PRELIMINARY IDENTIFICATION OF IPAS FOR MEDICINAL PLANTS IN THE HIMALAYAS

Country Report
INDIA

PRAGYA

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EXECUTIVE SUMMARY

The Himalayas are a storehouse of the most valuable and rare medicinal plants, but this heritage is being fast depleted as a result of anthropogenic and ecological factors. Towards guiding conservation activities, for ensuring maximal effectiveness and the protection of the most critical species and areas, Pragya carried out an extensive exercise of prioritising Important Plant Areas for medicinal plants in the entire Indian Himalayan Region.

A rigorous process was followed for collecting and analyzing data. Data collection involved:

1. Ground surveys across the high altitude belt, followed by regional CAMPs
2. Literature survey and secondary data analysis, wherever available, for the middle & lower altitude belt
3. Reports of key informants, community and state

Site prioritisation and IPA identification involved:

1. Compilation of site-specific data on presence of threatened species, species abundance & richness
2. Clustering of sites based on habitat homogeneity, biophysical boundaries and physical proximity
3. Prioritization of clusters ensuring representation of all ecotypes and proportionate to species abundance & diversity

The following 15 IPAs were identified on a preliminary basis (to be validated by ground truthing and a cross-regional CAMP workshop):

Himalayan division	***State***	***IPA #***	***IPA name***	***Tracts included***
Western Indian Himalayas	Jammu & Kashmir	IPA-1/WIH	Khardung-la	Khardung-la
		IPA-2/WIH	Sapi-Penzi-la	Sapi
				Panikher-Parkachik
				Penzi-la-Rangdum
		IPA-3/WIH	Argi-Sarchu	Argi
				Sarchu
	Himachal Pradesh	IPA-4/WIH	Chika-Peukar-Khangsar	Chika-Rarik-Patseo
				Peukar-Charji
				Khangsar
		IPA-5/WIH	Rohtang & Solang	Rohtang pass
				Solang valley
		IAP-6/WIH	Malana-Parbati-Sainj	Malana valley
				Sainj-Tirthan
				Manikaran-Mantalai
		IPA-7/WIH	Rakcham-Chitkul and Rupi-Bhaba	Rakcham-Chitkul
				Rupi-Bhaba
Central	Uttaranchal	IPA-	Kedar-Gangotri	Kedarnath

Indian Himalayas		8/CIH		Khatling-Sahastratal
				Kedartal-Gangotri
				Harsil-Bhaironghati
		IPA-9/CIH	Valley of Flowers and Niti	Mana-Valley of Flowers
				Niti valley
				Dronagiri
				Kuari pass
		IPA-10/CIH	Gauri & Pindar	Gauri valley
				Pindar valley
Eastern Indian Himalayas	West Bengal and Sikkim	IPA-11/EIH	Dzongri-Phedang and Sandakphu	Yuksam-Geochela
				Sandakphu
		IPA-12/EIH	Lachen & Lachung	Lachen-Chopta
				Lachung-Goechela
	Arunachal Pradesh	IPA-13/EIH	Dirang-Tawang	Thingbu-Luguthang
				Geshela-PTTso
				Sela-Bangajang
				Senge-Nyukmadung
		IPA-14/EIH	Upper Siang and Dibang	Pemako
				Anini-Bruini-Andra
		IPA-15/EIH	Western Lohit-Changlang	Deomali
				Demwee-Tiding

1. BACKGROUND

1.1 THE HIMALAYAS HOTSPOT

The mountain range of the Himalayas that stretches in an arc over 3,000 kilometers of northern India and its neighbouring countries, has been recognized by Conservation International as one of the 34 biodiversity hotspots of the world that are a priority for conservation action, having lost more than 70% of its original habitat. Being one of the nine newest hotspots identified, it has not had the advantage of receiving the conservation attention that the 25 hotspots identified about 15 years back have, and this makes it a priority site for protection and sustainable management today.

The Himalayan region is a bio-geographically unique zone in the world and has the maximum degree of endemism in the Asian region. Unfortunately, many of these species of plants, birds, mammals, are critically endangered today, threatened by both anthropogenic impacts and climate change.

