an average rate of 1 °C for every 270 metres of ascent, the drop being steeper and more rapid above 1500 m altitude (Mani 1984) and similar trend was also reported by Singh et al. (1994), a lapse rate of 0.44 1 °C with a rise of 100m in altitude for Kumaon Himalayan region.

Sharp variation in altitudes plays a greater role in determining climatic factors in the landscape in combination with terrain. The flora and fauna of the Himalaya vary with climate, rainfall, altitude, and soils. The altitudinal variation from 560 to 5600 m provides a range of climatic variations, resulting in variety of climatic zones. The climate ranges from tropical at the base of the mountains to snow at the highest elevations. The state of Uttarakhand has climatically been divided into six eco-climatic regions (Table 1, Fig. 2) viz., sub-tropical (< 1500 m), warm temperate (1500 ~ 2500 m), cool temperate (2500 ~ 3000 m), sub-alpine (3000 ~ 3500 m), alpine (3500 ~ 5500 m) and nival (> 5500 m; modified by Adhikari *et al.* 2003).

Table 1. Life Zone Distribution in the Askot Landscape Area

Climatic Zone	Altitude range (m)
Sub- tropical	<1500
Warm temperate	1500-2500
Cool temperate	2500-3000
Sub-alpine	3000-3500
Alpine	3500-5500
Alpine and Arid	>5500

(Adhikari *et al.* 2003)

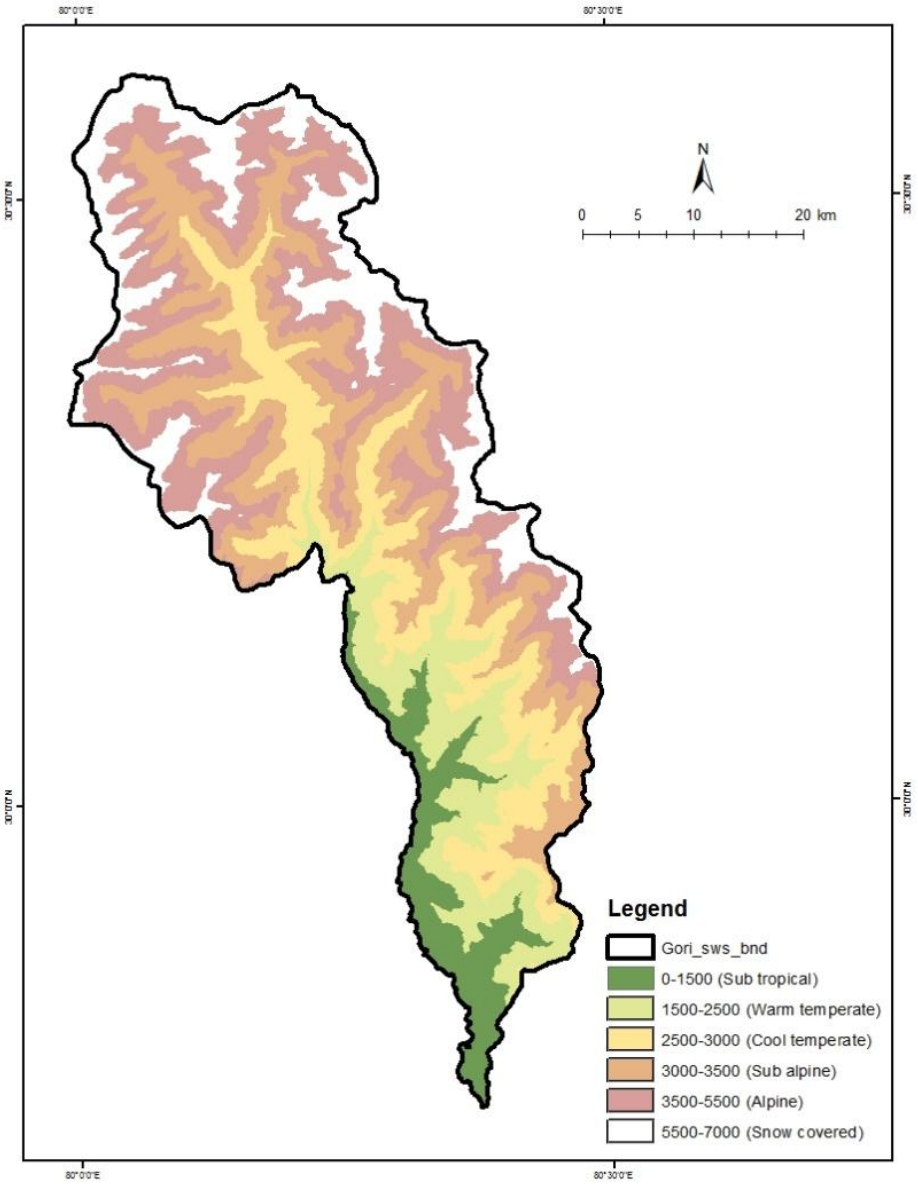


Fig. 2. Different climatic zones in Gori valley

1.3.2 The description of various study sites in Askot Landscape

Due to physiographic, altitudinal and climatic variations, Askot landscape provides an excellent diversity among landform units viz. agricultural fields interspersed with forest/habitation, stability of slopes etc. The major sites of the landscape are described below.

Jauljibi (600 m) - Low elevation zone, valley is relatively wider interspersed with agricultural fields on the left side of the river and sal dominated forest on the right.

Baram (900 m) - A relatively large flat valley with good human population, dominated by warm temperate Chir pine forest in the upper slopes, while the river side lower valley is dominated by sub-tropical Sal forest supports fairly a good number of orchids.

Basaura (1200 m) – Mid elevation zone, narrow valleys dominated by warm temperate Chir pine forest and mixed forests.

Bamoti (1500 m) - Moderate slope, relatively lower density of human population support warm temperate mixed forests.

Kanar (1900 m) – Steep slope with extensive agricultural fields along warm temperate mixed forests, mainly dominated by Oak species.

Buin (1900 m) – Steep slopes support warm temperate mixed forest (mainly different oak species) with good human population.

Walthi (2000 m) - Mountainous plateau with warm temperate Banj oak dominated forest along with cool temperate mixed forest supports good number of human population.

Chhiplakedar (3500 m) – The sub-alpine forest dominated by various forest communities such as *Rhododendron campanulatum*, *Betula utilis* and *Abies pindrow*, while *Danthonia cacheriana* is the major grass species in the alpine region.

Ralam (3600 m) – Temporary settlements of herders during summer season in the glaciated valley and seasonal cultivation of medicinal plants from such ecologically high sensitive area is detrimental to loss of biodiversity.

Milam Glacier (3600 m) – Steep slope, devoid of human settlement and forests.

Chapter 2. The Structure and Compostion of Forest Vegetation

The Askot landscape is an ecologically sensitive landscape due to abrupt altitudinal gradients, glaciel and fluvial movements and aspects and slopes create habitats for a variety of life forms of the primary products of this landscape. Vegetation stands the first manifestation of life forms. As the land form features change the vegetation communities/ associations also change their pattern. Therefore, for understanding the landscape vegetation types, their structure and composition, it is very crucial to study them. The present study aims to understand the landscape from the prospective of vegetation that grows over this landscape, which has been designed to create baseline data on vegetation types.

The study attempts to understand the structure and composition of vegetation types in likely climatic zones so as to create a baseline database on floral diversity and vegetation of the landscape.

The study also explores use of various elements of forest vegetation by local communities and tries to understand the dependence of local communities on these natural resources, specially the forests. This is likely to provide information on important plants in the landscape that have important relationships with local communities. Further, ecological investigations of species use in terms of sustainability, which maintenance of the ecological balance with the environment, is likely to lead the identification of indicators in the landscape.

2.1 Objectives

The overall objective of the study is to understand the structure and composition of various forest types in Askot landscape, dependency pattern on natural resources (i.e. various forest types) and impact of such dependence on the growth and health of the forest system within which the species of high use value occur. Since the study relates to landscape conservation, the first phase of study included surveys in Gori valley to create baseline information on structure and composition of forests and dependencies of local communities on them. Accordingly, the following objectives were set to create baseline information.

- To study the structure and composition of various forest communities and their patterns in Gori valley of Askot landscape , and
- To study the dependence of local people on forest resources.

2.2 Methods

2.2.1 Identification of forest communitites

Based on the initial reconnaissance of Gori valley and knowledge of the area, the valley was divided in to smaller natural units or strata. The strata were based on the vegetation types. Sampling within each stratum was done along the existing trails made by the locals, while on a steep hill slope transects were laid along the contour. Modified method was used following Rawat *et al.* (2004) and a 250 m long transect was laid in each forest patch to collect the information. Within an area of 5 sq.km, a transect was taken. After 50 m of distance in each transect sample plots were laid on either side, 2-3m away from the trail on fodder, fuelwood, timber species and medicinal plants. Thus, there were 5 sample points along each 250 m transects. For the study of tree layer circular plot of 10 m radius, for shrub, climber and sapling of trees circular plot of 5 m radius and for herbs and tree seedlings four quadrats (1x1 m) were taken. The smaller plots for shrubs and herbs were laid within the larger (10 m radius) plots using same centre. Quadrats of 1x1m were placed at four directions just outside the circle. GPS location, altitude (m), slope (°) and aspect, circumference at breast height (CBH), height of tree (m), % canopy cover (tree and shrub), % ground cover (Herb, Grass, Soil,) disturbance (lopping, logging, grazing and fire) and presence of plants with economic importance (Medicinal and Aromatic Plants, Non Timber Forest Products) were recorded. Data on the presence/absence and availability of plants in an area is shown in terms of frequency; density and cover for each transects. Density, diversity and IVI were calculated for different vegetation types of each transect. A total of 45 transects were laid with 225 sampling plots for the study of the vegetation in Gori valley and 10 transects in Kali valley along an altitudinal range from 600 to 2300 m.

2.2.2 Composition of Forest

Gori Valley was divided into eight bins (sampling units) and in each bin 5 transects (3.5 km long trail from the village) were laid. In each transect at a

distance of 500, 1000, 1500, 2500 and 3500m points were selected for laying plots (3 plots, each 200 m apart, 10 m radius circular plots for trees; 5 m plots for shrubs, climbers and saplings of trees; and 4, 1x1m quadrats for herbs) for data collection (Fig. 3). GPS locations, slope, aspect, canopy cover and disturbance (lopping, logging, grazing and fire) were recorded for each plot.

2.2.3. *Dependency of local people*

The use of natural resources viz., fodder, fuel wood, timber and medicinal plants by the locals of villages were collected through semi-structured questionnaire survey. The analysis was done following Misra (1968) and plant identification base on Osmaston (1928) and Polunin and Stainton (1992).

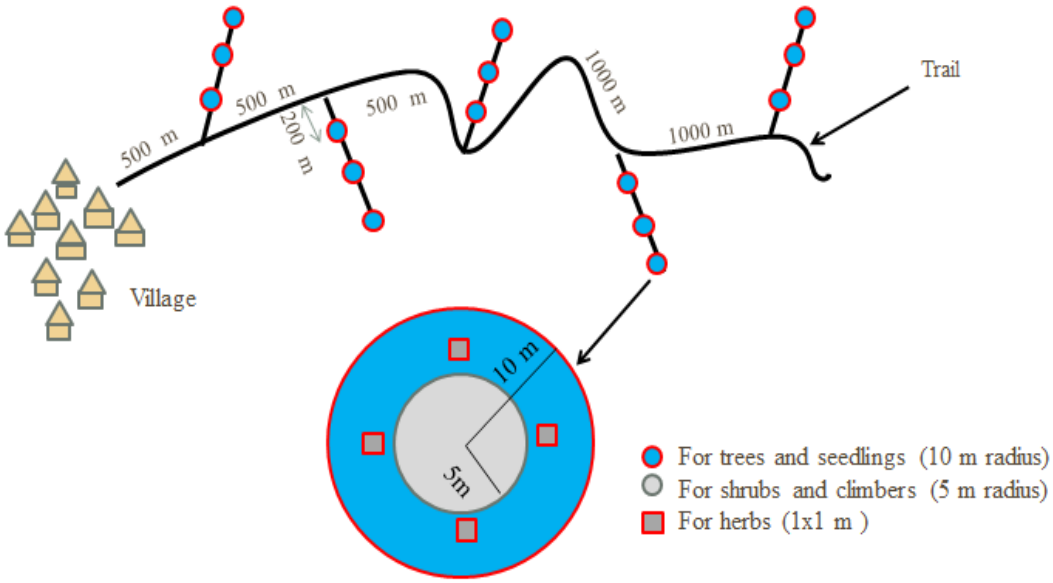


Fig. 3. A 3.5 km long trail and the transect layout with sample plots

2.3 Results

2.3.1 Forest communities

Based on TWINSPAN analysis eleven (11) forest communities have been identified in Gori valley which are as follows:

Sub-tropical zone

1. ***Macaranga pustulata*** **(Ramla)** – *Macaranga* being an eastern Himalayan element occupy certain pockets in Gori valley along riverine habitats and forms extensive forest stands. *Engelhardia spicata, Sapium insigne* and *Cocculus laurifolius* are the associated species.

2. ***Shorea robusta*** **(Sal)** – It occurs in between 600-1200 m asl and forms pure as well as mixed forest with few species like *Terminalia, Mallotus* etc.

3. ***Engelhardia spicata*** **(Mauva)** – It occurs in Sub-tropical to warm temperate zone between 700-1400 m asl.

4. ***Diploknema butyracea*** **(Chyura)** – It occurs in between 800-1100 m asl, while the associate species found in the forest is *Shorea robusta.*

5. ***Alnus nepalensis*** **(Utis)** – It occurs in warm temprate zone between 1300-2000 m asl. *Lyonia ovalifolia, Quercus lanuginosa* and *Rhododendron arboreum* are the associated species.

Warm temperate zone

6. ***Pinus roxburghii*** **(Chir pine)** – It occurs between 1100- 1800 m asl and most of the places forms pure forest.

7. ***Quercus leucotrichophora*** **(Banj oak)** – It occurs between 1500-2000 m asl with several associates, such as *R. arboreum, Lyonia ovalifolia.*

8. ***Litsea umbrosa*** **(Chirad)** – It occurs between 1700-1800 m asl. *Eurya acuminata, Q. glauca, Pyrus pashia* are the associated species.

9. ***Q. lanuginosa*** **(Rianj)** – It occurs in warm temperate to cool temperate zone between 1900-2200 m asl with associate species like *Lyonia ovalifolia* and *Rhododendron arboreum*.

10. ***Q. leucotrichophora - Neolitsea cuipala*** **(Banj-Sallu)** – It occurs in warm temperate to cool temperate zone between 1600-2300 m asl along with *Lyonia ovalifolia, Rhododendron arboreum and Q. glauca* as an associate species.

11. ***Sorbus foliolosa*** – It occurs in sub-alpine zone between 3500-3600 m asl with some other species like *Betula utilis.*

Among early successional forests *Alnus nepalensis* forest had density (381 trees ha^{-1}) and *Macaranga pustulata* (226 trees ha^{-1}) in lower valleys, whereas *Sorbus foliolosa* had 341 trees ha^{-1} in higher regions. Similarly the total basal area was highest for *A. nepalensis* (22.5 m^2 ha^{-1}) followed by *M.pustulata* (17.9 m^2 ha^{-1}). The density and TBA of mid-seral forest such as *Engelhardia spicata, Diploknema butyracea, Litsea umbrosa* ranged from 241-264 trees ha^{-1} and 17 to 28 m^2 ha^{-1}, respectively. Among climax forest the density and TBA was highest for *Quercus lanuginosa* (557 tree ha^{-1} and 38.8 m^2 ha^{-1}) forest followed by *Pinus roxburghii* (291 trees ha^{-1} and 31.8 m^2 ha^{-1}) and *Q.leucotrichophora* forest (279 tree ha^{-1} and 32.7 m^2 ha^{-1}). The values of density and total basal area of dominant and co-dominant species in each forest type are given in Table 2.

Table 2. Density (trees ha^{-1}) and Total Basal Area (TBA, m^2 ha^{-1}) of dominant and co-dominant species in various forest communities

Forest community	Forest		Dominant species		Co-dominant species name	Co-dominant species	
	Density	TBA	Density	TBA		Density	TBA
Macaranga pustulata	226.4	17.9	63.5	4.5	*Engelhardia spicata*	41.3	4.2
Shorea robusta	292.2	13.6	243.0	10.7	-	-	-
Engelhardtia spicata	264.1	27.5	107.9	14.1	-	-	-
Diploknema butyracea	263.4	17.1	114.3	9.1	*Sapium insigne*	57.1	1.6
Pinus roxburghii	291.4	31.8	227.3	28.6		-	-
Alnus nepalensis	380.9	22.5	225.4	16.9	*Lyonia ovalifolia*	77.8	3.3
Quercus leucotrichophora	279.3	32.7	131.2	20.2	-	-	-
Litsea umbrosa	241.2	25.9	66.6	3.4	*Lyonia ovalifolia*	44.4	2.4
Quercus lanuginosa	557.0	38.8	226.9	23.1	*Lyonia ovalifolia*	138.1	6.5
Q. leucotrichophora–Neolitsea cuipala	239.0	10.8	117.0	9.4	*Neolitsea cuipala*	97.9	4.3
Sorbus foliolosa	340.5	9.2	305.4	5.1	*Betula utilis*		

2.3.2 *Floral Diversity*

To capture the plant diversity thirty nine transects were laid with 117 sampling plots. Out of 2607 species of vascular plants in the landscape (Chandran 2012), 573 species of plants under 387 genera belonging to 114 families have been identified in Gori valley (Appendix I) containing 124 species of trees, 112 species of shrubs, 24 species of climber, 35 orchids and 278 species of herbs through transect sampling. The description of major tree species in Gori valley is given in Appendix II.

2.3.3 Density and TBA along elevation gradient

To know the status of different plant species in the forest, we need to understand the ecological parameters such as density and total basal area of the tree layer and density of shrub and herb layers. The bar graph shows the status of different species in the forest which are being used by locals in the landscape. The variation in TBA of *Q. leucotrichophora and Alnus nepalensis* was more than the density of the same species due to higher girth class of the tree species which shows their presence since long. Due to their multipurpose use by the locals, the

density of *Q. leucotrichophora* (used 85% as fodder, 71% as fuelwood and 63% as timber) and *A. nepalensis* (55 % as fuelwood and 76% as timber) was less in the forest. The variation in TBA *of Rhododendron arboreum* and *Q.lanuginosa* was found less than the variation in density of the same species which happens due to lower girth class of the tree species (Fig. 4 a). *R. arboreum* was preferred for fuelwood whereas *Q. lanuginosa* for fodder.

