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LANDSCAPE MAPPING AND TREE DIVERSITY ASSESSMENT OF PANGI VALLEY: A REMOTE TRIBAL AREA OF HIMACHAL PRADESH IN WESTERN HIMALAYA, INDIA

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Abstract

Pangi valley in Chamba district of Himachal Pradesh is one of the remote tribal areas in Indian western Himalaya. The plant resources in its landscapes are flourishing under least anthropogenic conditions. For social upliftment of the tribals in this area, a number of developmental activities are being implemented by the government. A study was conducted for mapping of its landuse/landcover using satellite remote sensing to identify major forested landscapes in the region. It was followed by a detailed random stratified sampling of the forested landscapes for phytosociological estimation of its tree species. The 21.97 % of study area was estimated under forests followed by Scrublands and Grassy meadows (18.24 %). Majority of area (54.05 %) was Snow and Scree slopes. Among the forests, maximum area was occupied by Mixed Broad Leaved Forest LSE type (36.08%) followed by Cedrus deodara (26.94%) and Betula utilis (18.07%) forest LSE types. These species, owing to immense medicinal properties and value for their economic utilization, feature in threatened and endangered category list of plants. It is, therefore, recommended that the developmental activities may be implemented in scientific way, which may not pose threat to bioresources in this region.

Keywords: *Remote sensing; GIS; quadrat; frequency; density; conservation*

Introduction

Pangi valley in Chamba district of western Himalayan state of Himachal Pradesh (H.P.), India, is one of the remote tribal areas [1]. It represents temperate climate with harsh weather conditions during winter. It is a difficult terrain and located in the agro-climatic zone-IV of the state Himachal Pradesh [2]. The least anthropogenic disturbances due to its unique location provide opportunity to conserve and maintain flora of the region [1]. Efforts are being made in recent years for social upliftment of the people in this region and thus many developmental plans are being implemented to connect this region with the other areas of the state. The construction of a road from Chamba to Pangi via Saach pass is one of such examples [3], which was earlier accessible only through Kullu and Lahaul-Spiti districts of H.P. This new road will link Pangi to its district headquarters and it may also provide another route to Leh *via* Chamba. These developments are good for the welfare of local people, but it has brought drastic change in their life styles and also in the land use utilization pattern of the region [1, 4]. Now, the

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people are more inclined towards cultivation of cash crops *viz.*, peas, apple, kuth, which require more land holdings and it may pose threat to the local forest resources. In this situation, understanding of distribution, quantity and current status of available plant resources in the region becomes imperative [5]. Keeping in view these issues, present study has been undertaken to identify major forested landscape elements types (LSE types) of the region using satellite remote sensing. It was followed by random stratified sampling of these landscapes to understand its tree diversity and to estimate tree species richness.

Study Area

The study area (Fig. 1**)** lies between 32º 12' 41" to 32º 47' 59" N latitude and 76º 13' 56" to 76º 47' 48" E longitude. The elevation ranges from 2006 to 6168m amsl (average elevation 4008 m). The geographical area of Pangi valley is 1,52,371.04ha and Killar is its administrative head quarters. It lies in the semi-arid zone of inner Himalaya and thus witnesses severe winters and heavy snowfall. It is located in upper part of Chamba district of Himachal Pradesh between Pir Panjal and Zanskar ranges of western Himalaya. It is bounded by Jammu & Kashmir in the north, Lahaul & Spiti in southeast, and Chamba in southwest. The region is drained by Chenab river, which is also known as Chandrabhaga.

Fig. 1. Map of study area

Materials and Methods

The IRS 1D LISS III satellite image (Path 094, Row 047) acquired on October 6, 2004 has been used in the present study (Fig 2A**)**. The topographic sheets (Ids 52 C/8, 52 C/12, 52 D/5, 52 D/9 and 52 D/13) on 1:50,000 scale from Survey of India (SOI), Dehradun were used for geo-referencing of the satellite image. Erdas Imagine 8.6 software was used for image processing [6] of the satellite data, while map composition was done in Geographic Information System (GIS) environment using ArcGIS 9.3 [7].