Despite their remoteness and inaccessibility, the high altitude Himalayas has suffered a high level of human & climate change induced biodiversity loss and habitat degradation. The steadily increasing population in the hotspot has led to extensive changes in the land cover and use. Large areas of remaining habitat in the hotspot are highly degraded. The main source of livelihood for smallholders, 37% of encroachment in protected forests is that of cultivation; pastoralists follow the same practice for grazing lands. Sustenance of the tribes is heavily dependent on the forests, agriculture & livestock supporting only a basic level of food requirement. Firewood constitutes over 90% of fuel in the region; overextraction of NTFPs & hunting of animals/birds and poaching of endangered species like snow leopards (*Uncia uncia*, EN) and red pandas (*Ailurus fulgens*, EN) sought for their beautiful pelts, has led to some species becoming critically endangered. Biomass demand of communities has grown manifold as a result of population growth and additional livelihood needs (eg.,fuelwood for hotels). Illicit felling & smuggling of timber is rampant by timber traders using local labour- 95% of industries in Arunachal for instance, are forest-based. NTFPs like medicinal plants are recent additions as their demand increases in the pharma sector and the flora of fragile alpine meadows is being overexploited. Other threats such as mining, construction of roads and large dams, pollution due to the use of agrochemicals, unplanned and poorly managed tourism, and political unrest, also threaten the integrity of the hotspot.

Further, the Intergovernmental Panel on Climate Change in its global climate scenarios (Assessment Report, 2001) has indicated that the pattern of global warming will be more pronounced at high altitude zones, especially those in the tropics and sub-tropics (of which the

Himalayas is the largest range) - upto 3 to 5 times faster warming than in the rest of the world. This is resulting in the rapidly thinning ice packs and receding glaciers and shrinking of wetlands; there are also other climate change impacts on biodiversity in the mountains in these regions, including change in vegetation, hibernation & migration patterns, growing rates, etc.

Data Gaps at High Elevations:

The high altitude belt of the Himalayas however, suffers from a severe paucity of information on status of biodiversity, development & its impacts. A sound understanding and information base on this region and the nature, extent & impacts of ecological change would enable scientific & appropriate conservation planning & action, at the local, national and global levels. The Mountain Research Initiative has recorded a large observational data gap in mountainous regions between approximately 40 degrees N and 30 deg. S. There are no high-elevation measurement and monitoring sites, its inaccessibility having robbed it of the research attention it deserves. Altitude has been found to be inversely related to resources and development, with the high altitude areas with the rarest of species and most vulnerable of ecosystems receiving almost no attention. It is increasingly evident today however that rapid environmental change in this region would significantly alter the very large & critical goods & services lowland populations receive from it, for instance, water, biodiversity.

1.2 HIMALAYAN MEDICINAL PLANTS

The Indian Himalayas are home to several of the most rare medicinal plants, including many endemic and high-value and Red Listed species like *Aconitum heterophyllum, Dactylorhiza hatagirea, Picrorhiza kurroa* and *Dioscera deltoida*. Deforestation and climatic changes in the region, compounded by overuse and destructive harvesting of medicinal plants, have led to the depletion of these valuable resources at an alarming rate. Apart from the significant loss of biodiversity, this is also impacting the health status of local communities who are dependant on plant-based traditional medicine.

Around 70% of India’s medicinal plants are found in tropical areas mostly in the various forest types spread across the Western and Eastern ghats, the Vindhyas, Chotta Nagpur plateu, Aravalis and Himalayas. Although less than 30% of the medicinal plants are found in the temperate and alpine areas and higher altitudes, they include species of high medicinal value. For the Indian Himalayan Region, a total of 1748 species of medicinal plants –1020 herbs, 338 shrubs, and 339 trees, apart from 51 pteridophytes – have been listed (Samant *et al.* 1998). These include several of the endangered medicinal plant species, using current IUCN, Red Data criteria under