Among shrubs the density of *Boehmeria platyphylla* was found maximum and it was least for *Woodfordia fructicosa*, which is the only shrub species used (69%) as fuelwood by the locals (Fig. 4b).

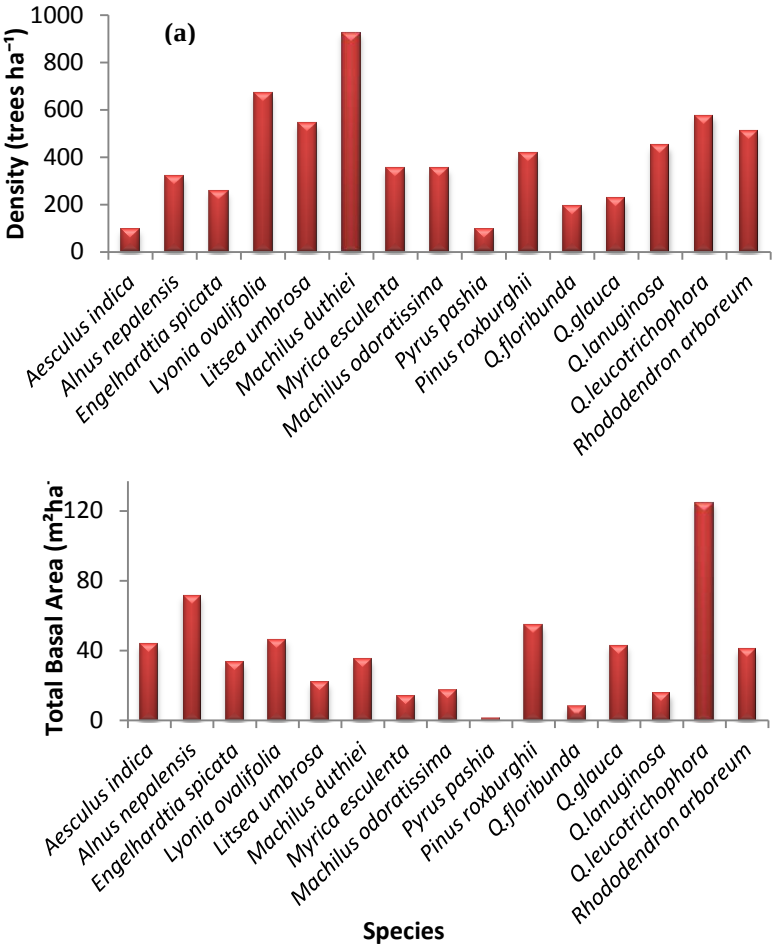


Fig. 4 a. Density (trees ha^{-1}) and total basal area (m^2 ha^{-1}) of different tree species in Gori valley

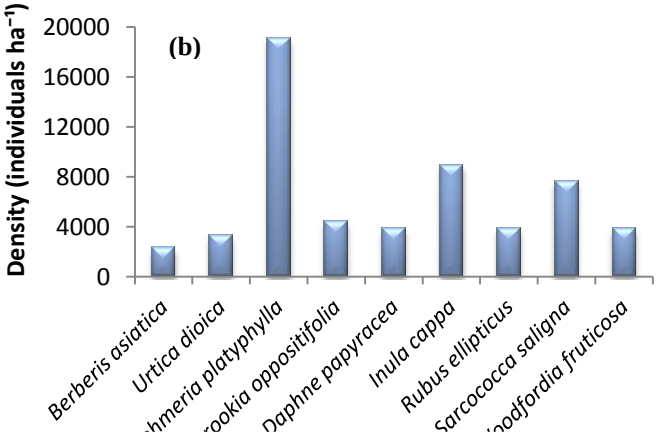


Fig. 4 b Density of shrubs in Gori valley

Among saplings, *Machilus odoratissima* and *Litsea umbrosa* exhibited high density being less useful (*M. odoratissima* used 34% as fodder, 13% as fuelwood and *L. umbrosa* 50% as fuelwood and 13% as timber), whereas *Pinus roxburghii (63% used as fuelwood, 65% as timber), Q. lanuginosa (56% as fodder), Q. leucotrichophora (85% as fodder, 71% as fuelwood, 63% as timber), Q. glauca* and *A. nepalensis* (55% used as fuelwood, 76% as timber) showed low density indicating their possible depletion by the local people (Fig. 4 c).

Among seedlings the variation in density of *Litsea umbrosa* was found maximum followed by *Pinus roxburghii,* whereas density of *Q. lanuginosa* and *Q. glauca* is low being highly harvested fodder species (Fig. 4 d).

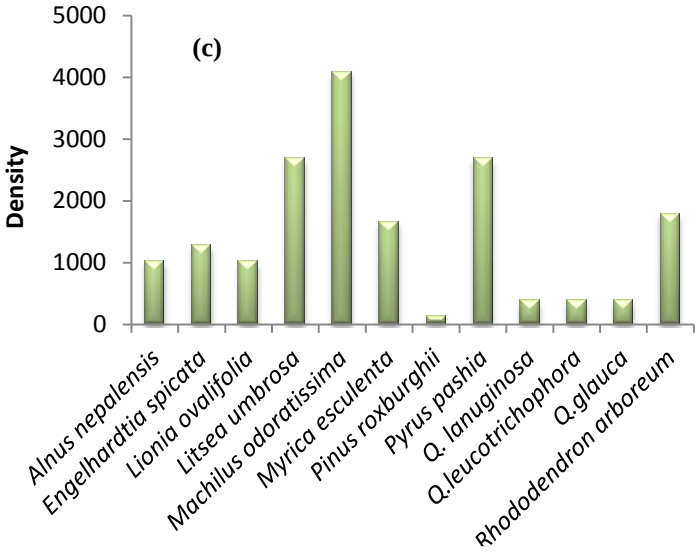


Fig. 4 c. Density (trees ha^{-1}) of saplings of different tree species in Gori valley

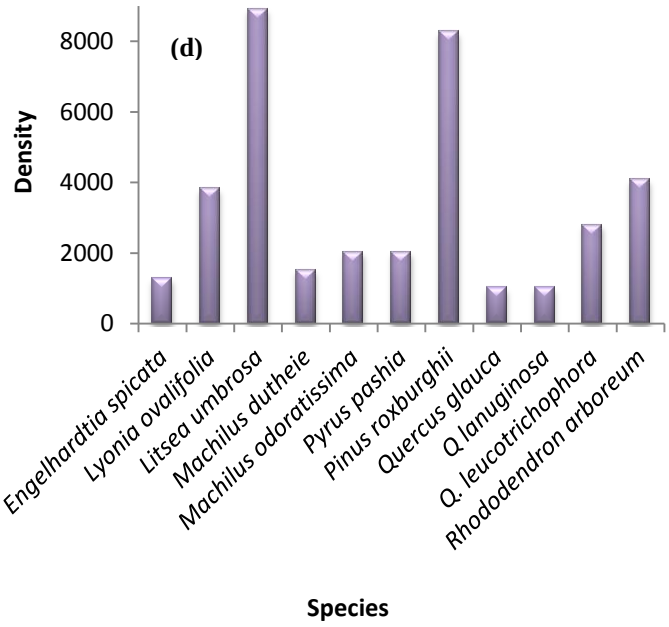
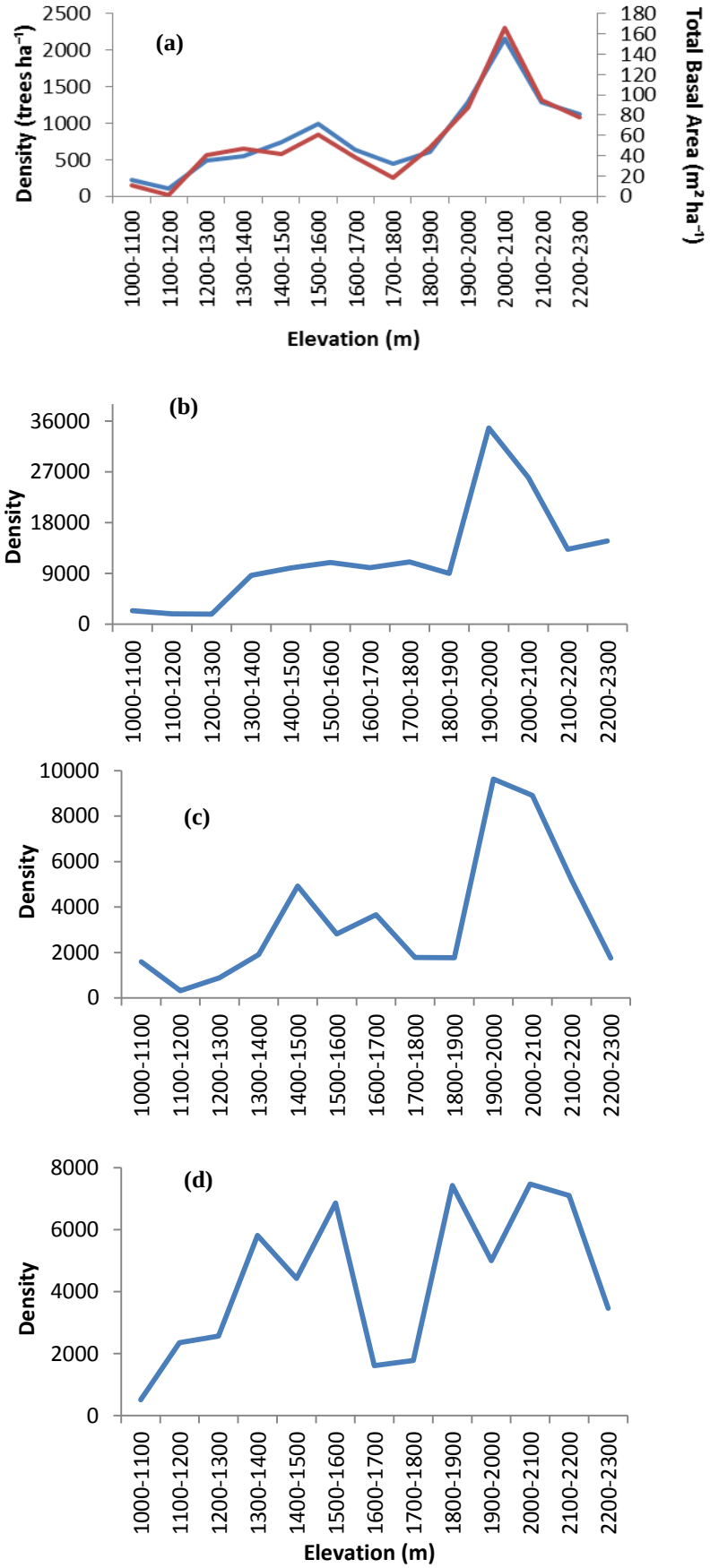


Fig. 4 d. Density of seedlings (individuals ha^{-1}) of different tree species in Gori valley

An increasing and decreasing trend of tree density along altitude indicates the increasing and decreasing adaptability of tree, shrub, sapling and seedling along altitudinal gradient. The Fig. 5 (a-d) shows the trend of different species density along elevation gradient. Density and TBA of trees were maximum between 1900-2100 m zone (Fig. 5 a). This zone is characterized by the species like *Q. leucotrichophora, Lyonia ovalifolia, Machilus duthiei, Litsea umbrosa, Rhododendron arboreum, Q. lanuginosa, Myrica esculenta* and *Alnus nepalensis* which has 60-90% canopy cover.

The density of shrub, sapling and seedling was maximum between 1900-2100 m zone (Fig. 5 b-d) whereas regeneration was very poor in 1600-1800 m zone which was due to the dominance of Chir pine forest (Fig. 5 d).



2.

3.

3.4 Aspect wise density and TBA

Aspect plays a major role on the density of tree layers. The radar diagram shows density and TBA of different tree layers in different aspects. Density of trees was found similar in all the aspects except SE due to presence of young growth forests like *Lyonia ovalifolia, Alnus nepalensis, Syzygium cumini, Litsea umbrosa, Quercus lanuginosa* and TBA of trees was less in SE aspect (Fig. 6 a).

NW aspect exhibited maximum density of shrubs (16 out of 56 plots) indicating that the fire propmotes regeneration more in NW aspect of hardy shrubs. Due to the presence of mixed forests (*Alnus nepalensis, Engelhardia spicata, Ficus auriculata, Lyonia ovalifolia, Mallotus philippensis, Pyrus pashia, Q. glauca, Rhododendron arboreum, Symplocos chinensis, Toona ciliata, Callicarpa macrophylla, Cocculus laurifolius, Emblica officinalis, Glochidion velutinum, Machilus duthiei, Melia azedarach*) density of seedling was found maximum in SW aspect (Fig. 6 b).

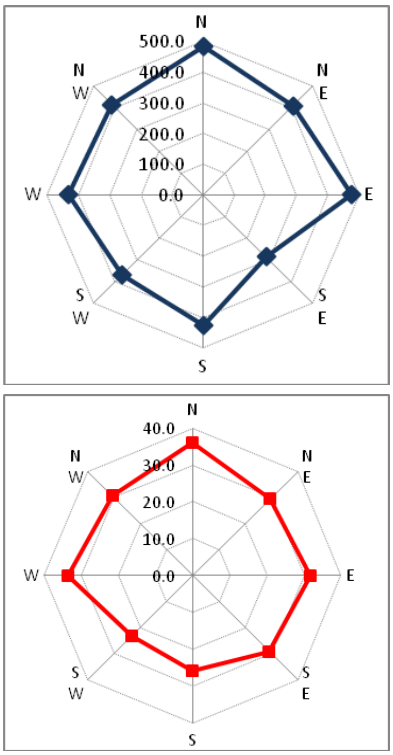


Fig. 6a. Density (trees ha^{-1})and TBA (m^2 ha^{-1}) of trees across aspects

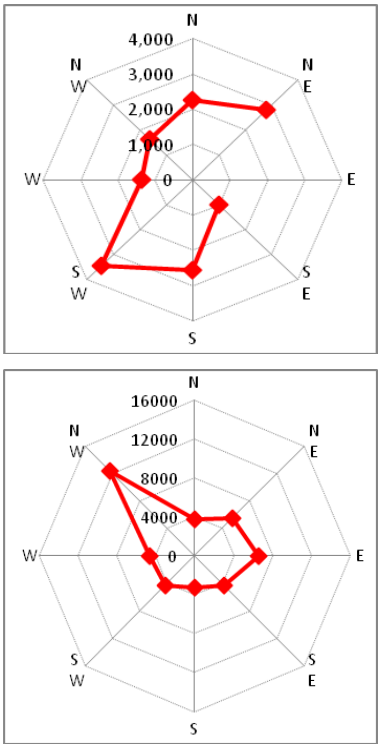


Fig. 6b. Density (individuals ha^{-1}) of saplings and seedlings across aspect

Chapter 3. Dependence of local people

Among human settlements (of the total families) in Gori valley catchment, The village survey was carried out by conducting semi-structured interviews in the selected villages to gather information on diversity of NTFPs extracted, the parts used and their end use. Considering the similar methodology which have been used in the previous year (25% families of village) was followed for each eight bins in the second year for NTFPs.

3.1 Methods

The villages were selected from the sample frame through stratified random sampling along elevational gradient for non timber forest products.Twenty five percent families were surveyed from 56 toks of 13 Van panchayats for NTFPs from 600 to 2300 m to represent the lrger area (Murthi *et al.* 2005).Tok was categorized into three zones based on elevational range i.e. Lower region (<1200 m) under which 26 toks fall, middle region (1200-1800 m) under which 16 toks fall and higher region (>1800 m) under which 14 toks fall. The data was analysed by calculating average use of different species of NTFPs for different villages.The density and distribution of fodder, fuelwood and timberwood species near different villages in Gori valley were also recorded. Maximum harvest of fodder was observed from Rianj forest as the density of fodder species in Rianj forest was maximum ie. 47.3 trees ha^{-1} followed byBanj oak forest (20.7 trees ha^{-1}). The density of fuelwood species in Chir pine forest was recorded maximum i.e. 51.8 trees ha^{-1}, while the density of timberwood in Alder forest was found maximum i.e. 51.2 trees ha^{-1}.

The total basal area of these communities which shows that the landscape is occupied by trees is in the following order: *Q.lanuginosa* (38.8 m^2 ha^{-1}) > *Q. leucotrichophora* (32.7 m^2 ha^{-1}) > *Pinus roxburghii* (31.8 m^2 ha^{-1}) > *Engelhardia spicata* (27.5 m^2 ha^{-1}) > *Litsea umbrosa* (25.9m^2 ha^{-1}) > *Alnus nepalensis* (22.5m^2 ha^{-1}) > *Macaranga pustulata* (17.9 m^2 ha^{-1}) > *Diploknema butyracea* (17.1 m^2 ha^{-1}) > Shorea robusta (13.6 m^2 ha^{-1}) > *Q. leucotrichophora-Neolitsea cuipala* (10.8 m^2 ha^{-1}) > Sorbus foliolosa (9.2 m^2 ha^{-1}). The density and total basal area of dominant and co-dominant species is given in Table2.

3.2 Results

The major plant species which are collected by the local people for fodder, fuelwood, timber and medicinal purposes from nearby forests in the Gori valley are given in Table 3.

Table 3. Major fodder, fuelwood, timber and medicinal species in Gori valley

Fodder	Fuelwood	Timber	Medicinal
Litsea monopetala	*Q. leucotrichophora*	*A. nepalensis*	*Eupatorium adenophorum*
Q. leucotrichophora	*Alnus nepalensis*	*P. roxburghii*	*Pleurospermum angelicoides*
Ficus auriculata	*Pinus roxburghii*	*Shorea robusta*	*Terminalia chebula*
Bauhinia variegata	*R. arboreum*	*Toona ciliata*	*Zanthoxylum alatum*
Bauhinia vahlii	*Macaranga pustulata*	*Q. leucotrichophora*	*Aconitum heterophyllum*
Q. lanuginosa		*Q. floribunda*	*Berginia ciliata*
Q. semecarpifolia		*B. rugulosa*	*Cissampelos paraira*
Boehmeria rugulosa			*Ageratum conyzoides*
Diploknema butyracea			*Dactylorhiza hatagirea*
Celtis australis			*Picrorhiza kurrooa*

3.2.1 Use of Non Timber Forest Products

Out of 24 species of fodder, Oak tree i. e. *Q. leucotrichophora* (85%) with the greatest amount of foliage was chosen for lopping by the locals followed by *Bauhinia vahlii* (75%), *Boehmeria rugulosa* (75%) and *Ougeinia oogenensis* (75%; Fig. 7 a). The household surveys showed that fuelwood continues to be the main source of household energy. Out of 26 species of fuelwood, local's dependency was found mainly on *Lyonia ovalifolia* (75%), *Rhododendron arboreum* (75%), *Q. leucotrichophora* (71%) *and Woodfordia fructicosa 69%* (Fig. 7b). The greatest demand of timber of large dimensions exists in construction sector. This includes residential houses, construction of walls and roofs, the bulk needed for roof beams. Out of 16 species of timber, *Shorea robusta* (100%), *Alnus nepalensis* (78%), *Pinus roxburgii* (65%) and *Q. leucotrichophora* (62%) were being used highly by the locals (Fig. 7 c).

