GENERAL METHODOLOGY

In order to assess the ecological status and other related aspects including population structure, ethno botanical knowledge and harvesting practices the present study titled “Conservation and utilisation of medicinal and aromatic plants in Dhauladhar mountain range of Himachal Pradesh” was carried out in district Kangra from 2013 to 2016.

2.1 Study area

2.1.1 Location

The present study was conducted in the Dhauladhar mountain range of the Indian Himalaylas, which lies in the state of Himachal Pradesh. The Dhauladhar mountain range begins from Dalhousie at northwest end, i.e., Chamba district and pass through the state to the banks of the river Beas in the Kullu district of Himachal Pradesh. The highest peak in Dhauladhar mountain range is the Hanuman ji Ka Tiba, which is about 5,639 meters. The range includes some other peaks, i.e., Mun (4610 m) near Dharamshala, Manimahesh Kailash (5653 m), Gaurjunda (4946 m), near the Talang pass, which is also commonly referred as the "Dhauladhar Matterhorn", Christmas (4581 m), Toral (4686 m), Dromedary (4553 m), Riflehorn (4400 m), Lantern (5100 m), Arthur’s Seat (4525 m), Camel (4520 m) and Slab (4570 m). The peaks have a sharp streak of snow and ice at the top and are typical dark granite rocky formations and are prominently seen from the Kangra valley of Himachal Pradesh. The elevation of Dhauladhar Mountain Range ranges widely from 1000 m to nearly 6000 m. District Kangra lies between 31°2’ to 32°59’ N latitude and 75°47’ to 77°45’ E longitude (Fig. 2.1). The district Kangra spans over 5,739 km geographical area, which constitutes 10.31% of the total geographical area of the state.
Kangra district derives its name from Kangra town that was known as Nagarkot in ancient times. Kangra proper originally was a part of the ancient *Trigarta* (Jullundur), which comprises of the area lying between the river "Shatadroo" (probably Sutlej) and Ravi. A tract of land to the east of Sutlej that probably is the area of Sirhind in Punjab also formed a part of *Trigrata*. Trigrata had two provinces. One, in the plains with headquarters at Jullundur and other in the hills with headquarters at Nagarkot (the present Kangra). The Dhauladhar wildlife Sanctuary located in district Kangra, between 32°01’42” to 31°27’27” N and 76°41’41” to 77°01’42” E towards the north east direction is one of the most important areas in the district. The area is rich in biodiversity with high percentage of valuable MAPs. Previously, there were 42 villages under the sanctuary area, but now the area includes only one village Bara Bhangal and rest is the forest area.

**Fig.2.1 Different blocks in District Kangra, Himachal Pradesh**
2.1.2 Administrative setup

From administrative point of view the district Kangra has been divided into eight sub-divisions viz., Kangra, Dharamsala, Jawali, Dehra Gopipur, Nurpur, Palampur, Baijnath, and Jaisinghpur. Kangra district is comprises of 19 Tehsils namely Nurpur, Indora, Jwali, Kangra, Palampur, Badoh, Kasba Kotla, Jaswan, Dehra Gopipur, Khundiyan, Jaisinghpur, Baijnath, Fatehpur, Dharamshala and Shahpur. Sub tehsils include, Harchakkian, Dhira, Rakkad, Thural and Meerthan and from a development point of view the district is divided into fourteen developmental blocks, viz. Baijnath, Bhawarna, Lambagaon, Panchrukhi, Kangra, Nagrota Bagwan, Rait, Dehra, Pragpur, Nagrota Surian, Nurpur, Indora, Fatehpur and Sulah at Bhedoo Mahadev. There are 732 Gram Panchayats and 3868 villages located along the altitudinal gradient in Kangra district, of which 29 villages were studied which are located in three subdivisions (Table 2.1).