the Biodiversity Conservation Prioritization Project (BCPP), by Conservation Assessment and Management Plan (CAMP) workshop organized by WWF at Lucknow from 21-25 January 1997 (Samant *et al*. 1998). Some examples of the endangered Himalayan medicinal plant species include: *Aconitum balfourii, A. deinorrhizum, Acorus calamus, Angelica glauca, Atropa belladonna, Berberis kashmiriana, Coptis teeta, Dioscorea deltoidea, Gentiana kurrooa, Nardostachys grandiflora, Picrorhiza kurrooa, Podophyllum hexandrum, Saussurea costus, Sweria chirayita* and *Taxus baccata subsp.wallichiana;* and the sub-tropical/sub-temperate species *Aquilaria malaccensis.*

Threats to Medicinal Plants

The expanding trade in medicinal plants has grave implications on the survival of several plants species, with many under serious threat to become extinct. According to an all India ethnobiological survey carried out by the *Ministry of Environment and Forests,* Government of India, there are over 8000 species of plants being used by the people of India. 90-95% collection of medicinal plants is from the forests (wild-collected). Only few are cultivated. The biodiversity loss is not only a threat to the ecology of the planet but also a more immediate threat to the health and livelihood security of rural communities. Data on threatened species are rare but national studies show 120 medicinal plants are rare or endangered in India.

Some of the persistent threats to IPAs for medicinal plants in the Himalayas have been dwelt on below:

i. *Unscientific and unsustainable extraction from the wild*: More than 70%[42] of medicinal plants collection involves destructive and unscientific harvesting, the collectors quite often removing parts like roots, bark, wood, stem, and sometimes uprooting the whole plant. The collectors are not trained enough to reduce wastage. Moreover medicinal plants in the wild are openly accessible and it is perhaps one of the main reasons for the current unsustainable levels of harvesting. As the prices paid to the gatherers tend to be very low, commercial plant gatherers often 'mine' the natural resources rather than manage them, as their main objective is to generate an income resulting in destructive harvesting. Less than 20 medicinal plants are under commercial cultivation when an estimated 800 species are currently used in industry for large-scale production of herbal products. A factor that discourages farmers from commercial cultivation of medicinal plants especially in the high altitude zones is the long gestation period of these species.

ii. *Over exploitation to meet the demands of trade*: The worldwide market of herbal medicines is of the order of US$60 billion *(WHO, 2002)* to US$80 billion *(Mathur, 2003)*. The use of herbal medicine is widespread, with as many as three in ten Americans using botanical remedies in a given year *(Raskin et al. 2002).* China with exports of over 120,000 tons per annum (US$ 264.5 million) and India with over 32,000 tons per annum dominate

the international market. The annual export of medicinal plants from India is valued at Rs. 1200 million (*Ramakrishnappa, 2002).* All the major herbal-based pharmaceutical companies are showing a constant growth of about 15% or more, next only to the Information Technology industry *(Kumar, 2000).* The turnover of herbal medicines in India as over-the-counter products, ethical and classical formulations and home remedies of Ayurveda, Unani, and Siddha systems of medicine is about US$1 billion *(Kamboj, 2000).* There is a huge requirement for plant material to meet the demands of trade. The present scale of commercial cultivation & production of medicinal plants is way below the raw material demand of the industry and largescale illegal harvesting from the wild is resorted to in order to meet the demand-supply gap.

iii. Habitat Degradation/ Loss of habitat: Most at-risk medicinal plant species are vulnerable largely because of habitat loss and degradation, much of it related to human activities, ranging from conversion to non-forest land for urban and agricultural uses, forest fires, shifting cultivation and overgrazing. Road construction contributes to fragmentation of habitats and also facilitates the spread of invasive species, diseases and harmful insects. The latest global Red List of plants released by the IUCN presents an alarming picture: nearly 34,000 species, or 12.5% of the world's flora, are facing extinction[56]. The impacts of climate change are going to be more pronounced for the highly sensitive sub-alpine and alpine species like *Saussurea* spp. Analyses of tree-ring samples of *Taxus baccata, Albies pindrow* and *Abies spectabilis* from various forest stands have provided valuable information on the plant growth and climate relationship[29].