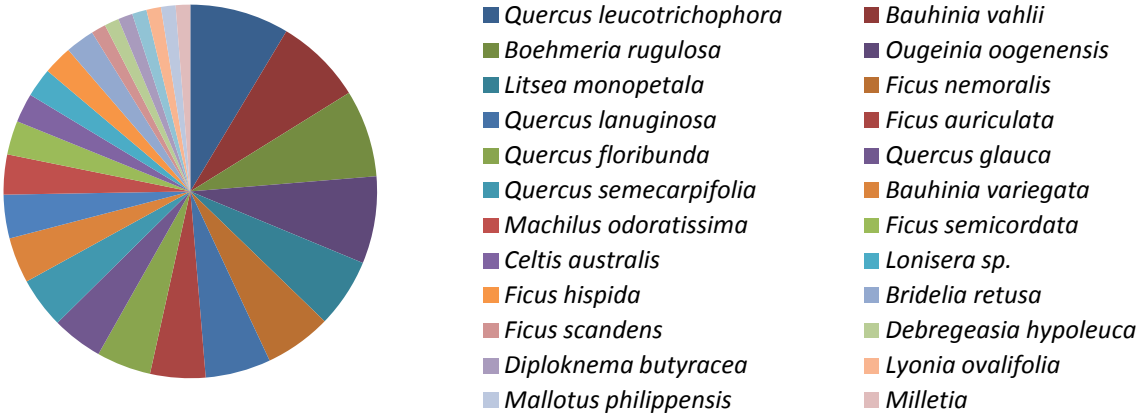


Fig. 7 a. Percent contribution (average use) of different species as fodder

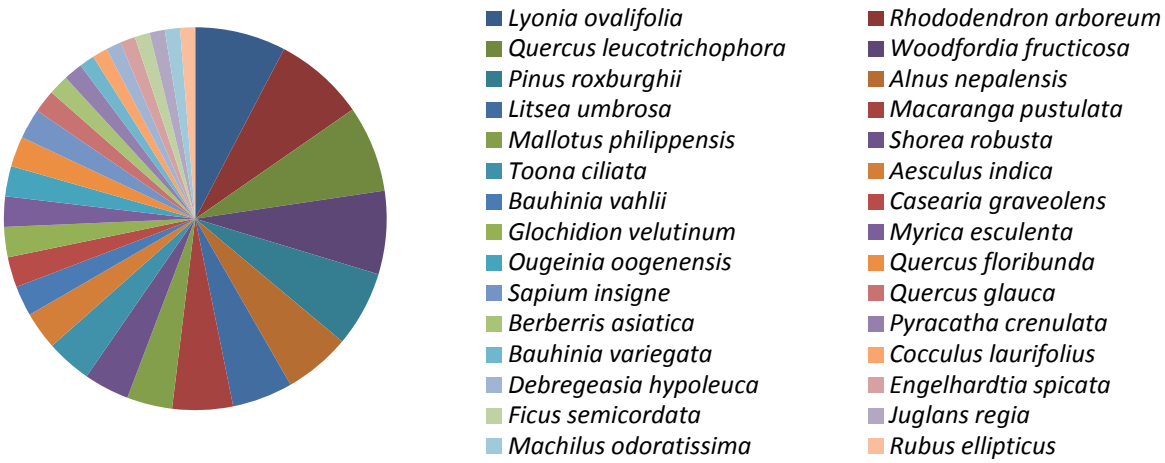


Fig. 7 b. Percent contribution of different species as fuelwood

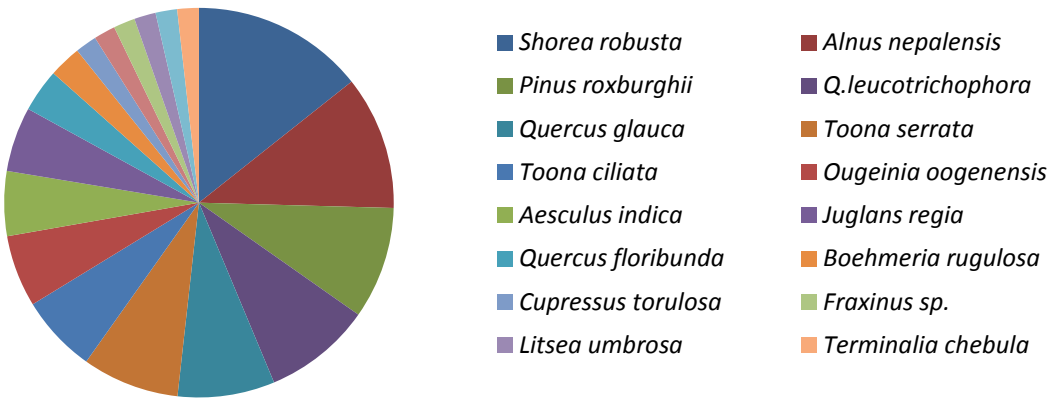


Fig. 7 c. Percent contribution of different species as timber

Distribution and uses of medicinal plants were recorded in the valley. Gradually the use of plants as medicine is decreasing as local people are not aware of the process of using it, as the traditional practitioners either do not share their knowledge with others or the information is not properly percolating down to next generation. They are more dependent on clinics medicine. Only some old people and 'Vaidya' used these plants as medicine. The common species used as medicine by the villagers are shown in Fig. 7 d. Out of 24 species of medicinal plants, local prefers mainly *Eupatorium adenophorum* (67%) (Weed used in skin cut), *Terminalia chebula* (63%), *Zanthoxylum alatum* (57%) and *Pleurospermum angelicoides* (48%).

Fig. 7 d. Percent contribution of different medicinal plants species

3.2.2 Impact of human use

1. Lopping: Forest biomass is the major source of energy**.** Livelihood of the people is closely driven by the forest resources. Lopping is one of the major disturbances to the forest. The radar diagram shows percent tree species lopped in different aspects by the local people. The principal sources of foliage found were *Quercus lanuginosa, Pinus roxburghii, Q. leucotrichophora* and *Rhododendron arboreum.* Through vegetation sampling it was found that *Q. lanuginosa* was lopped by 50%, *Pinus roxburghii, Q. leucotrichophora and Rhododendron arboreum* by 40% and *Alnus nepalensis* by 35% (Fig. 8 a). *Q. lanuginosa* is highly preferred fodder species because of its high nutritive value, which leads to good milk production.

2. **Forest fire**: causes loss of valuable timber to fire and ill effects on soils, watersheds, water quality and wildlife. The diagram shows that the forest fire occurred 40% in W, 35% in NW and 20% in SE aspects due to the dominance of Chir pine forests (Fig. 8 b).

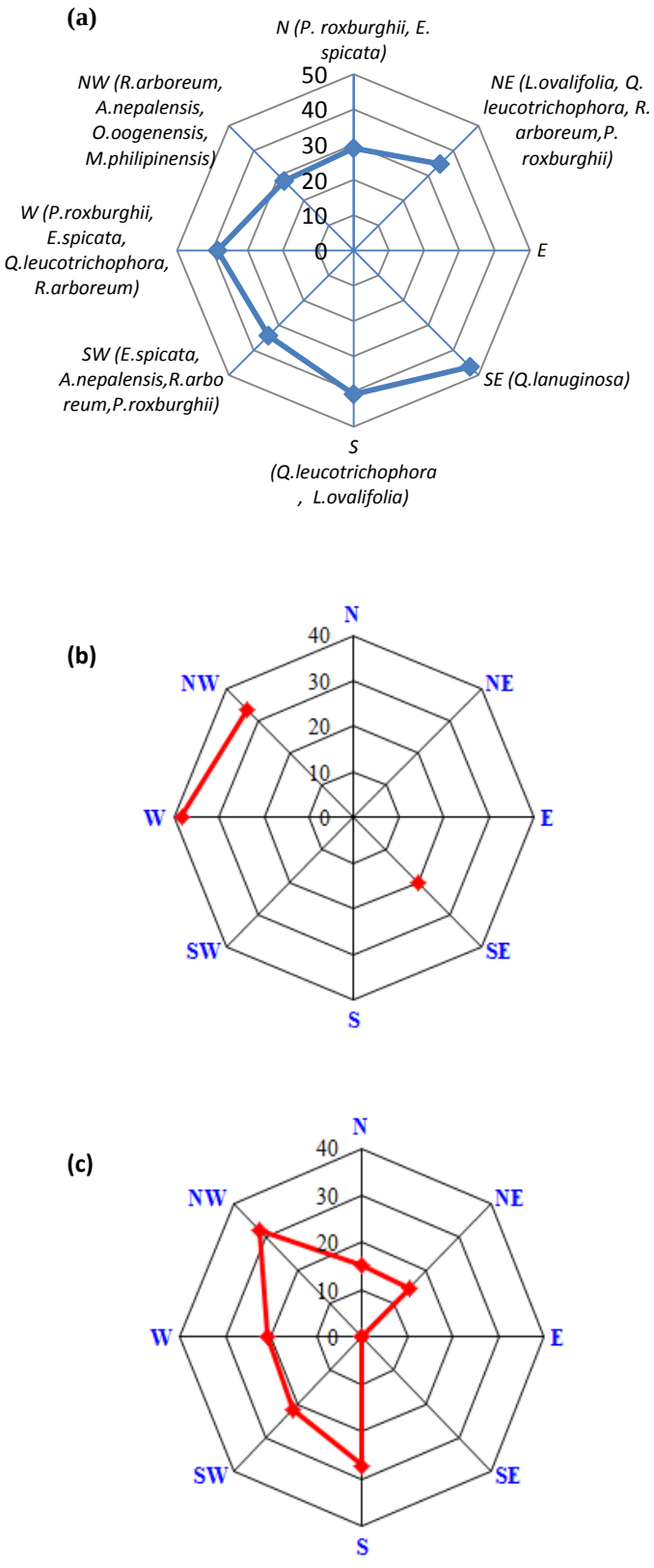


Fig. 8. Percent extent of lopping (a), forest fire (b) and weed infestation (c) in different aspects

3. **Weed infestation**: The infestation of weed reduces land value, and can be difficult and expensive to control. Their multifaceted adaptability and fast replicating characteristics have created a serious threat to the indigenous flora including orchids in the landscape. Several terrestrial orchid species were found to be shockingly less in number in such habitats. Orchids that face threats by these alien species are *Eulophia* spp., *Liparis deflexa, Nervilia spp., Goodyera procera, Habenaria marginata, H. plantaginea, H. pubescens, Pachystoma pubescens, Peristylus constrictus, P. Goodyeroides* and *P. lawii* etc. (Jalal, 2012). The proliferation of weed such as *Cannabis sativa, Eupatorium adenophorum, Urtica dioica, Impatience edgeworthii* in NW aspect was maximum (32%), which is also supported by fire followed by S aspect (27%; Fig. 8c). *E. adenophorum* weed is a noxious plant known to cause acute asthma, diarrhoea and even death of livestock.

3.2.3 Medicinal plants

Medicinal plants are in great demand all over the world due to their minimum side effects as compare to allopathic medicines. The Vaidyas in Askot landscape has not only the theoretical knowledge about use of medicinal plants but also a practical experience handed over from generation to generation. Vaidyas use a number of plants, and plant parts such as flowers, roots or whole plants, mostly on their maturation. The veterinary health care is also being taken care by the Vaidyas.

The common species used as medicine by the villagers were *Emblica officinalis, Terminalia chebula, Celtis australis, Syzygium cumini, Myrica esculenta, Berginia ciliata, Oxalis corniculata, Eupatorium adenophorum, Adhatoda zeylanica, Terminalia chebula, Cissampelos pareira, Fragaria nubicola, Tenospora cordifolia,* Orchid. The medicinal plants used by local people from various forest communities are given in Table 4 and Appendix III.

The sub-alpine and alpine regions in the landscape harbour high value yielding medicinal plants e.g., *Picrorhiza kurrooa, Podophyllum hexandrum, Nardostachys grandiflora, Dactylorhiza hatagirea* and *Aconitum heterophyllum* which have been banned for trade. The collection of such species is continued and traded from the wild because of a sustained market demand. The extensive extraction of lichens (*Jhula*) and *Ophiocordyceps sinensis* (*Keeda jari*) from the landscape is legal, except in the Askot Wildlife Sanctuary (KSLCI Report, 2010).

Table 4. Ethnobotanical practices by the locals of Gori valley

Medicinal plant	Part used	Uses
Abrus precatorius	Seed	eye problems
Acacia catechu	Root/Bark	Piles
Aconitum heterophyllum	Root	tonic, diarrhoea
Adhatoda zeylanica	Root	cough, toothache and tuberculosis
Ageratum conyzoides	Leaf	skin cuts, clotting of blood
Bauhinia variegata	Fruit	Dysentery
Berginia ciliata	Root	Stomachache
Bidens pilosa	Leaf	Wound
Boerhaavia diffusa	Whole	Stomachache
Casearia graveolens	Leaf	heart attack, stone
Cassia tora	Seed	flavour in tea
Celtis australis	Leaf	bone problems
Cissampelos pareira	Leaf	headache and typhoid
Dactylorrhiza hatagirea	Tuber	tonic, kidney complaints
Dioscorea belophylla	Tuber	Cooked and eaten
Drymaria cordata	Whole	Burn part
Emblica officinalis	Seed	Fever
Epipactis helleborine	Root	Insanity
Eupatorium adenophorum	Leaf	cut and wound
Ficus auriculata	Fruit	Dysentery
Ficus clavata	Leaf	chicken pox
Fragaria nubicola	Leaf	headache and typhoid
Habenaria edgeworthii		blood purifier and rejuvenator
Habenaria intermedia	Tuber	general tonic
Lindenbergia grandiflora	Root	cattle disease
Machilus sp.	Seed	Leprosy
Malaxis acuminata		tonic, tuberculosis, enhance sperm production
Malaxis cylindrostachya	Pseudobulb	Tonic
Malaxis muscifera		rejuvenating agent
Myrica esculenta	Bark	childrens fever
Oxalis corniculata	Leaf	injury healing, eye problems
Pholidota articulata	Whole	bone fractures
Picrorhiza kurrooa	Stem	fever, blood purification
Pinus roxburghii	Resin	External cuts
Pleurospermum angelicoides	Root	Stomachache
Podophyllum hexandrum	Fruit	Cough
Rheum australe	Root	internal pain
Rhynchostylis retusa	Leaf	rheumatic disease
Sapium insigne	Latex	skin wart
Sassuria heteromalla	Leaf	toothache and ear problem
Satyrium nepalense	Tuber	tonic, malaria and dysentery
Senecio nudicaulis	Leaf	fungus between toes
Solanum nigrum	Root	bodyache and headache
Stellaria media	Leaf	Headache
Syzygium cumini	Bark	applied on burnt area
Taxus wallichiana	Bark	tumours, cancer
Terminalia chebula	Fruit	Stomachache
Zanthoxylum alatum	Seed	cough, cold, fever, toothache

Chapter 4. Identification of Plant indicators

According to Spellerberg (1994), any biological species that defines a change in the environment known as an indicator, while Interactions that determine the distribution and abundance of organisms described by Krebs (1978). Indicator species are involved with information extrapolation, i.e. in revealing something extrinsic to the data collected. Indicators should tell us something about the environment which is not readily apparent, or which cost prevents us from measuring directly. The primary role of ecological indicators is to measure the response of the ecosystem to anthropogenic disturbances. Ecological indicators are primarily used either to assess the condition of the environment (e.g., as an early-warning system) or to diagnose the cause of environmental change (Dale & Beyeler 2001).

Characteristics of an indicator (Hutcheson et al, 1999) are as follows:

- Abundant and common
- Clearly measurable, e.g., in size, abundance, growth, structure or frequency measurement
- Cross-referable to other indicators, while having independent attributes
- Multipurpose use
- Ecology and life history well understood
- Economically and commercially important

4.1 Criteria for selection of potential indicators

Because the human habitation occurs in the landscape amidst the forested slopes and valleys, initial indicators have been identified considering their abundance and human use values. The detailed criteria for plant species selection is based as per climatic zones with special reference to the factors governing their distribution in various habitat types .i.e. forested areas, eroded slopes, disturbed areas etc. and is given in Table 5.

Table. 5. Criteria, Habitat and Climatic zone of selected Potential plant indicators

Factors	Potential indicators	Criteria and Characteristics*	Habit	Climatic Zone
Disturbance	*Eupatorium adenophorum*	A, C	Shrub	Sub-tropical
Landslide prone area/eroded slope	*Alnus nepalensis*	A, C, MP	Tree	Sub-tropical
Landslide prone area/eroded slope	*Macaranga pustulata*	A, C, MP	Tree	Sub-tropical
Multiple use	*Quercus leucotrichophora*	A, C, MP	Tree	Warm temperate
Fire resistance	*Pinus roxburghii*	A, C, MP	Tree	Warm temperate
Multiple use	*Quercus lanuginosa*	E, Co	Tree	Cool temperate
Soil binder	*Chimnobambusa falcata*	E, Co	Grass	Cool temperate
Climatic variation	*Rhododendron arboreum*	A, C, E, Cl	Tree	Cool temperate
Medicinal use	*Dactylorhiza hatagirea*	M	Orchid	Sub-alpine
	Aconitum heterophyllum	M	Herb	Sub-alpine
	Picrorhiza kurrooa	M	Herb	Alpine
	Pleurospermum angelicoides	M	Herb	Alpine

* A: Abundant, C: Common, Co: Commercial purpose, Cl: Climate sensitive, E: Economically important, M: Medicinal purpose, MP: Multipurpose use

4.2 Regeneration and Population Structure of Potential Indicator species

As population structure of any forest community depends on the harvested intensity, heavy lopping does not appear to have led to significant decreases in seedlings and saplings density. The density and size class distribution of major tree species (*Q. leucotrichophora, M. pustulata*, *Q. lanuginosa*, *A. nepalensis*, *R. arboreum* and *P. roxburghii* is shown in Fig. 9 (a-f).

Though, all the species were cut and lopped highly for various purposes, their regeneration status seems to be quite fair and flourishing well in the system. The pressure on oak species seems to be more in higher girth classes than that of lower girth classes, thus the population is low in that particular girth class. It is also reflected through the density of seedlings and saplings of oak species that there is no pressure of livestock grazing in these forest sites, while *Alnus* being ruderal species occupied disrturbed habitats along the river side or old landslide areas.