A reconnaissance survey of the study area was carried out during year 2001-2006 in order to understand landuse/landcover pattern prevailing in the region and to collect training sets thereof using a GPS handset [8]. The satellite image of the study area was geometrically corrected in reference to SOI toposheets. The image-to-map registration with 2nd degree of polynomial transformation resulted in root mean square error of less than one pixel. The image of the study area was extracted from satellite data by overlaying administrative boundary of Pangi area over the geo-referenced image by clipping operation [9]. The unsupervised classification using ISODATA algorithm followed by supervised classification using training sets [8] produced a landuse/landcover map of the study area. The map thus produced was verified in the field by ground truthing [10].

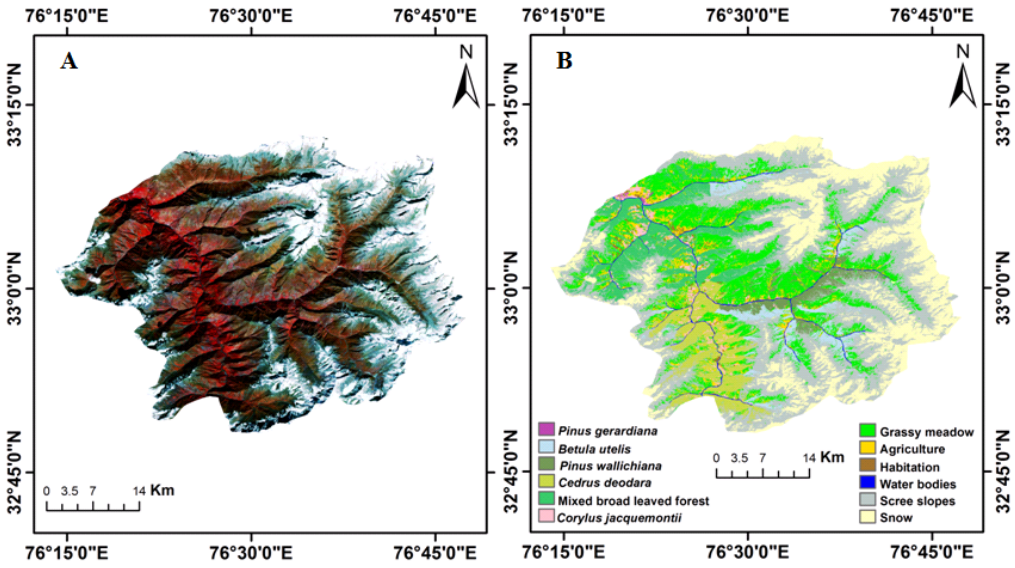

Fig. 2. IRS 1D LISS III image (A) and Landuse/landcover map of the study area (B)

The resulted map categorized the study area in various landuse/landcover classes (forest, agriculture, scrubland, grassy meadows, scree slopes, habitations, and water bodies) and various forested LSE types (Mixed Broad Leaved Forest, *Cedrus deodara*, *Betula utilis*, *Pinus wallichiana*, *Corylus jacquemontii* and *Pinus gerardiana*), which would be referred by the dominant species henceforth. The random stratified sampling was carried out in above derived LSE types using quadrat method [11] to study the tree diversity in each LSE-type. A total of 33 quadrats of 10m x10m size were randomly laid at different sites representing all LSE types. The inventories of trees falling in each quadrat were made and their populations were observed to derive their frequency and density [12]. The frequency and density of tree communities were calculated using the following formulae:

$$\text{Frequency (\%)} = \frac{\text{Number of quadrats in which tree species were encountered}}{\text{Total no. of quadrats}} \quad (1)$$

$$\text{Density (individual/100m}^2\text{)} = \frac{\text{Total number of tree species in all quadrats}}{\text{Total no. of quadrats}} \quad (2)$$