TABLE I: Threats to vegetal diversity (Medicinal Plant Diversity in the Himalayas)

Threat	**Percentage (%)**
Human interference	7.8
Over-exploitation	17.0
Harvest	19.8
Trade	24.6
Fragmentation	5.0
Loss of habitat	18.7
Others	6.7
TOTAL	100.0

Source: BCPP (1998) CAMP Workshop for Northern India – Report, WWF, India, Nature Conservancy & FRLHT, India, Zoo's print

iv. Lack of defined policies and appropriate technologies: There is an urgent need for clearly defined policies to regulate medicinal plant conservation, identification of plant rich sites, cultivation quality control standards, processing and preservation, marketing and trade including domestic and export, and a well-coordinated information network effort. In the current scenario there is inadequate regulations and legal protection (including intellectual property rights for local practitioners with local knowledge). Other factors contributing to the depleting state of medicinal plants include poor access to

appropriate technology for sound harvesting and plantation development. There is dearth of need-based research including selection of plants for biological activity and focus on environmental and bio-diversity conservation aspects medicinal plant habitats.

1.3 NEED FOR PRIORITISED CONSERVATION

The Indian Himalayas are part of a unique ecoregion, rich in biodiversity and with a high degree of diversity and endemism and critical levels of threat. The importance of the ecoregion and its protection has been recognised by India, as well as the global conservation community, which have designated it as critically requiring conservation focus. However, management of forests of the ecoregion has suffered heavily due to overexploitation & habitat degradation as well as inadequacies of conservation action. At a national level, special importance has been given to protection of these forests and 75 PAs have been established in the IHR. In spite of this, there is an accelerated loss of the habitat in the PAs, with 80% of the PAs suffering from encroachments; besides, only 15% of the Himalayan hotspot has some form of legal protection. Himalayan PAs are also poorly managed because of their extreme remoteness; what is more critical is that hardly four of them are interconnected by natural corridors, whereas the extremes of weather in the Himalayas imply that vegetation & animals need contiguous habitats in order to maintain adequate & viable populations. The region therefore needs concerted and effective conservation action to protect this globally valuable biodiversity.

The decisions & work programmes of CBD-COP7, especially the priority action of addressing strategic weaknesses of PA systems through informal approaches to site conservation through local & national civil society means, is especially relevant for the Himalayan region. Much of the high altitude areas in the Himalayas are truly beyond the power of the controlling arms of the government anyway, due to their sheer inaccessibility, unpolice-ability; the exclusion of communities from the forests has in fact alienated the communities from these resources and contributed in part to the unsustainable use of the resources. Recognising the inefficiency of the conventional conservation paradigm and the escalating man-nature conflicts, after decades of government-controlled management of wild areas, there is today an increasing trend towards community management of forests & habitats in India - the India government is

in the process of legitimising the customary rights of tribal communities over the forests.

At this juncture, it is essential to instill a strong sense of stewardship in the communities along with processes such as ecosystem monitoring that would help them in sustainable management of habitats. It would also be necessary to identify the in-situ sites most deserving of conservation focus and establish an ecological network of community conservation sites for local level protection & restoration actions. *Important Plant Areas* are the most important places in the world for wild plant diversity that can be protected and managed as specific sites (Plantlife International). Such IPA identification can help focus conservation efforts on these most important sites, and provide a framework for protection, research and policy implementation for plant conservation, inside and outside protected areas.

Medplants IPAs in the Himalayas are micro hotspots with a concentration of medicinal plants within the larger hotspot of the Himalayan region. Since in the higher altitudes, medicinal plants frequently act as keystone species for the particular habitats, nurturing other vegetal species through biodynamics and being food for several faunal species as well, determination and conservation of medplants focused IPAs would have significant ecosystem preservation value beyond the particular species themselves. It is desirable therefore to prioritise such medplants IPAs and establish a 'conservation grid' of small-scale community protected areas dispersed through various ecological zones in the region. These 'high resource wealth' sites could include govt. managed forests, sacred groves, community lands, individual landholdings, etc., and would function as micro-ecological niches of particular threatened species. The host communities should be facilitated to develop these sites into 'community heritage parks/PAs', maintaining them as genetic reserves for the dynamic conservation of the particular species; efforts should also be made to extend these sites, thus creating corridors with other neighbouring sites and also spreading the impacts of conservation wider in the ecosystem.