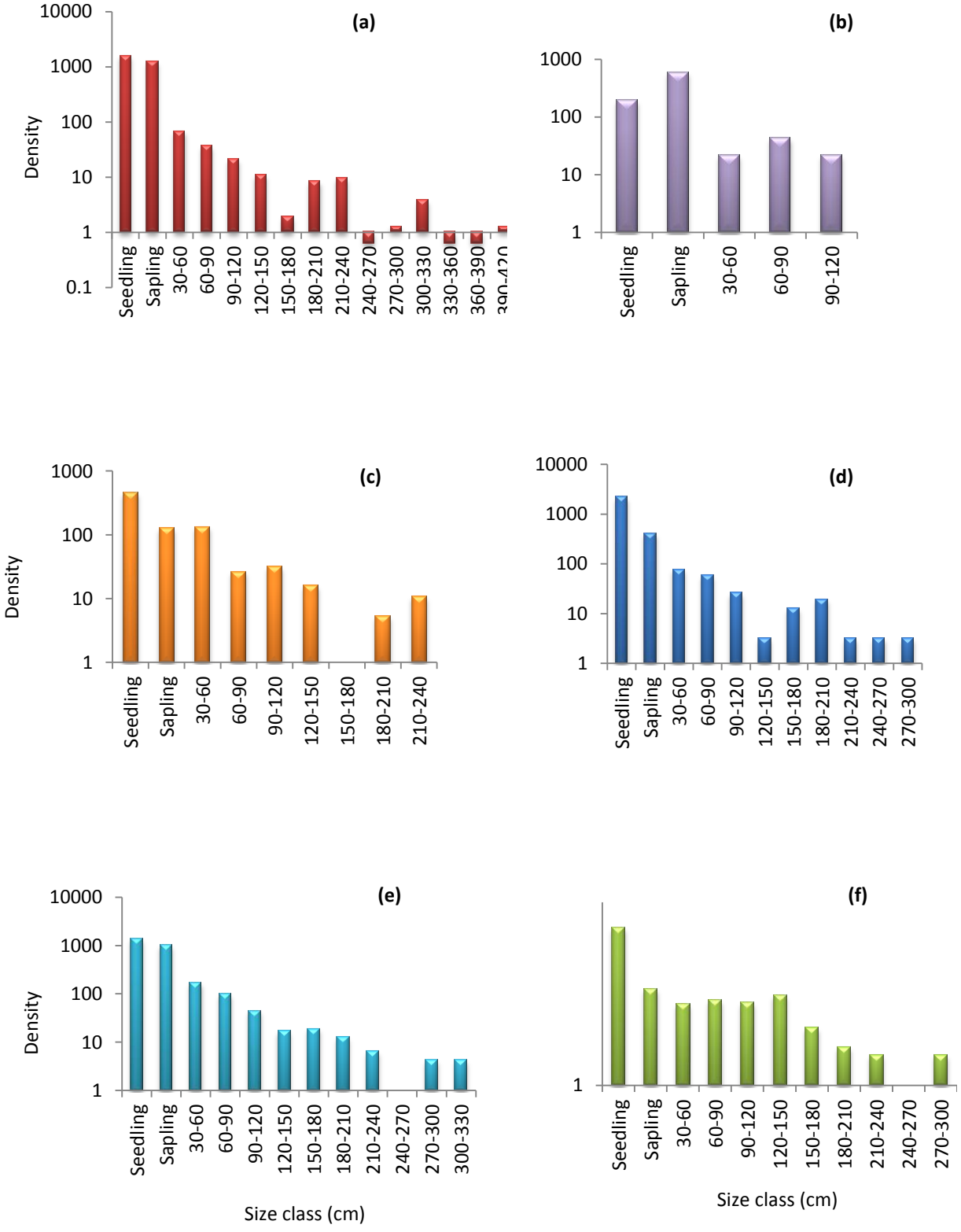
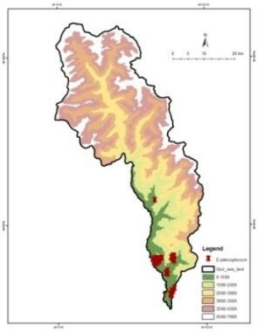


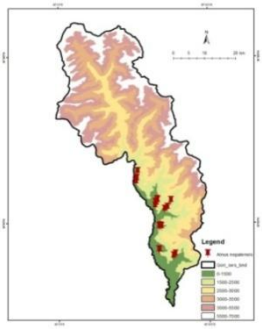
Fig. 9. Size class distribution of different tree species (a) *Q. leucotrichophora,* (b) *M. pustulata*, (c) *Q. lanuginosa*, (d) *A. nepalensis*, (e) *R. arboreum* and (f) *P. roxburghii*

4.3 Distribution of potential indicator species in Askot Landscape (Gori valley)

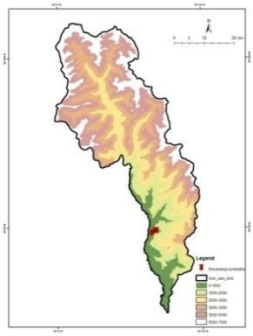
A data sheet was prepapred based on the data recorded for altitude of selected plant species in excel. With the help of Arc Gis software maps were generated for each species. The species distribution map was generated in GIS domain based on spatial information recorded from ground and extrapolated in Gori valley with the help of Euclidian and Digital Elevation Model (DEM) data. Following are the maps (Figs. 10-11) showing the distribution of these indicator species across the altitudinal gradient.



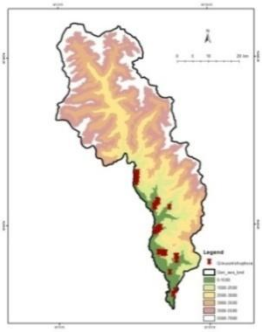
a (i)



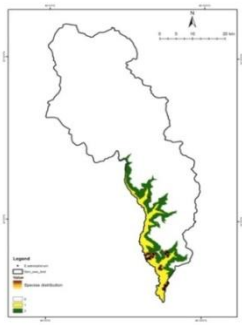
a (ii)



c (i)



d (i)



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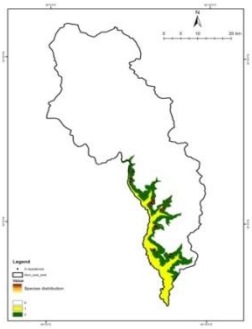
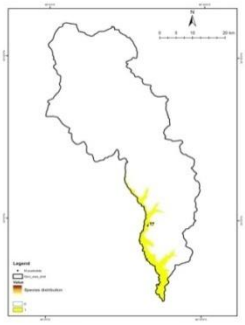
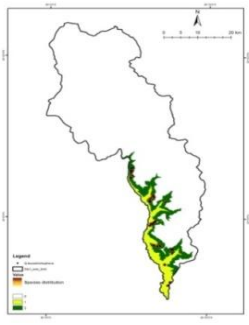


b (ii)



c (ii)



d (ii)

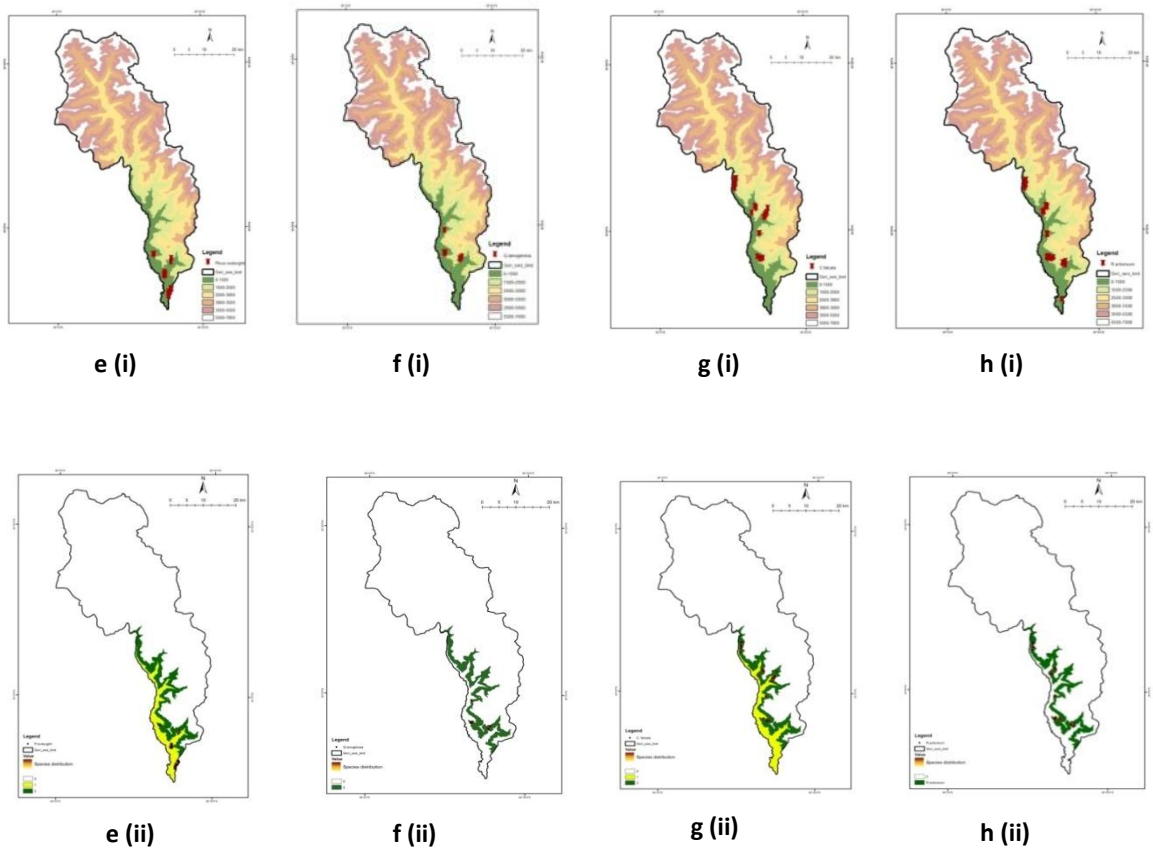


Fig. 10. Distribution point (i) and potential distribution (ii) map of selected indicator species *Eupatorium adenophorum* (a-i, a ii), *Alnus nepalensis* (b-i, bii), *Macaranga pustulata* (c-i, cii) in sub-tropical zone, *Quercus leucotrichophora* (d-i, d-ii), *Pinus roxburghii* (e-i, e-ii) in warm temperate zone *Quercus lanuginosa* (f-i, f-ii), *Chimnobambusa falcata* (g-i, g-ii), *Rhododendron* arboreum (h-i, h-ii) in cold temperate zone

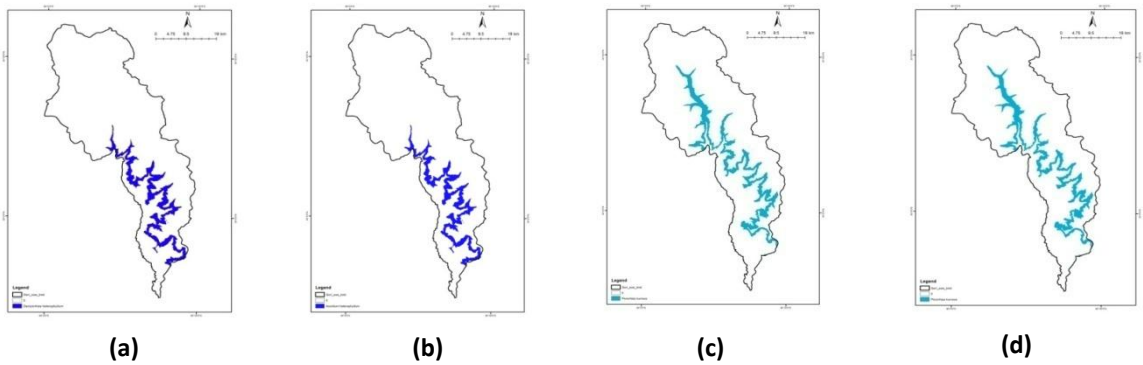


Fig. 11. Potential distribution map of selected indicator species of alpine and sub-alpine region *Dactylorhiza hatagirea* (a), *Aconitum heterophyllum* (b), *Picrorhiza kurrooa* (c), and *Pleurospermum angelicoides* (d)

4.4 Zone of high species richness

The plant species richness is the number of different species represented in a landscape. The species richness across trees, shrubs and seedlings is shown in Fig. 12, suggesting that in lower elevation species richness is less while it is higher at the transitional zone. This is mainly due to the culmination of sub-tropical and warm temperate zones where several other forests occur with different associates.

The species richness area consists of Broad leaved forests and mixed forests for example, *Alnus nepalensis, Macaranga pustulata, Engelhardia spicata, Quercus leucotrichophora, Q.leucotrichophora-Neolitsea cuipala, Litsea umbrosa, Ficus rumphii* etc. Out of 51 sites, 19% sites had high tree richness (10-15 species) in sub-tropical and warm temperate zones, while 16% sites had moderate shrub richness (5-10 species) that too in sub-tropical and warm temperate zones. The herb species richness was quite high in all the sites as compared to shrubs and trees. Most of the sites (49%) fall under herb species richness (10-15 species). Overall, 12% sites had high species richness including treees, shrubs and herbs ranging from 30-37 species, 51% sites were moderately rich with 21-28 species, while 37% sites were less than 20 species. The overall species richness data shows decreasing pattern wih increase in altitude for seedlings and shrubs while for trees it is uneven.

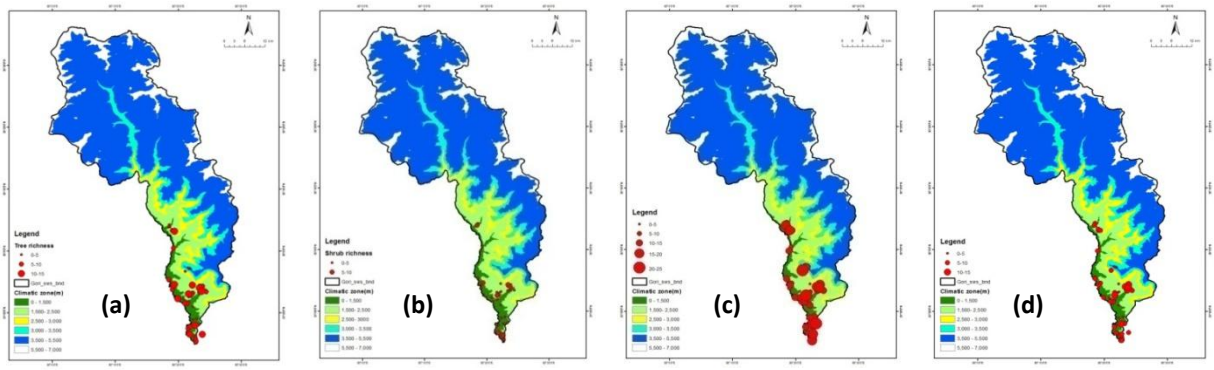


Fig. 12. Map showing species richness of different tree layers (a) trees, (b) shrubs, (c) herbs and (d) overall species layer in Gori valley

4.5 Status of RET Plant Species in Gori Valley

Over 196 plant taxa of threatened categories were identified in the Askot landscape, and are under the pressure of over exploitation and the destruction of their natural habitats (Samant *et al.* 1998). The extraction of roots by digging out whole plants indiscriminately causes low population densities and habitat degradation, which are major constraints for future regeneration. It is a usual practice in the Gori valley to sell and use its root as medicine. Moreover, trampling by livestock was also noted as a major factor for the depletion of its population in natural habitats. In relation to these observations, over-collection and grazing pressure are the disturbances highly responsible for the low density and continuous decline of the wild populations of most of the rare and endangered medicinal plants in the Indian Himalayan region (Kala, 2000). Of the 196 species 11 have already been recorded in the Red Data Book of Indian Plants (Samant *et al.* 1998, Uniyal *et al.* 2002, Table 6).

Table 6. RET plant species in Gori valley recorded in RDB of Indian Plants

Botanical name	Common name	RDB Status	Habitat
Acer caesium		V	Cool temperate
Allium stracheyi	Jambu	V	Sub-alpine
Athyrium duthiei		V	Sub-alpine
Cymbidium eburneum		V	Sub-tropical
Cypripedium cordigerum		R	Cool temperate
Cypripedium elegans		R	Sub-alpine
Cypripedium himalaicum		R	Sub-alpine
Dioscorea deltoidea		V	Warm temperate
Eria occidentalis		R	Sub-tropical
Nardostachys grandiflora	Jatamasi	V	Alpine
Picrorhiza kurrooa	Kutki	V	Alpine

V: Vulnerable, R:Rare

Chapter 5. Orchid Flora of Gori valley

Orchidaceae is one of the largest families of flowering plants with an estimate of 24,500 species worldwide. The Indian orchid flora (1,331 species) is one of the richest in tropical Asia. The state of Uttarakhand ranks fifth among the Indian states in terms of orchid richness. More than 50% orchids of Uttarakhand are distributed only in the Gori valley. Therefore, it symbolizes as an orchid hotspot in the Western Himalaya. Out of 255 species of orchids so far recorded from western Himalaya, 122 species belonging to 44 genera are recorded from the Gori valley alone (Balodi, 1987; Deva and Nathani, 1986; Jalal, 2005; Murti *et al.,* 2000; Singh, 2001; Seidenfaden and Arora, 1982, Bisht & Adhikari 2014). *Bulbophyllum* is the largest genus in the area followed by *Dendrobium, Habenaria, Eria, Cymbidium* and *Oberonia. D. normale, E. occidentalis Flickingeria hesperis* and *Nervillia mackinnonii* are endemic to Uttarakhand. The significant host species for the orchids are *Toona ciliata*, *Engelhardia spicata* and *Quercus leucotrichophora*. The common orchid species of Gori valley are given in Appendix IV.

5.1 Addition to Orchid Flora

Dendrobium is the third largest epiphytic genera of the Orchidaceae with 1,184 species. In India, the genus is represented by 116 species (Misra, 2007), 18 species in Western Himalaya, 16 species in Uttarakhand (Jalal & Rawat 2008) and 11 species (*D. amoenum, D. bicameratum, D. candidum, D. chysanthum, D. chryseum, D. crepidatum, D. denudans, D. heterocarpum, D. monticola, D. normale and D. primulinum*) in Askot Landscape. (Appendix V).