Table 2.1 The administrative setup of study area and sampled area

<table>
<thead>
<tr>
<th>Name</th>
<th>Total Number</th>
<th>Sampled in the study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Divisions</td>
<td>8</td>
<td>3 (Dharmshala, Palampur, Baijnath)</td>
</tr>
<tr>
<td>Tehsils &amp; Sub-Tehsils</td>
<td>19</td>
<td>4 &amp; 1 (Dharmshala, Palampur, Baijnath, Shahpur &amp; Rakkad)</td>
</tr>
<tr>
<td>Development Blocks</td>
<td>14</td>
<td>3 (Baijnath, Bhawarna, Rait)</td>
</tr>
<tr>
<td>Gram Panchayats</td>
<td>732</td>
<td>12</td>
</tr>
<tr>
<td>Inhabited villages</td>
<td>3619</td>
<td>29</td>
</tr>
</tbody>
</table>

(Source: Economics and Statistical Department, Dharamshala)

2.1.3 Topography

The study area is characterised by deep river valleys and steep mountain slopes with an altitudinal range of 1000 m to 6000 m (Fig. 2.2). Dhauladhar Wildlife Sanctuary covers nearly 50% of the study area, which lies between the altitudinal range of 4000-5600 m. The slope-wise distribution of the area shows
that more than 50% of the area lies between the slope categories of 27°- 45°. The study area terrain is characterised by numerous high ridges, deep gorges and precipitous cliffs, rocky, glaciers and narrow valleys. The topography of the area has also been influenced by avalanches and landslides. Avalanches occur frequently after heavy snow, often originating from the steep southern aspect, especially during April to June. Landslides and earthquakes are common to this region.

Fig. 2.2 Altitudinal distribution across the district Kangra

2.1.4 Geology and Soil

The geology, rock and soil affect the vegetation of a place by influencing the moisture regime, structure, texture and drainage pattern. Based on these factors, the area is divided into five sub micro-regions viz., Pir Panjal, Dhauladhar, Kangra Valley, Kangra Shiwalik and Beas Basin. The soil found in the area is mainly ochrepts, which are shallow, black, brown, and alluvial. As per the Rural Development Department Report, the geological structure of the district is formed chiefly by alluvium, shiwalik, murree series, julogh group and granites.
Dhauladhar ridge is composed of coarse grained granite and gneiss. The rock type found in the area is sand stone, siltstone to phyllite quartzite. The drainage pattern of the district is mainly formed by the Beas River. Glaciers, which provide the stream with perennial water flow, include Shah, Sili, Laluni, Bhadal, Kuru, Tantgair and Raighar. The soil is light textured with neutral pH in the valley. The changar regions have coarse textured shallow soils with low water holding capacity and poor fertility. The Beas basin is deep alluvial silty loam with high fertility. The direction of slope varying from flat to high steep is the result of tectonic activities prevailing in the area.

2.1.5 Climate

Kangra district with agro-ecological situation varies from sub-tropical, wet / dry temperate to alpine region. The region is one of the most fragile ecosystems which support rich biological diversity. The region typically exhibits subtropical, temperate and alpine climate. The region experiences 3 seasons: Hot weather: April to June (Maximum temperature ranges from 25°C to 30°C), Rainy: July to October (Average annual rainfall – up to 1700 mm) and Cold weather: November to March (Minimum temperature ranges from –5°C to – 20°C. The maximum annual rainfall is received from July-September. The monsoon rains are heavy and well distributed. The high ranges receive heavy snow in winter (November-March). The distribution of rainfall and mean temperature varies across the region. The area in sub humid subtropical zone receives about 1000mm to 2500mm of rainfall and mean temperature of about 20°C to 24°C. The area under wet temperate zone receives annual rainfall of 2500 mm-2800 mm and the temperature varies from 15° to 19°C. The maximum mean temperature in past ten years varied from 18.32 to 30.8°C in the Kangra district, whereas minimum mean temperature ranged from 1.23 to 29.2°C (Fig. 2.3) and annual rainfall from 2003 to 2016 varied from 147.37 to 228.43 cm (Fig. 2.4).
Fig. 2.3 Distribution of maximum and minimum temperature in District Kangra