2. METHODOLOGY

Important Plant Areas are defined as the most important places in the world for wild plant diversity that can be protected and managed as specific sites. They are identified according to scientific criteria, agreed by consensus within the global botanical community and based on the presence of threatened species, endemics, botanical richness and threatened habitats.

Pragya has worked on identifying and prioritizing sites for medicinal plants conservation in the Himalayas through a mix of ground surveys and secondary data/ literature analysis. The process followed has included:

- A comprehensive plant diversity mapping exercise undertaken in the Western, Central and Eastern divisions of Indian Himalayan

region (2003-2005) covered the high altitude and very high altitude regions (9000-18500ft.) and have formed the basis for IPA sites identified in this belt; earlier studies carried out in this belt, if any, have also been consulted.

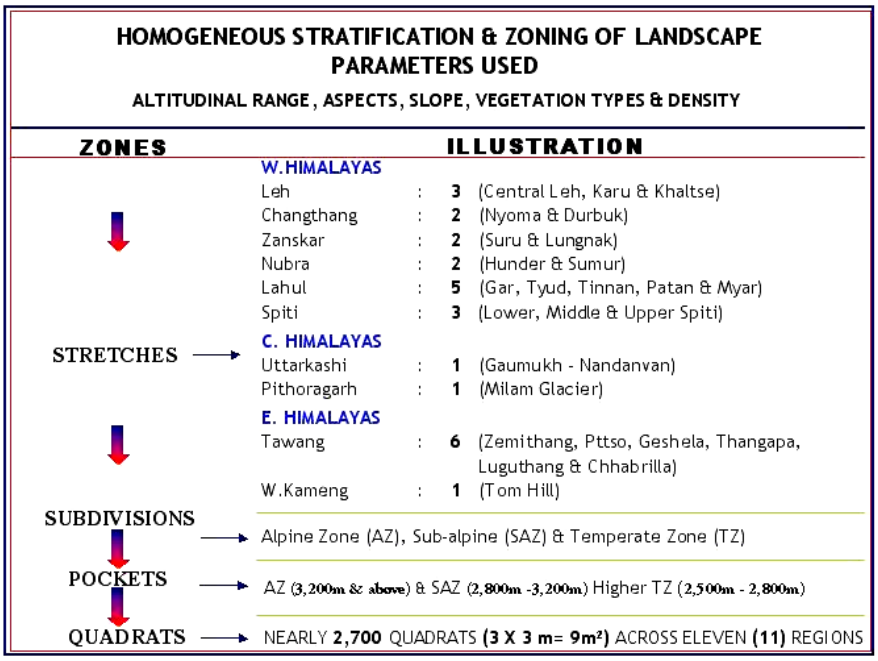
- IPA sites identified at lower altitude regions are based on secondary data and literature reviews.

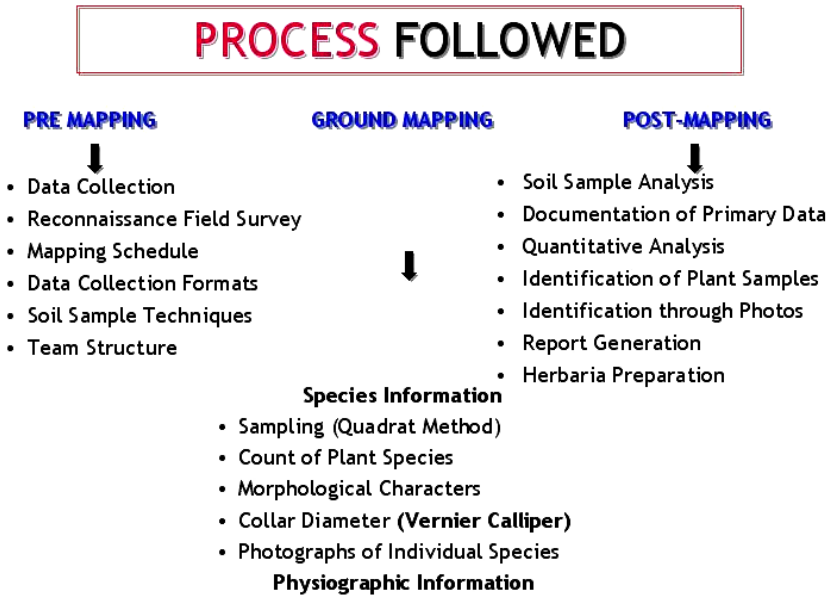
The mapping data and collated information has led to the preliminary identification of IPAs and these sites are subject to another round of field validation.