Results and Discussion

The results of the present study showed that 21.97 % of study area is under the forests (Fig 2B**)**. This is followed by Scrubland and Grassy meadows (18.24 %). Most of the area (54.05 %) is occupied by Snow and Scree slopes. Rest 5.74 % of the land is occupied by agriculture, habitations and water bodies. Among the forests, maximum area is occupied by Mixed Broad Leaved Forest (36.08%) followed by *C. deodara* (26.94%), *B. utilis* (18.07%), *P. wallichiana* (11.26%), *C. jacquemontii* (7.30 %) and *P. gerardiana* (0.35%) LSE types.

It was observed that the north-western region of Pangi is dominated by Mixed Broad Leaved Forests. The forests near Pontu, Killar, Sansari, Perigran and Lujj localities have having dominance of coniferous species like *C. deodara*, *P. wallichiana* and *P. gerardiana* while those around Pindru, Sacch and Khilmi, are dominated by species like *C. jacquemontii*, *Celtis australis*, and *Acer negundo*. The *P. gerardiana* communities were observed to be mixed with

species like *C. australis* and *Pyrus pashia* near Lujj locality. The forests in the southern region of the valley near Kulal, Purthi and Shor localities are dominated by *C. deodara* tree species (Fig. 3A). Sural valley in the north; Cheni nala, Banthalwal nala and Kulna nala in the west; Papitha nala in the east, and north facing slopes of Salchu nala near Dodon in the southeast have large continuous patches of *B. utilis* (Fig. 3B**)** and also represent tree lines. The eastern region of the Pangi valley near Dodon, Sunari and Salchu is occupied by *P. wallichiana* dominated LSE types. The *C. jacquemontii* LSE type was found to be distributed all along the Chenab river mixed with other species like *Acer* sp., *Aesculus indica*, *Juglans regia* and *Cedrus deodara*.

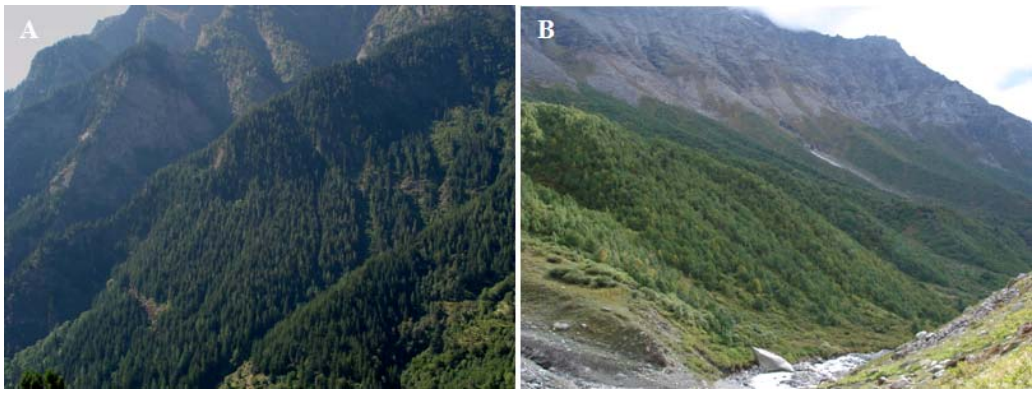

Fig. 3. *Cedrus deodara* LSE types (A) and *Betula utelis* LSE types (B)

The Mixed Broad Leaved Forests were found to be composed of *C. jacquemontii*, *C. australis, Aesculus indica*, *P. wallichiana*, *Juglans regia, C. deodara* and *A. negundo* (Table 1).