(Source: Meteorological Centre, India Meteorological Department, Shimla)

Fig. 2.4 Distribution of rainfall from 2003-2016, District Kangra

(Source: Meteorological Centre, India Meteorological Department, Shimla)
2.1.6 Forest

The immense variability in the altitude, geography, climate and soil supports wide biological diversity in the region. The forest of district Kangra consists of different types of vegetation right from scrub forest at low elevation to the alpine pastures at higher altitude. As per the Annual State Forest Report Himachal Pradesh (2012-2013), the total forest area of district Kangra is 2064 km² with a very dense forest of about 310 km² and moderately dense forest is 1221 km². The open forest in the district is about 533 km². Under this, the reserved forests are 7415 per ha, Demarcated protected forests are 54754 per ha, Undemarcated protected forests 1,65,220 per ha and Unclassed forests are 44,295 per ha. The forests of chir, ban oak mixed conifers (kail, spruce and fir) and kharsu oak forests are common to the region (Table 2.2).

The region is categorised by various forest types by Champion and Seth (1968) based on permanent vegetation, i.e. tropical forest, sub tropical forest, temperate forest, sub alpine forest and alpine vegetation along the altitudinal range (Plate 2.1, 2.2,2.3). Major categories of the vegetation according to Champion and Seth (1968) in the area include: 1. Type 9/c – Ia Upper or Himalayan Chir pine Forests 2. Type 12/c – Ia Ban Oak Forests/ 3. Type 12/c – Id Western mixed Coniferous Forests 4. Type 12/c – Ie Moist Temperate Deciduous Forest 5. Type 12/c – If Low level Blue Pine Forests: - 6. Type 12/c – IIa Kharsu Oak Forests 7.Type 12/ ISI Alder Forests 8. Type 14/c – I Western Himalayan sub Alpine Forest. 9. Type 15/c – 3 Alpine Pastures 10.Type 16/c – I Dry alpine scrub.

Among the faunal diversity, musk deer, leopard, Himalayan tahr, Himalayan black bear, goral, Himalayan ibex, serow, blue mountain sheep, pheasants, western tragopan, Himalayan monal, snow partridge, koklass and white crested kalij were the most dominant ones. A species believed to be locally threatened are musk deer and western tragopan.
Table 2.2: Distribution of forest types across the altitudinal gradient in the study area.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Type of Forests</th>
<th>Elevation (mts. a.s.l.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scrub forest</td>
<td>600-1200</td>
</tr>
<tr>
<td>2</td>
<td>Chir forests</td>
<td>800-1700</td>
</tr>
<tr>
<td>3</td>
<td>Ban oak forests</td>
<td>1600-2300</td>
</tr>
<tr>
<td>4</td>
<td>Deodar forest</td>
<td>2000-2500</td>
</tr>
<tr>
<td>5</td>
<td>Mixed conifers</td>
<td>2100-3000</td>
</tr>
<tr>
<td>6</td>
<td>Kharsu oak forest</td>
<td>2300-3800</td>
</tr>
<tr>
<td>7</td>
<td>Alpine scrub and alpine pastures</td>
<td>Above 3800</td>
</tr>
</tbody>
</table>

(Source: Forest Department, Dharamshala)

2.1.7 Local People and land use practices

The latest demographic position shows that the Kangra district has first position in Himachal Pradesh with a population of 13,38,536 (about 23% of the state). More than 90% of the population directly or indirectly depends on agriculture for livelihood. The rural population accounts 94.27%, whereas the urban population is about 5.73% (Census, 2011). Inhabitants include the Gaddi tribe along with the Kangri (Pahadi) people. The main occupation of locals comprises of animal husbandry, agriculture, collection of MAPs and grazing of livestocks (Plate 2.4). The Gaddis are the semi nomadic people also called as a pastoralist community who are partly settled in the middle of the Dhauladhar range (Plate 2.5, 2.6). Migration by the tribes to the higher altitudes is the part of the livelihood annually.