5.2 Conservation

Rapid changes in the habitat and microhabitat conditions have caused depletion of orchids in this valley. Many species have either become rare and endangered and are restricted to a few specialized habitats. The major threats are destruction of riverine habitats, deforestation, forest fire and traditional medicine. For saving this highly advanced group of plants, it is necessary to identify suitable host species and orchid rich sites for in-situ conservation, spread awareness and conducting experimental orchid farming.

Conclusion

The Askot landscape is a vital ecological entity harbouring a range of biological diversity, providing ecological services and supporting livelihoods of a large population of mountain people. The trees, shrubs and herbs of various kinds have been used by people for their sustenance since million years. Increasing demands for better livelihoods however is gradually increasing pressure on highly vulnerable natural vegetation patches.

The study thus far, has tried to document the vegetation characteristic of the landscape represented by Gori valley, in identification and description of various vegetation types. Being a mountainous country the hills and valleys along altitudinal gradient create multiple vegetation types where from the local communities have been extracting resources from their own sustenance.

Askot landscape is divided into six climatic zones. Eleven vegetation types fall in three zones out of the six. Through aspect study of human impacts slopes have been identified which are under greater pressure and conditional vegetation on those areas.

In sub-tropical zone orchid flora is rich along Gori river along with *Shorea robusta, Alnus nepalensis* and *Litsea monopetala* which are used highly by the local people whereas in warm temperate zone *Quercus leucotrichophora, Pinus roxburghii* and *Q. lanuginosa* are preferred. Twelve potential indicator species have been identified which will be monitored in the next phase of the study for long term monitoring by involving local youth and para-taxonomist.

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Appendix I: Checklist of plants observed during the survey in Gori valley

Species	Family
Trees	
Acer oblongum	Aceraceae
Acer acuminata	Aceraceae
Acer caesium	Aceraceae
Pistacia integerrima	Anacardiaceae
Rhus punjabensis	Anacardiaceae
Rhus semialata	Anacardiaceae
Lannea grandis	Anacardiaceae
Plumeria rubra	Apocynaceae
Holarhena antidysenterica	Apocynaceae
Schefflera arboricola	Araliaceae
Leucomeris spectabilis	Asteraceae
Alnus nepalensis	Betulaceae
Betula alnoides	Betulaceae
Betula utilis	Betulaceae
Carpinus viminea	Betulaceae
Jacaranda ovalifolia	Bignoniaceae
Oroxylum indicum	Bignoniaceae
Bombax ceiba	Bombacaceae
Boswellia serrata	Burceraceae
Bauhinia variegata	Caesalpiniaceae
Delonix regia	Caesalpiniaceae
Trema orientalis	Cannabaceae
Terminalia bellirica	Combretaceae
Terminalia chebula	Combretaceae
Terminalia tomentosa	Combretaceae
Alangium alpinum	Cornaceae
Cornus oblonga	Cornaceae
Thuja orientalis	Cupressaceae
Shorea robusta	Dipterocarpaceae
Rhododendron arboreum	Ericaceae
Lyonia ovalifolia	Ericaceae
Bischofia javanica	Euphorbiaceae
Daphnephyllum himalayense	Euphorbiaceae
Emblica officinalis	Euphorbiaceae
Glochidion velutinum	Euphorbiaceae
Macaranga pustulata	Euphorbiaceae
Mallotus philippensis	Euphorbiaceae
Sapium insigne	Euphorbiaceae
Acacia catechu	Fabaceae
Acacia mearnsii	Fabaceae
Albizia julibrissin	Fabaceae
Albizia lebbek	Fabaceae
Butea monosperma	Fabaceae
Dalbergia sissoo	Fabaceae
Ougeinia oojeinensis	Fabaceae
Quercus floribunda	Fagaceae
Quercus glauca	Fagaceae
Quercus lanuginosa	Fagaceae
Quercus leucotrichophora	Fagaceae
Quercus semecarpifolia	Fagaceae
Ilex dipyrena	Ilicaceae
Engelhardtia spicata	Juglandaceae
Juglans regia	Juglandaceae
Gmelina arborea	Lamiaceae
Cinnamomum tamala	Lauraceae
Litsea monopetala	Lauraceae
Litsea umbrosa	Lauraceae
Machilus duthiei	Lauraceae
Machilus odoratissima	Lauraceae
Phoebe lanceolata	Lauraceae
Duabanga grandiflora	Lythraceae
Melia azedarach	Meliaceae
Toona ciliata	Meliaceae
Toona serrata	Meliaceae
Cocculus laurifolius	Menispermaceae
Ficus auriculata	Moraceae
Ficus benghalensis	Moraceae
Ficus hispida	Moraceae
Ficus palmata	Moraceae
Ficus religiosa	Moraceae
Ficus rumphii	Moraceae
Ficus semicordata	Moraceae
Ficus virens	Moraceae
Morus alba	Moraceae
Moringa oleifera	Moringaceae
Myrica esculenta	Myricaceae

Psydium guajava	Myrtaceae
Eucalyptus obliqua	Myrtaceae
Syzygium cumini	Myrtaceae
Fraxinus micrantha	Oleaceae
Osmanthus fragrans	Oleaceae
Phoenix sylvestris	Palmaceae
Bridelia ferruginea	Phyllanthacae
Abies spectabilis	Pinaceae
Abies densa	Pinaceae
Cedrus deodara	Pinaceae
Cupressus torulosa	Pinaceae
Pinus roxburghii	Pinaceae
Pinus wallichiana	Pinaceae
Tsuga dumosa	Pinaceae
Grevillea robusta	Proteaceae
Cyclostemon assamicus	Putranjivaceae
Rhamnus sp.	Rhamnaceae
Prunus cerassoides	Rosaceae
Prunus communis	Rosaceae
Prunus cornuta	Rosaceae
Prunus nepalensis	Rosaceae
Prunus persica	Rosaceae
Pyrus lanata	Rosaceae
Pyrus pashia	Rosaceae
Sorbus foliolosa	Rosaceae
Mitragyna parvifolia	Rubiaceae
Aegle marmelos	Rutaceae

Populus trimula	Salicaceae
Salix disperma	Salicaceae
Flacourtia cataphracta	Salicaceae
Casearia graveolens	Samydaceae
Aesculus indica	Sapindaceae
Sapindus mukorossi	Sapindaceae
Diploknema butyracea	Sapotaceae
Saurauia nepaulensis	Saurauiaceae
Symplocos chinensis	Styraceae
Symplocos sp.	Styraceae
Taxus wallichiana	Taxaceae
Grewia oppositifolia	Tiliaceae
Grewia optiva	Tiliaceae
Celtis australis	Ulmaceae
Boehmeria rugulosa	Urticaceae
Callicarpa arborea	Verbenaceae
Premna latifolia	Verbenaceae
Tectona grandis	Verbenaceae
Vitex nigundo	Verbenaceae
Shrubs	
Adhatoda zeylanica	Acanthaceae
Aechmanthera gossypina	Acanthaceae
Barleria cristata	Acanthaceae
Dicliptera bupleuroides	Acanthaceae
Eranthemum pulchellum	Acanthaceae
Lepidagathis sp.	Acanthaceae
Rungia pectinata	Acanthaceae

Strobilanthes atropurpureans	Acanthaceae
Agave americana	Agavaceae
Rhus wallichii	Anacardiaceae
Heptapleurum venulosum	Araliaceae
Hoya lanceolata	Asclepiadaceae
Bidens pilosa	Asteraceae
Xanthium indicum	Asteraceae
Berberis asiatica	Berberidaceae
Berberis chhitria	Berberidaceae
Berberis Jaeschkeana	Berberidaceae
Berberis kumonensis	Berberidaceae
Berberris erythroclada	Berberidaceae
Xylosma longifolium	Bixaceae
Opuntia sp.	Cactaceae
Lonicera metalis	Caprifoliaceae
Viburnum coriaceum	Caprifoliaceae
Viburnum grandiflorum	Caprifoliaceae
Lonicera spinosa	Caprifoliaceea
Eunymous pendulus	Celastraceae
Coriaria nepalensis	Coriariaceae
Juniperus communis	Cupressaceae
Juniperus indica	Cupressaceae
Juniperus recurva	Cupressaceae
Juniperus squamata	Cupressaceae
Dillenia sp.	Dilleniaceae
Hippophae tibetana	Elaeagnaceae
Ephedra gerardiana	Ephedraceae

Gaultheria nummularioides	Ericaceae
Gaultheria trichophylla	Ericaceae
Rhododendron anthopogon	Ericaceae
Rhododendron barbatum	Ericaceae
Rhododendron campanulatum	Ericaceae
Rhododendron lepidotum	Ericaceae
Cassiope fastigiata	Ericaceae
Excoecaria acerifolia	Euphorbiaceae
Euphorbia royleana	Euphorbiaceea
Jatropha curcas	Euphorbiaceea
Ricinus communis	Euphorbiaceea
Sarcococca saligna	Euphorbiaceea
Astragalus candolleanus	Fabaceae
Astragalus grahamianus	Fabaceae
Butea minor	Fabaceae
Flemingia macrophylla	Fabaceae
Indigofera heterantha	Fabaceae
Crotalaria sp.	Fabaceae
Desmodium heterocarpon	Fabaceae
Lespedeza sp.	Fabaceae
Piptanthus nepalensis	Fabaceae
Ribes alpestre	Grossulariaceae
Hypericum oblongifolium	Hypericaceae
Colebrookia oppositifolia	Labiateae
Pogostemon benghalensis	Labiateae
Lygodium japonicum	Ligodiaceae
Reinwardtia indica	Linaceae

Dendropthoe falcata	Loranthaceae
Scurulla elata	Loranthaceae
Viscum album	Loranthaceae
Woodfordia fruticosa	Lythraceae
Osbeckia stellata	Melastomataceae
Ficus clavata	Moraceae
Ardisia solanacea	Myrsinaceae
Maesa indica	Myrsinaceae
Callistemon citrinus	Myrtaceae
Boerhavia diffusa	Nyctaginaceae
Syringa emodi	Oleaceae
Plumbago zeylanica	Plumbaginaceae
Rumex hastatus	Polygonaceae
Rumex nepalensis	Polygonaceae
Zizyphus mauritiana	Rhamnaceae
Rosa webbiana	Rosaceae
Rubus ellipticus	Rosaceae
Rubus foliolosus	Rosaceae
Rubus nepalensis	Rosaceae
Rubus niveus	Rosaceae
Cotoneaster acuminatus	Rosaceae
Cotoneaster affinis	Rosaceae
Cotoneaster integrifolius	Rosaceae
Cotoneaster microphyllus	Rosaceae
Prinsepia utilis	Rosaceae
Pyracantha crenulata	Rosaceae
Sorbus lanata	Rosaceae

Viburnum cotinifolium	Rosaceae
Randia dumetorum	Rubiaceae
Randia tetraspermum	Rubiaceae
Leptodermis kumaonensis	Rubiaceae
Leptodermis lanceolata	Rubiaceae
Pavetta indica	Rubiaceae
Murraya koenigii	Rutaceae
Murraya paniculata	Rutaceae
Meliosma pungens	Sabiaceae
Buddleja paniculata	Scrophulariaceae
Datura stramonium	Solanaceae
Datura suaveolens	Solanaceae
Stachyurus salicifolia	Stachyuraceae
Hypericum japonicum	Tamaricaceae
Myricaria rosea	Tamaricaceae
Myricaria squamosa	Tamaricaceae
Eurya acuminata	Theaceae
Daphne papyracea	Thymelaeaceae
Boehmeria macrophylla	Urticaceae
Debregeasia hypoleuca	Urticaceae
Callicarpa macrophylla	Verbenaceae
Lantana camara	Verbenaceae
Caryopteris odorata	Verbenaceae
Clerodendron benghalensis	Verbenaceae
Climbers	
Raphidophora decursiva	Araceae
Hedera helix	Araliaceae

Hedera nepalensis	Araliaceae
Ceropegia longifolia	Asclepiadaceae
Bauhinia vahlii	Caesalpiniaceae
Caesalpinia decapetala	Caesalpiniaceae
Ipomea purpurea	Convolvulaceae
Cuscuta reflexa	Cuscutaceae
Dioscorea belophylla	Dioscoreaceae
Dioscorea bulbifera	Dioscoreaceae
Abrus precatorius	Fabaceae
Millettia auriculata	Fabaceae
Mucuna pruriens	Fabaceae
Hydrangia anomala	Hydrangeaceae
Smilax elegans	Liliaceae
Cissampelos pareira	Menispermaceae
Tinospora cordifolia	Menispermaceae
Ficus hederacea	Moraceae
Jasminum multiflorum	Oleaceae
Clematis gauriana	Ranunculaceae
Helinus lanceolatus	Rhamnaceae
Rosa macrophylla	Rosaceae
Rubus paniculatus	Rosaceae
Neohymenopogon parasiticus	Rubiaceae
Zanthoxylum alatum	Rutaceae
Vitis sp.	Vitaceae
Herbs	
Allium humile	Alliaceae
Allium sp.	Alliaceae

Allium wallichii	Alliaceae
Achyranthes aspera	Amaranthaceae
Aerva scandens	Amaranthaceae
Cyathula capitata	Amaranthaceae
Cyathula tomentosa	Amaranthaceae
Crinum amoenum	Amaryllidaceae
Zephyranthes carinata	Amaryllidaceae
Angelica archangelica	Apiaceae
Centella asiatica	Apiaceae
Pleurospermum angelicoides	Apiaceae
Pleurospermum benthamii	Apiaceae
Pleurospermum candolei	Apiaceae
Prangos pabularia	Apiaceae
Salinum tenufolium	Apiaceae
Arisaema griffithii	Araceae
Arisaema intermedium	Araceae
Arisaema jacquemontii	Araceae
Arisaema propinquum	Araceae
Remusatia hookeriana	Araceae
Thomsonia nepalensis	Araceae
Asclepias curassavica	Asclepiadaceae
Polygonatum verticillatum	Asparagaceae
Smilacina purpurea	Asparagaceae
Eremurus himalaicus	Asphodelaceae
Ageratum conyzoides	Asteraceae
Anaphalis cinnamomea	Asteraceae
Anaphalis contorta	Asteraceae

Anaphalis royleana	Asteraceae
Anaphalis triplinervis	Asteraceae
Artemisia nilagirica	Asteraceae
Aster fulconerii	Asteraceae
Cicerbita micrantha	Asteraceae
Cichorium intybus	Asteraceae
Circium berutum	Asteraceae
Cirsium arvense	Asteraceae
Crassocephalum crepidioides	Asteraceae
Cremanthodium arnicoides	Asteraceae
Encilia latifolia	Asteraceae
Erigeron andryaloides	Asteraceae
Eupatorium adenophorum	Asteraceae
Galinsoga parviflora	Asteraceae
Gerbera gossypiana	Asteraceae
Gnaphalium affine	Asteraceae
Inula cappa	Asteraceae
Lactuca dolichophylla	Asteraceae
Laggera crispata	Asteraceae
Leontopodium monocephalum	Asteraceae
Ligularia amplexicaulis	Asteraceae
Myriactis nepalensis	Asteraceae
Myriactis wallichi	Asteraceae
Parthenium hysterophorus	Asteraceae
Sassuria hypoleuca	Asteraceae
Sassuria obvallata	Asteraceae
Saussuria heteromalla	Asteraceae

Senecio chrysanthemoides	Asteraceae
Senecio ellatus	Asteraceae
Senecio kunthianus	Asteraceae
Senecio nudicaulis	Asteraceae
Siegesbeckia sp.	Asteraceae
Sonchus arvense	Asteraceae
Synotis alatus	Asteraceae
Tanacetum gracile	Asteraceae
Tanacetum longifolium	Asteraceae
Taraxacum officinale	Asteraceae
Tridax procumbens	Asteraceae
Vernonia sp.	Asteraceae
Youngia japonica	Asteraceae
Youngia sp.	Asteraceae
Leontopodium stracheyi	Asteraceae
Impatiens cristata	Balsaminaceae
Impatiens edgeotheri	Balsaminaceae
Impatiens racemosa	Balsaminaceae
Impatiens scabida	Balsaminaceae
Impatiens sulcata	Balsaminaceae
Arnebia euchroma	Boraginaceae
Cynoglossum zeylanicum	Boraginaceae
Eritrichium canum	Boraginaceae
Hackelia uncinata	Boraginaceae
Lindelofia anchusoides	Boraginaceae
Lindelofia longiflora	Boraginaceae
Arabidopsis himalaica	Brassicaceae
Barbarea vulgaris	Brassicaceae
Megacarpaea polyandra	Brassicaceae
Thlaspi arvense	Brassicaceae
Campanula latifolia	Campanulaceae
Campanula pallida	Campanulaceae
Cyananthus lobatus	Campanulaceae
Morina longifolia	Caprifoliaceae
Nardostachys grandiflora	Caprifoliaceae
Nardostachys jatamasi	Caprifoliaceae
Valeriana hardwichi	Caprifoliaceae
Arenaria festucoides	Caryophyllaceae
Arenaria globiflora	Caryophyllaceae
Arenaria polytrichoides	Caryophyllaceae
Drymaria cordata	Caryophyllaceae
Silene setisperma	Caryophyllaceae
Stellaria media	Caryophyllaceae
Chenopodium ambrosoides	Chenopodiaceae
Commelina benghalensis	Commelinaceae
Murdannia hookerii	Commelinaceae
Swertia ciliata	Convulvulaceae
Rhodiola wallichiana	Crassulaceae
Sedum filipes	Crassulaceae
Sedum trifidum	Crassulaceae
Dipsacus mitis	Dipsacaceae
Equisetum arvense	Equisetaceae
Euphorbia hirta	Euphorbiaceae
Euphorbia pilosa	Euphorbiaceae
Euphorbia sp.	Euphorbiaceae
Astragalus rhizanthus	Fabaceae
Cassia occidantalis	Fabaceae
Cassia tora	Fabaceae
Desmodium microphyllum	Fabaceae
Flemingia fruticulosa	Fabaceae
Hedysarum cachemirianum	Fabaceae
Oxytropis cachemiriana	Fabaceae
Oxytropis lapponica	Fabaceae
Oxytropis mollis	Fabaceae
Parochetus communis	Fabaceae
Thermopsis barbata	Fabaceae
Trigonella emodi	Fabaceae
Corydalis cashmeriana	Fumariaceae
Corydalis govaniana	Fumariaceae
Corydalis juncea	Fumariaceae
Corydalis racemosa	Fumariaceae
Gentiana capitata	Gensianaceae
Circa chirata	Gentianaceae
Gentiana moorcroftiana	Gentianaceae
Gentiana ornata	Gentianaceae
Gentiana tubifora	Gentianaceae
Gentiana urnula	Gentianaceae
Halenia elliptica	Gentianaceae
Lomatogonium carinthiacum	Gentianaceae
Swertia petiolata	Gentianaceae
Geranium pratense	Geraniaceae