Table 1. Population status of forested LSE types in Pangi valley

LSE Type	Plant Name	Frequency (%)	Density (Individuals/100m^2)
Mixed Broad Leaved	*Corylus jacquemontii*	100.00	2.14
	Celtis australis	100.00	1.50
	Aesculus indica	66.67	0.67
	Pinus wallichiana	25.00	0.50
	Acer negundo	28.57	0.29
	Juglans regia	33.33	0.33
	Cedrus deodara	25.00	0.25
Cedrus deodara	*Cedrus deodara*	100.00	6.83
	Pinus wallichiana	66.67	1.33
Betula utilis	*Betula utilis*	100.00	8.00
	Corylus jacquemontii	33.33	0.33
Pinus wallichiana	*Pinus wallichiana*	100.00	2.00
	Euonymus fimbriatus	100.00	1.00
	Lonicera quinquelocularis	100.00	1.00
	Cedrus deodara	33.33	0.33
	Celtis australis	33.33	0.33
	Crataegus oxyacantha	33.33	0.33
Corylus jacquemontii	*Corylus jacquemontii*	100.00	7.20
	Cedrus deodara	100.00	3.00
	Juglans regia	50.00	2.25
	Aesculus indica	33.33	0.33
	Acer negundo	28.57	0.29
Pinus gerardiana	*Pinus gerardiana*	100.00	4.67
	Celtis australis	66.67	1.00
	Pyrus pashia	33.33	0.67

Among these, the density of occurrence of *C. jacquemontii* trees was highest (2.14/100m^2). It was lowest in case of *C. deodara* (0.25/100m^2) forests. The *C. deodara* LSE types consisted of 6.83/100m^2 individuals of *C. deodara* and 1.33/100m^2 of *P. wallichiana* with 66.67% frequency. The *B. utilis* LSE type consisted of 2.14/100m^2 of *B. utilis* followed by 0.33/100m^2 density of *C. jacquemontii*. The *P. wallichiana* LSE is composed of *P. wallichiana* (2.00/100m^2), *Lonicera quinquelocularis* (1.00/100m^2), *Euonymus fimbriatus* (1.00/100m^2), *C. deodara* (0.33/100m^2), *C. australis* (0.33/100m^2) and *Crataegus oxyacantha* (0.33/100m^2). The *C. jacquemontii* LSE consists of *C. jacquemontii* (7.20/100m^2), *C. deodara* (3.00/100m^2), *Juglans regia* (2.25/100m^2), *A. indica* (0.33/100m^2) and *A. negundo* (0.29/100m^2). The *P. gerardiana* LSE consist of *P. gerardiana* (4.67/100m^2), *C. australis* (1.00/100m^2) and *P. pashia* (0.67/100m^2).

In this study the distribution of tree species and their population status in a hitherto unexplored area is presented. The *P. gerardiana* is listed as a rare species [13]; *C. jacquemontii* and *J. regia* are identified as endemic taxa [14] and *B. utilis* is recognised as endangered species in the region [13]. The region serves as niche for *P. gerardiana* and *C. jacquemontii*, and presence of large uniform landscapes of *B. utilis* is also of a great significance. The *C. deodara* is state tree of H. P. The wood of *C. deodara* is good for furniture and also yields cedar oil. The bark of *B. utilis* is useful in convulsion, bronchitis and disease of blood and the needle of *P. wallichiana* has antibacterial properties [15].

Conclusions

It was concluded that the various LSE types recorded and sampled in the Pangi valley are composed of important tree species of western Himalayan region which have medicinal properties and valued for their economic utilization. The area is least explored and has largely been free from large scale anthropogenic disturbances, hence requires estimation of the baseline information on forest resources through modern techniques. The present study is an effort in this direction to document the extent of occurrence of tree communities of the region and their population status. It was observed that these important bioresources of the region are at risk and need scientific interventions for their conservation. Although the development of this area is necessary for the betterment of local people, yet it is recommended that it may be undertaken in a sustainable manner with a prior knowledge of existing conditions, in order to conserve the bioresources of this region.

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