As, the region supports rich diversity of MAPs the dependency of locals is quite high on these valuable MAPs, which serve as a source of livelihood for them. Recently, the extraction of MAPs formed a major source of cash income. This
activity, in some cases, contributes as high as 65% of the total cash income. Besides, rearing sheep and goats is still practiced on a large scale. Animal husbandry is common practice for the farm yard manure and for milk products.

Horticulture is becoming more popular in the area and raising orchards of apple, plum, walnut and cherry, etc. are being developed while maize, barley, wheat, potato, rajmah and vegetables are generally cultivated as food crops. Intensive grazing activity is one of the major drawbacks for the degradation of the forest, which have resulted in large scale soil erosion at the Dhauladhrs. Anthropogenic pressures, which include overexploitation of MAPs, unscientific harvesting practices and illegal trading of the MAPs have resulted in the loss of biodiversity in this area.

2.2 Field methods

2.2.1 Sampling design

The sampling technique followed in the present study was stratified random sampling. The area was stratified based on the classification of forest types as proposed by Champion and Seth (1968) as well as altitude. Each forest type along the altitudinal gradient was considered as the strata. From each stratum the villages were selected randomly.

2.2.2 Forest structure

Equidistant transects were laid at a distance specified in all the four directions considering village as the center point. Sample plots (Quadrat) were laid at equal intervals along the transect. Each sample plot on the transect was of 10×10 m for tree species, 5×5 m for shrubs/ saplings and 1×1 m for herbs/ seedlings. In each plot the number of individuals of each plant species was enumerated. The circumference at breast height (CBH) of tree species was measured using the measuring tape. In case of uncertainty on species identity, the specimens were verified from the herbaria of the Institute of Himalayan Bioresource Technology (IHBT) at Palampur and ISM, Jogindernagar in Himachal Pradesh.
2.2.3 Ethnobotanical survey

The randomly selected villages in each stratum were surveyed. The survey was spread across seasons so as to get maximum information. Structured questionnaires and interviews were carried out among the different groups, i.e. the elders, women, traditional healers, amchis and traders. Focal group discussion was organised in the respective villages. Detailed information about the MAPs utilisation, traditional harvesting practices, and collection of plant parts, collection period, cultivation practices and trade of MAPs was collected. Secondary data related to the village population, annual income, MAPs permit information and the meteorological data was collected from the concerned departments.

2.3 Data analysis

2.3.1 Population structure

For the MAPs distribution and population structure, the relative density, relative frequency and relative dominance following Cottam (1949), Curtis (1959) and Mishra (1968) was estimated, and the Importance Value Index (IVI) and Shannon–Wiener Diversity Index (Shannon, 1948) was calculated.

2.3.2 Ethnobotanical analysis

To estimate the user variability of MAPs, Informant Consensus Factor (ICF) and the Fidelity Level were calculated as they represent the percentage of informants claiming the use of certain plant for the same major purpose, following Gazzaneo et al. (2005). For the local importance of MAPs, Use Value Index (Phillips et al., 1994) was calculated. The method developed by Mander et al. (1997) was applied in order to calculate the conservation priority score.

2.3.3 Statistical analysis

The significant differences among the various parameters at the 95% confidence level was checked using univariate tests and non parametric tests with the assistance of the software SPSS Statistic 20.0 and the species list was made based on the conservation priority score. To determine the relationship of different MAPs with environment variables Canonical correspondence analysis was
conducted in CANOCO 4.5 software. Maps based on the distribution of MAPs and collection sites in the study area were prepared using ARCGIS 10.2.1 software developed by ESRI.
Plate 2.1 Subtropical forest type  
Plate 2.2 Temperate forest type  
Plate 2.3 Sub alpine forest type  
Plate 2.4 Local carrying fodder for livestock  
Plate 2.5 Collection of wool by local  
Plate 2.6 Cottage industry (blankets), Naddi