Geranium procurrens	Geraniaceae
Geranium wallichianum	Geraniaceae
Arundinaria falcata	Gramineae
Bambusa arundinarea	Gramineae
Chrysopogon gryllus	Gramineae
Cynodon dactylon	Gramineae
Dendrocalamus strictus	Gramineae
Pennisetum purpureum	Gramineae
Saccharum spontaneum	Gramineae
Thamnocalamus falconeri	Gramineae
Thysanolaena maxima	Gramineae
Hypoxis aurea	Hypoxidaceae
Iris clarkei	Iridaceae
Iris hookerana	Iridaceae
Iris kemaonensis	Iridaceae
Iris milesii	Iridaceae
Iris potaninii	Iridaceae
Leucas lanata	Labiateae
Ajuga bracteosa	Lamiaceae
Anisomeles indica	Lamiaceae
Clinopodium umbrosa	Lamiaceae
Micromeria biflora	Lamiaceae
Phlomis bracteota	Lamiaceae
Plectranthus rugosus	Lamiaceae
Prunella vulgaris	Lamiaceae
Scutellaria prostrata	Lamiaceae
Scutellaria scandens	Lamiaceae

Stachys crisis	Lamiaceae
Thymus sp.	Lamiaceae
Utricularia striatula	Lentibulariaceae
Asparagus racemosus	Liliaceae
Fritillaria roylei	Liliaceae
Lilium nanum	Liliaceae
Lilium oxypetalum	Liliaceae
Theropogon pallidus	Liliaceae
Linum usitatissimum	Linaceae
Loranthus sp.	Loranthaceae
Malva rotundifolia	Malvaceae
Sida cordata	Malvaceae
Anagallis arvensis	Myrsinaceae
Circaea alpina	Onagraceae
Circea ciliata	Onagraceae
Epilobium royleanum	Onagraceae
Aeginetia indica	Orobanchaceae
Lathraea squamaria	Orobanchaceae
Oxalis corniculata	Oxalidaceae
Eschscholzia caespitosa	Papaveraceae
Meconopsis aculeata	Papaveraceae
Picrorhiza kurrooa	Plantaginaceae
Veronica cana	Plantaginaceae
Veronica persica	Plantaginaceae
Bistorta affinis	Polygonaceae
Bistorta emodi	Polygonaceae
Bistorta vaccinifolia	Polygonaceae

Bistorta vivipara	Polygonaceae
Persicaria wallichii	Polygonaceae
Polygonum barbatum	Polygonaceae
Polygonum capitatum	Polygonaceae
Polygonum hydropiper	Polygonaceae
Polygonum koeningia	Polygonaceae
Polygonum polystachyum	Polygonaceae
Polygonum scandens	Polygonaceae
Rheum acuminatum	Polygonaceae
Rheum australe	Polygonaceae
Androsace delavayi	Primulaceae
Androsace muscoidea	Primulaceae
Androsace primuloides	Primulaceae
Primula calderana	Primulaceae
Primula denticulata	Primulaceae
Primula drummondiana	Primulaceae
Primula glomerata	Primulaceae
Primula involucrata	Primulaceae
Primula minutissima	Primulaceae
Primula redii	Primulaceae
Primula sp.	Primulaceae
Primula sturtii	Primulaceae
Aconitum heterophyllum	Ranunculaceae
Anemone rivularis	Ranunculaceae
Anemone tetrasepla	Ranunculaceae
Anemone vitifolia	Ranunculaceae
Aquilegia sp.	Ranunculaceae

Caltha palustris	Ranunculaceae
Delphinium brunonianum	Ranunculaceae
Oxygraphis polypetala	Ranunculaceae
Paraquilegia microphylla	Ranunculaceae
Ranunculus diffuses	Ranunculaceae
Thalictrum foliolosum	Ranunculaceae
Agremonia pilosa	Rosaceae
Campanula argyrophylla	Rosaceae
Duchesnea indica	Rosaceae
Fragaria nubicola	Rosaceae
Geum elatum	Rosaceae
Potentilla argillophylla	Rosaceae
Potentilla atrosanguinea	Rosaceae
Potentilla cuneata	Rosaceae
Potentilla eriocarpa	Rosaceae
Potentilla fructicosa	Rosaceae
Potentilla fulgens	Rosaceae
Potentilla peduncularis	Rosaceae
Potentilla plurijuga	Rosaceae
Potentilla sundaica	Rosaceae
Sibbaldia cuneata	Rosaceae
Sibbaldia purpurea	Rosaceae
Galium aparina	Rubiaceae
Rubia cordifolia	Rubiaceae
Boenninghausenia albiflora	Rutaceae
Bergenia ciliata	Saxifragaceae
Chrysosplenium forrestii	Saxifragaceae

Parnassia nubicola	Saxifragaceae
Saxifraga personifolia	Saxifragaceae
Euphrasia himalica	Scrophulariaceae
Hemiphragma heterophyllum	Scrophulariaceae
Lindenbergia grandiflora	Scrophulariaceae
Mazus pumilus	Scrophulariaceae
Pedicularis hoffmeisteri	Scrophulariaceae
Peducularis sp.	Scrophulariaceae
Peducularis pectinata	Scrophulariaceae
Scrophularia decomposita	Scrophulariaceae
Scrophularia sp.	Scrophulariaceae
Scrophularia himalaica	Scrophulariaceae
Verbascum thapsus	Scrophulariaceae
Nicandra physalodes	Solanaceae
Solanum nigrum	Solanaceae
Solanum verbascifolium	Solanaceae
Solanum xanthocarpum	Solanaceae
Elatostema sessile	Urticaceae
Gerardinia diversifolia	Urticaceae
Pouzolzia sp.	Urticaceae
Urtica dioica	Urticaceae
Valeriana hardwichi	Valerianaceae
Viola biflora	Violaceae
Viola canescens	Violaceae
Cautleya gracilis	Zingiberaceae
Costus barbatus	Zingiberaceae
Curcuma angustifolia	Zingiberaceae

Curcuma aromatica	Zingiberaceae
Hedychium spicatum	Zingiberaceae
Globba andersonii	Zingiberaceae
Roscoea alpina	Zingiberaceae
Roscoea purpurea	Zingiberaceae
Zingiber chrysanthum	Zingiberaceae
Orchids	
Acampe rigida	Orchidaceae
Aerides odorata	Orchidaceae
Bulbophyllum affine	Orchidaceae
Bulbophyllum reptans	Orchidaceae
Calanthe tricarinata	Orchidaceae
Cephlanthera longifolia	Orchidaceae
Coelogyne corymbosa	Orchidaceae
Coelogyne cristata	Orchidaceae
Coelogyne ovalis	Orchidaceae
Dactylorrhiza hatagiera	Orchidaceae
Dendrobium amoenum	Orchidaceae
Dendrobium chrysanthodium	Orchidaceae
Dendrobium fimbriata	Orchidaceae
Dendrobium heterocarpum	Orchidaceae
Epipactis helleborine	Orchidaceae
Eria lasiopetala	Orchidaceae
Eria spicata	Orchidaceae
Vanda cristata	Orchidaceae
Zeuxine flava	Orchidaceae
Gastrochilus calceolaris	Orchidaceae

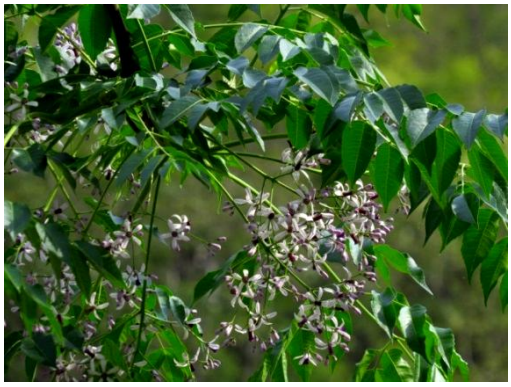
Guderia fushia	Orchidaceae
Liparis viridiflora	Orchidaceae
Malaxis mucifera	Orchidaceae
Nervilia mackinnonii	Orchidaceae
Oberonia pachyrachis	Orchidaceae
Oberonia prainiana	Orchidaceae
Oberonia pyrulifera	Orchidaceae
Otochilus lancilabius	Orchidaceae
Phalaenopsis taenalis	Orchidaceae
Rhynchostylis retusa	Orchidaceae
Satyrium nepalense	Orchidaceae
Smitinandia micrantha	Orchidaceae
Spiranthes sinensis	Orchidaceae
Spiranthes spiralis	Orchidaceae
Thunia alba	Orchidaceae

Appendix II - Major tree species of Askot Landscape

Botanical name: *Celtis australis* (Ulmaceae) **Common name:** Eastern nettle tree **Vernacular name:** Kharik **Distribution:** 500-1500 m **Role in livelihood and local economy:** Leaf is used as fodder and in Bone problems		खडीक का वृक्ष लगभग १० मीटर ऊँचा होता है। यह ५०० - १५०० मीटर तक पाया जाता है। उपयोगिता- यह चारे के रूप में प्रयुक्त होता है तथा पत्तियों को हड्डियों सम्बंधित रोगों को दूर करने के लिए प्रयोग में लाया जाता है। इसकी छाल को फोड़े फुंसी में प्रयोग किया जाता है।
Botanical name: *Emblica officinalis* (Euphorbiaceae) **Common name**: Indian gooseberry **Vernacular name:** Anwla **Distribution:**500-1400 m **Role in livelihood and local economy:** Fruits are used to cure fever		आँवला का वृक्ष लगभग ८-१८ मीटर ऊँचा होता है। यह ५००-१५०० मीटर तक पाया जाता है। उपयोगिता- फल का प्रयोग अचार बनाने व बुखार के लिए किया जाता है बीजो से तेल निकाला जाता है।
Botanical name: *Ficus roxburghii* (Moraceae) **Common name:** Elephant ear Fig **Vernacular name:** Timla **Distribution:** 1000-2100 m **Role in livelihood and local economy:** Fruits are eaten raw, Leaves are lopped for fodder		तिम्ला का वृक्ष लगभग ५-१० मीटर ऊँचा होता है। यह १०००-२१०० मीटर तक पाया जाता है। उपयोगिता- इसके फलों को कच्चा खाया जाता है तथा पत्तियों को चारे के लिए काटा जाता है। बीजों का प्रयोग पेचिस में किया जाता है।

Botanical name: *Glochidion velutinum* (Euphorbiaceae) **Common name:** Velvety Melon Featherfoil, downy melon featherfoil **Vernacular name:** Mauva **Distribution:** 500-1200m **Role in livelihood and local economy:** leaves are used as fodder		मौवा का वृक्ष लगभग ९ मीटर ऊँचा होता है। यह ७००-१२०० मीटर तक पाया जाता है। उपयोगिता- पत्तियों का प्रयोग चारे के लिए किया जाता है।
Botanical name: *Grevillea robusta* (Proteaceae) **Common name:** Silky oak**,** Silver oak **Vernacular name:** Safed Banj **Distribution:** 600-1000m **Role in livelihood and local economy:** It has been used in preparing shilajit and tea		सफ़ेद बांज का वृक्ष १८-३५ मीटर ऊँचा होता है । यह ६००-१००० मीटर तक पाया जाता है। उपयोगिता- इसका प्रयोग शीलाजीत बनाने तथा चाय की पत्ती बनाने में किया जाता है।
Botanical name: *Grewia optiva* (Tiliaceae) **Common name:** Bheemal **Vernacular name:** Biul **Distribution:** 500-2500m **Role in livelihood and local economy:** leaves are used as fodder		भिंयुल का वृक्ष ९-१२ मीटर ऊँचा और ३-४ मीटर चौड़ा होता है और ५००-२५०० मीटर तक मिलता है। उपयोगिता- पत्तियों का प्रयोग चारे के लिए किया जाता है।

Botanical name: *Taxus wallichiana* (Taxaceae) **Common name:** Himalayan yew **Vernacular name:** Thuner, Lwaint **Distribution:** 2500-3400 m **Role in livelihood and local economy:** Bark is used to treat ovary and breast cancer		ल्वेंट का वृक्ष प्रायः १० मीटर से कम ऊँचा होता है। यह २१००-३४०० मीटर तक पाया जाता है। उपयोगिता- तने का छिलका कैंसर के लिए उपयोगी है।
Botanical name: *Juglans regia* (Juglandaceae) **Common name:** Walnut **Vernacular name**: Akhrot **Distribution:** 1200-2200m **Role in livelihood and local economy:** Fruit is edible and seed is used to extract oil. Bark is used in toothache		अखरोट का वृक्ष २० मीटर ऊँचा और १२००-२२०० मीटर तक पाया जाता है। उपयोगिता- फल खाने के लिए प्रयोग में लाया जाता है तथा बीज से तेल निकाला जाता है। खाल का प्रयोग दांत दर्द में किया जाता है।
Botanical name: *Litsea umbrosa* (Lauraceae) **Vernacular name:** Chirad **Distribution:** 1000-2200m **Role in livelihood and local economy:** It is used as fodder		चिरड का वृक्ष १५ मीटर ऊँचा होता है। यह १०००-२२०० मीटर तक पाया जाता है। उपयोगिता- इसका प्रयोग चारे के रूप में किया जाता है।

Botanical name: *Mallotus philippensis* (Euphorbiaceae) **Common name**: Kamala tree, Monkey face tree **Vernacular name:** Ruina **Distribution:** 500-1500m **Role in livelihood and local economy:** Leaves are used as fodder and fruits are used to make sindoor		रुइना का वृक्ष लगभग १० मीटर ऊँचा होता है। यह ५०० से १५०० मीटर तक पाया जाता है। उपयोगिता- पत्तियों का प्रयोग चारे के रूप में किया जाता है तथा फलों को सिन्दूर बनाने के प्रयोग में लाया जाता है। फलों को खुजली दूर करने के काम में लाया जाता है।
Botanical name: *Melia azedarach* (Meliaceae) **Common name:** Chinaberry tree **Vernacular name:** Bhainkan **Distribution:** 500-1200m **Role in livelihood and local economy:** Leaves, bark and fruit are insect repellant. Seed-oil is used in rheumatism		भैंकन का वृक्ष नीम के वृक्ष के समान होता है। यह १५ मीटर ऊँचा होता है। यह ५००-१२०० मीटर तक पाया जाता है। उपयोगिता- पत्तियों, खाल और फल को कीड़े भगाने के काम में लाया जाता है।
Botanical name: *Ougeinia oojeinensis* (Fabaceae) **Common name:** Sandan **Vernacular name:** Sandan **Distribution:** 500-1200m **Role in livelihood and local economy:** Juice of the root, mixed with the powder of two fruits of black pepper is taken in cases of eye trouble. A paste of bark is applied to cuts and wounds		सांदन का वृक्ष ६-१२ मीटर ऊँचा होता है। यह ५००-१२०० मीटर तक पाया जाता है। उपयोगिता- पत्तियों का प्रयोग चारे के रूप में किया जाता है तथा लकड़ी का प्रयोग बर्तन जैसे पिन्ना, बल्ली आदि बनाने के प्रयोग में किया जाता है।

Botanical name: *Prunus communis* (Rosaceae) **Common name:** Pear tree **Vernacular name:** Plum, Alubukhara **Distribution:** 1000-2000m **Role in livelihood and local economy:** Fruit is edible		आलूबुखारे का वृक्ष लगभग १२ मीटर ऊँचा होता है। यह १०००-२००० मीटर तक पाया जाता है। उपयोगिता- फल को खाने के प्रयोग में लाया जाता है।
Botanical name: *Pyrus pashia* (Rosaceae) **Common name:** Himalayan pear **Vernacular name:** Mehal **Distribution:** 600-2700m **Role in livelihood and local economy:** Fruit is edible when half-rotten		मेहल का वृक्ष १२ मीटर ऊँचा होता है। यह ६००-२७०० मीटर तक पाया जाता है। उपयोगिता- अध्पके फल को खाया जाता है तथा उससे तम्बाखू भी बनाया जाता है।
Botanical name: *Quercus leucotrichophora* (Fagaceae) **Common name:** Grey oak **Vernacular name:** Banj **Distribution:** 1500-2500m **Role in livelihood and local economy:** Leaves are used as fodder		बांज का वृक्ष लगभग २५ मीटर ऊँचा होता है। यह १५००-२५०० मीटर तक पाया जाता है। उपयोगिता- इसकी पत्तियाँ चारे के रूप में प्रयोग की जाती हैं।

Botanical name: *Sapium insigne* (Euphorbiaceae) **Common name:** Tiger's milk spruce **Vernacular name**: Kheera, khinna **Distribution:** 500-1500m **Role in livelihood and local economy:** Latex is used in skin wart for killing fish		खीरे का वृक्ष लगभग १० मीटर ऊँचा होता है । यह ५००-१५०० मीटर तक पाया जाता है। उपयोगिता- इससे निकलने वाले दूध का प्रयोग मस्से के लिए तथा मछलियाँ मारने के लिए किया जाता है।
Botanical name: *Shorea robusta* (Dipterocarpaceae) **Common name:** Sal **Vernacular name**: Sal **Distribution:** 500-1500m **Role in livelihood and local economy:** It is used as fodder, fuelwood and timber		साल का वृक्ष ३०-३५ मीटर ऊँचा और चौड़ाई में २-२.५ मीटर होता है। उपयोगिता- इसकी पत्तियाँ चारे और लकड़ी जलाने तथा मकान बनाने के काम आती है।
Botanical name: *Salix alba* (Salicaceae) **Common name:** White willow **Vernacular name:** Majnu **Distribution:** 500-1500m **Role in livelihood and local economy:** It is used to make playing bats. The young stems are very flexible and are used in basket making		मजनू का वृक्ष १५-२० मीटर ऊँचा होता है। उपयोगिता-इसका प्रयोग बल्ले तथा टोकरियाँ बनाने में किया जाता है।

Botanical name: *Terminalia chebula* (Combretaceae) **Common name:** Chebulic Myrobalan **Vernacular name:** Harad **Distribution:** 600-1200m **Role in livelihood and local economy:** Fruit is used in stomach ache and cough		हरद का वृक्ष २० मीटर ऊँचा होता है ।यह ६००-१२० मीटर तक पाया जाता है। उपयोगिता- फल को पेट दर्द तथा खांसी में खाया जाता है।
Botanical name: *Diploknema butyracea* (Sapotaceae) **Common name:** Indian Butter tree **Vernacular name:** Chyura **Distribution:** 800-1600m **Role in livelihood and local economy:** Buds are used to make ghee and oil is extracted from the seeds		चयूरा का वृक्ष २५ मीटर ऊँचा होता है । यह ८००-१६०० मीटर तक पाया जाता है। उपयोगिता- कलिओं से घी व बीजों से तेल निकाला जाता है।
Botanical name: *Ficus hispida* (Moraceae) **Common name:** Hairy Fig **Vernacular name:** Khinia **Distribution:** 600-1200m **Role in livelihood and local economy:** Leaves are used as fodder		खिनिया का वृक्ष १५ मीटर ऊँचा होता है । यह ६००-१२०० मीटर तक पाया जाता है। उपयोगिता- पत्तियों का प्रयोग चारे के रूप में किया जाता है।

Botanical name: *Ficus palmata* (Moraceae) **Common name:** Punjab Fig **Vernacular name:** Bedu **Distribution:** 600-1200m **Role in livelihood and local economy:** fig is eaten largely and is succulent, sweet and pleasant		बेडू का वृक्ष लगभग १० मीटर ऊँचा होता है। यह ५००-१५०० मीटर तक पाया जाता है। उपयोगिता- इसका फल खाने के प्रयोग में आता है।
Botanical name: *Ilex dipyrena* (Ilicaceae) **Common name:** Himalayan Holi **Vernacular name:** Kandela **Distribution:** 1500-3000m **Role in livelihood and local economy:** red berries are often sold as Christmas decorations		कंडेल का वृक्ष १५००-३००० मीटर तक पाया जाता है। उपयोगिता-इसके फलों को सजावट के लिए काम में लाया जाता है।
Botanical name: *Jacaranda obtusifolia* (Bignoniaceae) **Common name:** Fern leaf Jacaranda, Fern Tree **Vernacular name:** Jacaranda **Distribution:** 200-1400m **Role in livelihood and local economy:** It is a shade tree and is grown as an ornamental plant		जकारंडा का वृक्ष लगभग १० मीटर ऊँचा होता है। यह ५००-१२०० मीटर तक पाया जाता है। उपयोगिता–यह एक छाया पेड़ है और एक सजावटी पौधे के रूप में उगाया जाता है।

Botanical name: *Macaranga pustulata* (Euphorbiaceae) **Common name:** Blistery macaranga **Vernacular name:** Rumla **Distribution:** 500-1400m **Role in livelihood and local economy:** It has very light wood which is used to make furnitures		रूमला का वृक्ष लगभग १८ मीटर ऊँचा होता है यह २००-१४०० मीटर तक पाया जाता है। उपयोगिता- इसकी लकड़ी हल्की होने के कारण लकड़ियों का सामान बनाने के लिए उपयोग में लाई जाती है । पत्तियों से बेलों के लिए सुतौर बनाया जाता है।
Botanical name: *Oroxylum indicum* (Bignoniaceae) **Common name:** Broken bone's tree, Indian Trumpet flower **Vernacular name:** Tantiya **Distribution:** 500-1000m **Role in livelihood and local economy:** seed is used in the traditional Indian ayurvedic medicine. The root bark is used administered as astringent, bitter tonic, stomachic and anodyne		टांटिया का वृक्ष १२ मीटर ऊँचा होता है। यह ५००-१००० मीटर तक पाया जाता है। उपयोगिता-बीजों का प्रयोग आयुर्वैदिक दवा के रूप में किया जाता है।
Botanical name: *Quercus semecarpifolia* (Fagaceae) **Common name:** Brown Oak **Vernacular name:** Kharsu **Distribution:** 2800-3600m **Role in livelihood and local economy:** it is used as a fodder		खरसू का वृक्ष २८००-३६०० मीटर तक पाया जाता है। उपयोगिता– पत्तियाँ चारे के रूप में प्रयोग की जाती है।

Botanical name: *Albizia lebbeck* (Fabaceae) **Common name:** Siris tree, Woman's tongue **Vernacular name**: Siris **Distribution:** 2800-3600m **Role in livelihood and local economy:** the tree is used to produce timber		सिरिस का वृक्ष २८००-३६०० मीटर तक पाया जाता है। उपयोगिता- इस वृक्ष का प्रयोग इमारती लकड़ी के लिए किया जाता है।
Botanical name: *Toona ciliata* (Meliaceae) **Common name:** Indian mahogany, Red cedar **Vernacular name:** Tun **Range of distribution:** 500-1200m **Role in livelihood and local economy:** it is used as a timber		तून का वृक्ष ४५ मीटर ऊँचा होता है। यह ५०-१२०० मीटर तक पाया जाता है। उपयोगिता- इसका प्रयोग ईमारती लकड़ी के रूप में किया जाता है।
Botanical name: *Machilus odaratissima* (Lauraceae) **Common name:** Fragrant Bay tree **Vernacular name:** Kaul **Range of distribution:** 1500-2100m **Role in livelihood and local economy**: leaves are collected as fodder for domesticated animals. The wood of the trunk is burned as firewood, and the better sections are used in house construction and for furniture		कॉल का वृक्ष १६ मीटर ऊँचा होता है। यह १५००-२१०० मीटर तक पाया जाता है। उपयोगिता–पत्तियाँ पालतू जानवरों के लिए चारे के रूप में एकत्र की जाती हैं। ट्रंक की लकड़ी जलावन के रूप में तथा भवन निर्माण और फर्नीचर के लिए इस्तेमाल की जाती है।

Botanical name: *Moringa oleifera* (Moringaceae) **Common name:** Drumstick tree **Vernacular name:** Sajna **Distribution:** 500-1000m **Role in livelihood and local economy:** Seed pods and leaves are used as a vegetable		साजन का वृक्ष १६ मीटर ऊँचा होता है। यह ५००-१००० मीटर तक पाया जाता है। उपयोगिता- बीजों तथा पत्तियों का प्रयोग सब्जी बनाने के लिए किया जाता है।
Botanical name: *Casearia graveolens* (Caesalpiniaceae) **Common name:** Chilla **Vernacular name:** Peepri **Distribution:** 300-2000m **Role in livelihood and local economy:** Leaves are used as fodder		पीपरी का वृक्ष ६ मीटर ऊँचा होता है। यह ३००-२००० मीटर तक पाया जाता है। उपयोगिता- पत्तियाँ चारे के प्रयोग में लाई जाती है।
Botanical name: *Litsea monopetala* **(**Lauraceae**)** **Common name:** Meda **Vernacular name:** Begania, Kathmora **Distribution:** 700-1000m **Role in livelihood and local economy:** It's a very fast growing tree used for fodder		बेंगनिया का वृक्ष १८ मीटर ऊँचा होता है। यह ७००-१००० मीटर तक पाया जाता है। उपयोगिता- यह तेज़ी से बढ़ने वाला वृक्ष है जो चारे के लिए उपयोगी है।

Botanical name: *Acacia catechu* (Mimosaceae) **Common name:** Cutch tree **Vernacular name:** Khair **Distribution:** 600-900 m **Role in livelihood and local economy:** its wood is used as timber		खैर का वृक्ष १५ मीटर ऊँचा होता है । यह ६००-९०० मीटर तक पाया जाता है। उपयोगिता- इसका प्रयोग ईमारती लकड़ी के रूप में किया जाता है ।
Botanical name: *Acer caesium* (Aceraceae) **Common name**: Bluish Grey maple **Vernacular name:** Thunder **Distribution:** 2200-3000m **Role in livelihood and local economy:** The juice of the bark is used externally in Nepal to treat muscular swellings, boils and pimples		खमिया का वृक्ष २५ मीटर ऊँचा होता है । यह २२००-३००० मीटर तक पाया जाता है। उपयोगिता-तने के छिलके के रस को मांसपेशिओं के दर्द तथा फोड़े फुंसियो को दूर करने के प्रयोग में लाया जाता है।
Botanical name: *Aesculus indica* (Sapindaceae) **Common name:** Indian Horse Chestnut **Vernacular name:** Pangar **Distribution:** 2000-3000 m **Role in livelihood and local economy:** It is used in traditional Indian medicine for the treatment of certain skin diseases, rheumatism, as an astringent, and strong drugs and relief of headache		पाँगर का वृक्ष २२ मीटर ऊँचा होता है । यह २०००-३००० मीटर तक पाया जाता है। उपयोगिता- ईमारती लकड़ी के रूप में इसका प्रयोग होता है । फूलों को पेट के कीड़े दूर करने के लिए खाया जाता है तथा बीजों का भी सेवन किया जाता है।

Botanical name: *Lyonia ovalifolia* (Ericaceae) **Common name:** Oval leaved staggerbush **Vernacular name:** Ayar **Distribution:** 1500-3000m **Role in livelihood and local economy:** it is used as fuelwood		अयाँर का वृक्ष १० मीटर ऊँचा होता है । यह १५००-३००० मीटर तक पाया जाता है। उपयोगिता- लकड़ी को जलाने के उपयोग में लाया जाता है।
Botanical name: *Maesa indica* (Myrsinaceae) **Common name:** Wild berry **Vernacular name:** Bakaryol **Distribution:** 600-1200m **Role in livelihood and local economy:** It has soft, brownish wood which is used as fuel		बकरयोल का वृक्ष १६ मीटर ऊँचा होता है । यह ६००-१२०० मीटर तक पाया जाता है। उपयोगिता- पत्तियों का प्रयोग चारे के रूप में किया जाता है।
Botanical name: *Toona serrata* (Meliaceae) **Common name**: Red Toon **Vernacular name:** Toon **Distribution:** 700-1800m **Role in livelihood and local economy:** It is used as fuelwood		इसका वृक्ष २५ मीटर ऊँचा होता है । यह ७००-१८०० मीटर तक पाया जाता है। उपयोगिता-लकड़ी को जलाने के उपयोग में लाया जाता है।

Botanical name: *Delonix regia* (Caesalpiniaceae) **Common name:** Flame tree **Vernacular name:** Gulmohar **Distribution:** 500-900m **Role in livelihood and local economy:** It is grown as an ornamental plant		गुलमोहर का वृक्ष २० मीटर ऊँचा होता है । यह ५००-९०० मीटर तक पाया जाता है। उपयोगिता-इसे सजावटी पौधे के रूप में उगाया जाता है ।
Botanical name: *Ficus scandens* (Moraceae) **Vernacular name:** Betula **Range of distribution:** 500-900m **Role in livelihood and local economy:** It is used as a fodder		बटुला का वृक्ष १६ मीटर ऊँचा होता है । यह ५००-९०० मीटर तक पाया जाता है। उपयोगिता- पत्तियों का प्रयोग चारे के रूप में किया जाता है।
Botanical name: *Ficus semicordata* (Moraceae) **Common name:** Drooping Fig **Vernacular name:** Khasatya **Distribution:** 500-900m **Role in livelihood and local economy:** It is used as fodder		खासतिया का वृक्ष १५ मीटर ऊँचा होता है। यह ५००-९०० मीटर तक पाया जाता है। उपयोगिता- पत्तियों का प्रयोग चारे के रूप में किया जाता है।

Botanical name: *Carpinus viminea* (Betulaceae) **Vernacular name:** Gadyo **Distribution:** 1800-2400 m **Role in livelihood and local economy:** Leaves are used as fodder. It burns very well and makes excellent charcoal for burning		गढ़यो का वृक्ष २० मीटर ऊँचा होता है । यह १८००-२४०० मीटर तक पाया जाता है। उपयोगिता-पत्तियों का प्रयोग चारे के रूप में किया जाता है तथा लकड़ी Ãंधन के रूप में प्रयुक्त की जाती है।
Botanical name: *Acer oblongum* (Aceraceae) **Common name:** Himalayan maple **Vernacular name:** Putli **Distribution:** 600-2000 m **Role in livelihood and local economy:** Wood is used in making farming implements		पुतली का वृक्ष ६००-२००० मीटर तक पाया जाता है। उपयोगिता- लकड़ी का प्रयोग खेती के औजार बनाने के काम आता है।
Botanical name: *Albizia julibrissin* (Mimosaceae) **Common name:** Silktree Mimosa **Vernacular name:** Laal siris **Distribution:** 1000-2100 m **Role in livelihood and local economy:** It is an ornamental plant		लाल सिरिस का वृक्ष लगभग १२ मीटर ऊँचा होता है । यह १०००-२१०० मीटर तक पाया जाता है। उपयोगिता- यह एक सजावटी पौधा है ।

Botanical name: *Albizia lebbeck* (Mimosaceae) **Common name:** Siris tree, Woman's tongue **Vernacular name:** Siris **Distribution:** 600-1000 **Role in livelihood and local economy:** The leaves are reported to be good fodder, excellent fuelwod		सिरिस का वृक्ष लगभग १२ मीटर ऊँचा होता है। यह ६००-१००० मीटर तक पाया जाता है। उपयोगिता-पत्तियों का प्रयोग चारे के रूप में किया जाता है तथा लकड़ी ईंधन के रूप में प्रयुक्त की जाती है।
Botanical name: *Erythrina variegata* (fabaceae) **Common name:** Indian Coral tree, tiger's-claw **Distribution:** 1000-1500 m **Role in livelihood and local economy:** ethnomedicinally used as a therapeutic agent for a variety of diseases		इसका वृक्ष लगभग ३० मीटर ऊँचा होता है। यह १०००-१५०० मीटर तक पाया जाता है। उपयोगिता- इसका प्रयोग रोगों को दूर करने में किया जाता है।
Botanical name: *Mitragyna parvifolia* (Rubiaceae) **Common name:** Kaim **Vernacular name:** Kadamb **Distribution:** 600-1000 m **Role in livelihood and local economy:** The bark of the plant is used for blood related diseases		कदम्ब का वृक्ष लगभग २० मीटर ऊँचा होता है। यह ६००-१००० मीटर तक पाया जाता है। उपयोगिता-इस वृक्ष की छाल को खून से सम्बंधित बिमारियों को दूर करने के लिए प्रयोग किया जाता है।

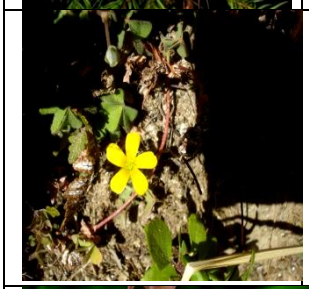
Botanical name: *Bombax ceiba* (Bombacaceae) **Common name:** Silk Cotton Tree **Vernacular name:** Semal **Distribution:** 600-900 m **Role in livelihood and local economy:** Extraction of cotton called "kopak" from the fruit which is used for filling sofa, pillows etc. The fruit is cooked and eaten and also pickled		सेमल का वृक्ष लगभग ३० मीटर ऊँचा होता है। यह ६००-९०० मीटर तक पाया जाता है। उपयोगिता-फल का प्रयोग सोफे तथा तकिए भरने के लिए किया जाता है, फल को पका के खाया और अचार भी बनाया जाता है ।
Botanical name: *Q. lanuginosa* (Fagaceae) **Common name:** Downy Oak **Vernacular name:** Rianj **Distribution:** 1700-2200 m **Role in livelihood and local economy:** Leaves are used as fodder		रियाँज का वृक्ष लगभग १८ मीटर ऊँचा होता है। यह १७००-२२०० मीटर तक पाया जाता है। उपयोगिता-पत्तियों का प्रयोग चारे के रूप में किया जाता है।
Botanical name: *Pinus roxburghii* (Pinaceae) **Common name:** Chir pine **Vernacular name:** Chir **Distribution:** 900-1800 m **Role in livelihood and local economy:** Leaves are used as fuel		चीर का वृक्ष लगभग २५-३० मीटर ऊँचा होता है। यह ९००-१८०० मीटर तक पाया जाता है। उपयोगिता- लकड़ी ईंधन के रूप में प्रयुक्त की जाती है।

Appendix III. Important medicinal plant species used by local people in the landscape

	***Pleurospermum angelicoides*** Common name- Chhipi Sub-alpine zone Highly used herb Root- stomachache
	***Asparagus racemosus*** Commonname-Satavari Sub-tropical zone Moderately used herb Root- medicine
	***Eupatorium adenophorum*** Common name- Kala basa Sub-tropical zone Highly used weed Leaf- skin cut
	***Abrus precatorius*** Common name- Ratti Sub-tropical zone Less used climber Seed- eye problems
	***Acacia catechu*** Common name- Khair Sub-tropical zone Less used climber Root and bark- piles
	***Ageratum conyzoides*** Common name- Nirfalya Sub-tropical zone Highly used herb Leaf- skin cuts, blood clotting
	***Bauhinia variegata*** Common name- Koiral Sub-tropical zone Highly used tree Fruit- dysentery

	***Solanum nigrum*** Common name- Makoi Sub-tropical zone Moderately used herb Root-Bodyache, headache
	***Adhatoda zeylanica*** Common name- Kalabasa Sub-tropical zone Moderately used shrub Root- cough, toothache and tuberculosis
	***Berginia ciliata*** Common name- Paththar chatta Sub-tropical zone Highly used herb Root- Stomachache
	***Bidens pilosa*** Sub-tropical zone Moderately used herb Leaf- Wound
	***Cissampelos pariera*** Common name- Musbel Sub-tropical zone Moderately used Leaf- Heart attack and stone
	***Epipactis helleborine*** Sub-alpine zone Less used orchid Root- Insanity
	***Fragaria nubicola*** Common name- Bhui kafal Sub-tropical zone Moderately used herb Leaf- Headache and typhoid

	***Stellaria media*** Common name- Badyalu Warm temperate zone Moderately used herb Leaf- Headache
	***Emblica officinalis*** Common name- Anwla Sub-tropical zone Highly used tree Seed- Fever
	***Habenaria intermedia*** Sub-alpine zone Less used orchid Blood purifier and rejuvinator
	***Senecio naudicaulis*** Common name- Neelkanthi Warm temperate zone Less used herb Leaf- toe's fungus
	***Picrorhiza kurrooa*** Common name- Kutki Sub-alpine zon Highly used herb Stem- Fever, blood purifier
	***Sapium insigne*** Common name- Kheera Sub-tropical zone Less used tree Latex- Skin wart
	***Terminalia chebula*** Common name- Harad Sub-tropical zone Highly used tree Fruit- Stomachache
	***Aconitum heterophyllum*** Common name- Meetha zehar Sub-alpine zone Highly used herb Root- tonic

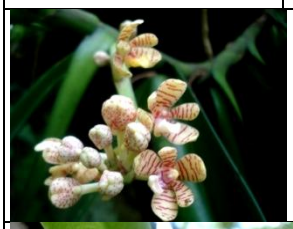
	***Rhynchostylis retusa*** Sub-tropical zone Moderately usd orchid Leaf- Rheumatic disease
	***Lindenbergia grandiflora*** Sub-tropical zone Moderately used herb Cattle disease
	***Pholidota articulata*** Sub-tropical zone Less used orchid Whole- Bone fractures
	***Rheum australe*** Common name- Dolu Cool temperate zone Highly used herb Root- Internal pains
	***Taxus wallichiana*** Common name- Thuner Cool temperate zone Moderately used tree Bark- tumours, cancer
	***Oxalis corniculata*** Common name- Chilmada Sub-tropical zone Highly used herb Leaf- injury healing, eye problems
	***Satyrium nepalense*** Sub-alpine zone Less used orchid Tuber- tonic, malaria and dysentery
	***Sassuria heteromalla*** Common name- Murang Sub-tropical zone Less used herb Leaf- Tooth problem

Appendix IV. Common orchids of Gori valley

	***Spiranthes sinensis*** Common name- Firliya Terrestrial orchid Warm temperate zone Flowering- Feb - Sep
	***Smitinandia micrantha*** Epiphytic orchid Sub-tropical zone Flowering- Apr-Aug Host- *Mallotus philippensis*
	***Rhynchostylis retusa*** Common name- Fox tail orchid Epiphytic orchid Sub-tropical zone Flowering- Apr-Aug Host- *Toona ciliata* Leaves are used in Rheumatic disease
	***Satyrium nepalense*** Common name- Nakli Salam mishri Terrestrial orchid Sub-alpine zone Flowering- Aug - Sep Tuber is used in malaria, dysentry
	***Ornithochilus difformis*** Epiphytic orchid Warm temperate zone Flowering- June-Aug, Dec-Apr Host- *Lyonia ovalifolia*
	***Oberonia pachyrachis*** Epiphytic orchid Warm temperate zone Flowering- Oct-Mar Host- *Toona ciliata*
	***Aerides multiflora*** Common name- Maana Epiphytic orchid Sub-tropical zone Flowering- Apr-July Host- *Toona ciliata* Leaf is used in cuts

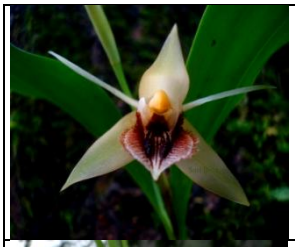
	***Liparis viridiflora*** Epiphytic orchid Sub-tropical zone Flowering- Aug-Dec, Mar-July Host- *Toona ciliata*
	***Phalaenopsis taenialis*** Epiphytic orchid Cool temperate Flowering- May- Aug Host- *Q. leucotrichophora*
	***Gastrochilus calceolaris*** Epiphytic orchid Warm temperate Flowering- Jan-May Host- *Q. floribunda*
	***Eria lasiopetala*** Epiphytic orchid Warm temperate Flowering- Feb-June Host- *Toona ciliata*
	***Epipactis helleborine*** Common name- Tahendiya Terrestrial orchid Cool temperate Flowering- July-Aug Root is used for curing insanity
	***Pholidata articulata*** Common name- Hadjojan, Jeevanti Epiphytic orchid Warm temperate zone Flowering- May-Aug Used in bone fracture
	***Denrobium longicornu*** Epiphytic orchid Warm temperate zone Flowering- June-Nov Host- *Q. leucotrichophora*
	***Nervillia mackinnonii*** Terrestrial orchid Warm temperate zone Flowering- Apr-June

Aerides odorata
Epiphytic orchid
Sub-tropical zone
Flowering- May-June
Host- *E. spicata*

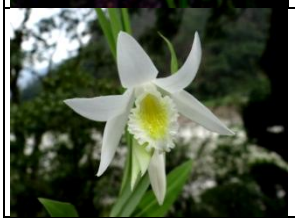


Acampe rigida
Epiphytic orchid
Sub-tropical zone
Flowering- June-Aug
Host- *Dalbergia sissoo*

Bulbophyllum affine
Epiphytic orchid
Sub-tropical zone
Flowering- June-July
Host- *P. roxburghii*



Coelogyne ovalis
Epiphytic orchid
Warm temperate zone
Flowering- May-June, Oct-Dec
Host- *E. spicata*



Thunia alba
Epiphytic orchid
Sub-tropical zone
Flowering- May-Aug
Host- *Toona ciliata*

Appendix V: An addition to orchid flora: published paper

Dendrobium longicornu: an addition to the orchid flora of Western Himalaya[a]

Soni Bisht[1] & Bhupendra S. Adhikari[1]*

Keywords/Mots-clés : Askot WS, Long-horned dendrobium, Nigro-hirsute dendrobium, Uttarakhand.

Abstract

Dendrobium is one of the largest genera of the Orchidaceae. Hitherto, 116 species of the genus have been reported from India, of which 17 (including 2 doubtful taxa) have been recorded from Western Himalaya and 7 from the Askot Wildlife Sanctuary (AWS). By this publication, we add *Dendrobium longicornu* to the flora of Western Himalaya.

Résumé

***Dendrobium longicornu* : une espèce supplémentaire pour la flore de l'Himalaya occidental** – Le genre *Dendrobium* est l'un des genres les plus vastes parmi les Orchidaceae. Jusqu'ici 116 espèces ont été enregistrées pour l'Inde, dont 17 (en comptant deux taxons douteux) pour l'Himalaya occidental et 7 pour le sanctuaire AWS (Askot Wildlife Sanctuary). Le présent article ajoute une espèce, *Dendrobium longicornu*, à la flore de l'Himalaya occidental.

Introduction

Orchidaceae is one of the largest families of flowering plants with an estimate of 24,500 species worldwide (73% epiphytic: Dressler, 2005). Most of the species has been listed under appendix II of CITES, due to their mycorrhizal associations (Gill, 1989; Taylor & Bruns ,1997; McCormick *et al.*, 2004; Otero & Flanagan, 2006; Shefferson *et al.*, 2007), habitat specificity

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(Linder, 1995; Shefferson *et al.*, 2008) or specialised pollinators (Darwin, 1862; Cozzolino & Widmer, 2005), and are categorized as critically endangered and rare. Often their growth is correlated with environmental conditions of the habitat (Aravindhavan *et al.*, 2011). Orchids have a wide ecological range of distribution, especially in tropical forests of America, Indo-Malayan and East Himalayan regions and contribute to a large extend to the epiphytic community (Dressler, 2005). Their high economic value is due to an incredible range of floral diversity attracting botanists, ecologists, traditional healers and naturalists. The Indian orchid flora comprises 1,331 species (of which 400 are endemic) in 184 genera (Misra, 2007). This makes the Indian orchid flora one of the richest in tropical Asia (Sathishkumar & Manilal, 1990; Dressler, 1981; Joseph, 1982; Santapau & Henry, 1973; Bose & Bhattacharjee, 1980).

Dendrobium is the third largest epiphytic genera of the Orchidaceae with 1,184 species (Leitch *et al.*, 2009) and can be characterised by a mentum made up from the column foot, the lip and the lateral sepals. Its distribution range comprises India, China, South East Asia, Japan, Malaya, Philippines, New Guinea, Australia, Pacific Islands and New Zealand. Papua New Guinea has the highest density with a total of 150 species. In India, the genus is represented by 116 species (Misra, 2007). According to Lokho (2013) the highest number of *Dendrobium* species (82) is recorded from the North-Eastern states, with a hotspot of 49 species in Arunachal Pradesh. In 2011, Kumar *et al.* reported eleven *Dendrobium* species from the Chotanagpur Plateau.

While collecting the data about the composition of the forest and the medicinal plants, one of authors (SB) came across the orchid species, and various parameters such as the habit, slope (habitat inclination), the light conditions, the number of plants in the population and the elevation coordinates of the population were recorded. The specimen was examined and reviewed with the help of various floras (Collett, 1902; Duthie, 1906; Raizada *et al.*, 1981; Vij *et al.*, 1982; 1983; Chowdhery & Wadhwa, 1984; Deva & Naithani, 1986; Pangtey *et al.*, 1991; Pearce & Cribb, 2002; Lucksom, 2007; Misra, 2007; Rokaya *et al.*, 2013) and various research papers in national and international journals (Jalal, 2007; 2012a; 2012b; Jalal *et al.*, 2008a; 2008b). It was identified as *Dendrobium longicornu* Lindley, a species that hitherto never has been recorded from the western Himalaya. The accepted name and its synonyms are given according to the World Checklist of Monocotyledons (Govaerts, 2003).

Results

Ecology

Habitat: *Dendrobium longicornu* (Long-horned *Dendrobium*) is found in conifer-broadleaved mixed forest, coniferous forest or oak forest on the stem and branches of the trees between 1200 and 3000 m elevation. The species was encountered in few quadrats laid for vegetation assessment in oak-conifer forest (*Quercus lanuginosa, Q. leucotrichophora* and *Pinus roxburghii*) by the first author.

Host plants: The host species were *Quercus leucotrichophora, Q. lanuginosa* with an association of other tree species (*Lyonia ovalifolia, Myrica esculenta, Pinus roxburghii, Pyrus pashia*) and *Rhododendron arboreum*. The plants were growing on the branches of oak species (80-85%) and stems of *Lyonia* (15-20%) in exposed sites (moderate canopy cover and windy) on a south facing gentle slope (< 25°) in Askot WS (Fig. 1). The populations comprised 300 to 350 individuals.

Systematic treatment

Dendrobium longicornu Lindley
Genera and Species of Orchidaceous Plants: 80 (1830).
Homotypic Synonym: *Callista longicornis* (Lindley) Kuntze, *Revisio Generum Plantarum* 2: 655 (1891)
Heterotypic Synonyms:
Froscula hispida Rafinesque, *Flora Telluriana* 4: 44 (1838)
Dendrobium flexuosum W.Griffith, *Notulae ad Plantas Asiaticas* 3: 317 (1851)
Dendrobium hirsutum W.Griffith, *Notulae ad Plantas Asiaticas* 3: 318 (1851)
Dendrobium bulleyi Rolfe, *Notes from the Royal Botanic Garden, Edinburgh* 8:20 (1913)
Dendrobium fredianum hort.

Description

The plant, commonly described as a nigro-hirsute dendrobium which refers to the fine black hairs that cover the pseudobulbs, is a 10-40 cm tall epiphyte. The plant is tufted, minutely sulcate, somewhat fractiflex, several noded. Its roots are fasciculate. The plant carries 5-11 obliquely pointed linear lanceolate deciduous leaves. It blooms on very short, axillary racemes that arise from the top of leafed canes with 1-3, fragrant, waxy, long-lasting flowers. Stems clustered, pendulous, cylindric, 7-35 cm, 2-4 mm thick, slightly rigid, erect, wavy, unbranched, with many nodes, internodes

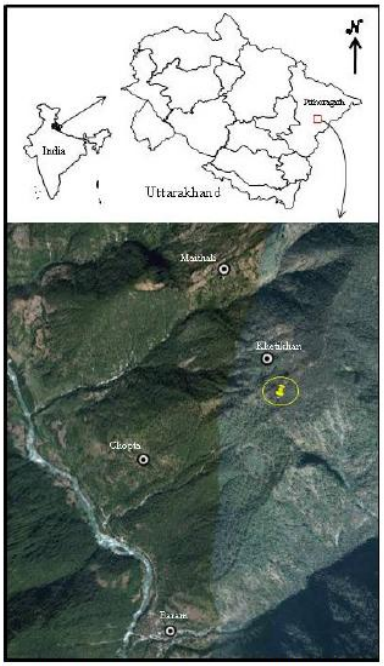

Fig. 1: Location of *Dendrobium longicornu* in Askot Wildlife Sanctuary
in the state of Uttarakhand, India (yellow circle)

2-4 cm, sheaths tubular, funnel shaped, black-hairy, 2.5-4 cm long. Leaves 6-10, distichous, lamina ovate-elliptic to oblong-lanceolate, base a tubular clasping sheath, apex acuminate, emarginate, puberulose, leathery, both surfaces with blackish brown rigid hairs including leaf sheaths, sessile, 2.5-8 × 1-2.2 cm. Inflorescence 5-7.5 mm, terminal or axillary racemes on leafless stem with 1-3 pedicellate flowers; peduncle attenuate *ca.* 5 mm, terete, smooth, enveloped by 2-4, 0.4-1.5 cm long, ovate to lanceolate, acute, imbricate scarious sheaths, with black hairs; rachis 0-2 mm, slightly terete, smooth. Pedicel and ovary nearly cylindric, 2.5-3.5 cm, obscurely ribbed, smooth, slender; floral bracts ovate-lanceolate, 0.5-1.7 cm, subacute to acuminate, coarsely black-hairy, 8 × 3 mm. Flowers white with a lip with yellow or red-orange lamellae, fragrant, 3.0-4.5 cm across, pendulous, pointing downward, cylindric, often not opening fully, nodding, sepals carinate, mentum straight or hooked, 1.5-2 cm long, forming a spur (Fig. 2). Flowering takes place during rainy season (August-September) and flowers are long lasting (up to December).

Fig. 2: ***Dendrobium longicornu***
front (right) and side (left) view of flower

Sepals sub-similar, ovate-lanceolate, acuminate, keeled; dorsal sepal ovate, 1.5-2.0 × ca. 0.5-0.7 cm, 7-veined, mid-vein slightly keeled abaxially, apex acute; lateral sepals obliquely ovate-triangular; petals oblong or lanceolate, 15-20 × 4-7 mm, 5-veined, margin irregularly denticulate, apex acute; lip 3-lobed, broadly triangular when spread, 2.2-3.0 × 2.4-2.9 cm; lateral lobes rounded, margins entire to weakly undulate, 2.2-2.5 × 1.0-1.1 cm; mid-lobe small, suborbicular, fimbriate-lacerate, 6-9 mm wide; disc with a broad

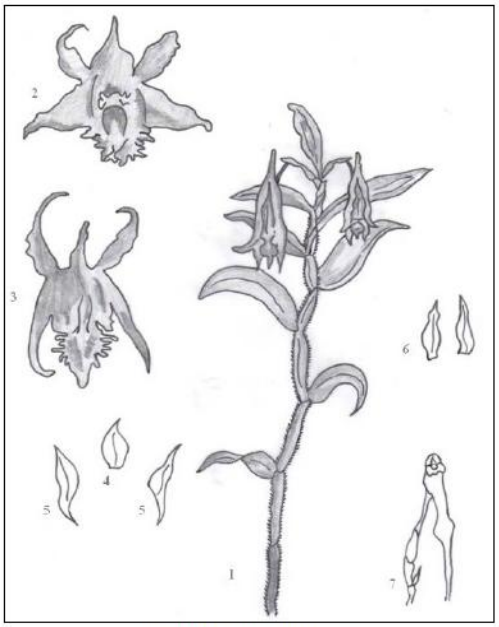

Fig. 3: ***Dendrobium longicornu***
1: habit; 2: dorsal view of a single flower; 3: lateral view; 4: dorsal sepal; 5: lateral sepals; 6: petals; 7: column (anther *in situ*)

central ridge from base to mid-lobe where it divides into 3 or 4 branches. Column with 2 stelidia at apex, 4-8 mm long; foot 1.0-1.2 cm long, teeth triangular; anther cap nearly flatly conic, front margin densely barbate, apex subtruncate; pollinia four, 1.5-2.0 mm long, in two appressed pairs, ovoid or oblong, without caudicle (Fig. 3).

Overall Distribution

India: East Himalaya (including Arunachal Pradesh, Assam, Meghalaya, Mizoram and Nagaland), Sikkim and Darjeeling in West Bengal (Rao, 2007; Lokho, 2013; Yonzone *et al.*, 2012); China (Zhengyi *et al.*, 2010); Bangladesh (Hossain, 2002); Nepal (Subedi *et al.*, 2013; Rokaya, 2013); Bhutan (Pearce & Cribb, 2002); Myanmar (Tanaka, 2003); Vietnam (Averyanov & Averyanova, 2003) and Thailand (Sathapattayanon *et al.*, 2009; Yukawa, 2009).

Orchid diversity in Western Himalaya

The orchid diversity of the Uttarakhand state of India is 240 species (130 terrestrial, 11 saprophytic and 99 epiphytic) from 73 genera (Jalal *et al.*, 2008a). *Habenaria, Dendrobium, Bulbophyllum, Liparis, Oberonia, Eulophia, Eria, Calanthe, Cymbidium* and *Herminium* are the most dominant genera in Western Himalaya. The genus *Dendrobium* is represented by seventeen species: *Dendrobium amoenum, D. aphyllum, D. bicameratum, D. candidum, D. chrysanthum, D. chryseum, D. crepidatum, D. denudans, D. fimbriatum, D. fugax, D. hesperis, D. heterocarpum, D. monticola, D. normale, D. primulinum, D. moschatum* and *D.transparens* (Jalal *et al.*, 2012a; Pangtey *et al.*, 1991). The last two species have been treated as doubtful in both studies, as they were collected by Duthei in 1906 and have not been reported again since. With the collection of *Dendrobium longicornu* from Askot WS (Coll. No.:31 dated 23 October, 2013 at 2005 m altitude; Soni Bisht), the number of *Dendrobium* species rises to 18 for Western Himalaya and 8 for Askot WS.

Etymology

The generic name *Dendrobium* has been derived from the greek words '*Dendron*' meaning 'tree' and '*bios*' meaning 'life', referring to the epiphytic nature of the genus. The species epithet is combined from the characteristics of the mentum: '*longus*' meaning 'long' and '*cornu*' meaning '*horn*'.

Medicinal Use

The species is very rarely used for medicinal purposes. In Askot, WS, the local people occasionally feed the plants to their goats. The juice of the stems is consumed by humans for the treatment of fever and cough in Nepal and the boiled roots are fed to the livestock when the animals are suffering from cough (Subedi *et al.*, 2013). In the traditional Chinese medicine the stems of several *Dendrobium* species are used as '*Shi-Hu*', mainly for throat problems and to enhance the immune system (*Ye et al.*, 2002). Hitherto, fifteen known phenolic compounds have been isolated from the stems of *Dendrobium longicornu* (Hu *et al.*, 2008; 2010).

Trade

Most of the species of orchids are listed under Appendix II and can be traded through export permits (CITES). The data available through the CITES reports suggest that over the last four years living plants of *D. longicornu* have been traded to Germany (80 individuals), USA (40 individuals), France (41 individuals) and Japan (5 individuals), which shows that the trade of *D. longicornu* has been more or less constant over a period of three years (CITES, 2009; 2010; 2012).

Threat

In the present situation the habitat of *Dendrobium longicornu* is not under threat. However, recurrent fire incidences are happening in the lower side of the forest, which is dominated by *Pinus roxburghii*, and may affect the regeneration and establishment of the species in other host species.

Conservation

The presence of maximum number (*ca.* 95%) of *Dendrobium* species in the eastern part of Uttarakhand state i.e. Askot WS in particular suggests that it is one of the best suited habitat. Efforts have to be made for the conservation of the genus in the region by conducting awareness programmes for the local youth including school/college students, while, to maintain the gene pool in nature, the frontline staff should be motivated to conserve the genus.

Acknowledgement

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