2.1 THE MAPPING EXERCISE

A comprehensive ground mapping of the biodiversity wealth and status evaluation was carried out from June 2003 - 2005 in the Western, Central and Eastern divisions of Indian Himalayan region. This participative study and survey was carried out in the high altitude and very high altitude regions (9000-18500ft.) of Jammu & Kashmir, Himachal Pradesh, Uttaranchal, W. Bengal, Sikkim and Arunachal Pradesh. It was undertaken with the help of indigenous stakeholder groups comprising pastoral nomads, traditional healers, women, farmers, youth and local administration. Local communities provided information on traditional knowledge value of species and participated in their documentation as well as identification of species-rich *in-situ* areas. The premier research and academic institutes of India including the Forest Research Institute (FRI, Dehradun) of India, Botanical Survey of India, G.B. Pant Institute of Himalayan Environment and Development (GBPIHED), Field Labs of Defence Research and Development Organization (DRDO) collaborated at various stages of study- from imparting inventorying skills to identification of plant specimens collected, for the forty-odd strong mapping team of PRAGYA professionals.

Field orientation and training sessions were conducted at the local level for community participants in the various bioregions delineated for inventorying. 2700 nested quadrats were used for the study in 3 divisions of the Himalayas covering 115 stretches of plant diversity identified by the communities. 2100 floral species were documented with their ethno-botanical value in the region. Soil profile analysis of 300 samples collected from the study region, was also conducted with the help of various ICAR institutes and the PRAGYA Applied Environment Research Laboratory. An exhaustive database of bio-profiles and herbaria of high-altitude flora is also being prepared. The species documented have been subjected to 7 regional level and 2 sub-regional level Conservation Assessment and Management Plan (CAMP) workshops for validation of threat status and population dynamics by the local stakeholders using IUCN guidelines. Species of CITES enlisted flora, IUCN red list entries and Indian Red Data entries have also been covered in addition to 732 species discussed and evaluated for threat by the local communities and stakeholder groups.





2.2 SECONDARY DATA/ LITERATURE STUDIES

Only recently, publications regarding the resources of medicinal plants in Asia are becoming available; information on their relative

abundance or scarcity, ecological conditions of growth, distribution patterns, etc., is being recorded (Chadha and Gupta 1995; Chandel *et al.* 1996; Samant *et al.* 1998; Kumar *et al*. 2000). Although traditional and local identification systems existed for long, actual and formal scientific identification of these plants started only in the 1900's (Dymock 1890; Dragendorff 1898; Boosma 1926; Burkill 1935). Scattered and meager, and unfortunately, frequently, incomplete information is available on medicinal plants of the Himalayas. Though species related information have been documented in the recent years, in-situ site and habitat information is still largely missing.

The secondary literature studies carried out by Pragya for extracting information primarily on middle and low altitude Himalayas, not covered through its mapping exercise, has involved review of both historical and current information from published literature, field biologists, local administrators in the regions and available literature on Himalayan flora, comprising scientific papers, reports and books. The approach of the study has been an intensive but discretionary perusal of literature, primarily relying on the premier institutes for plant research in the country, reputed NGOs, prominent university departments and govt. bodies for data collection.

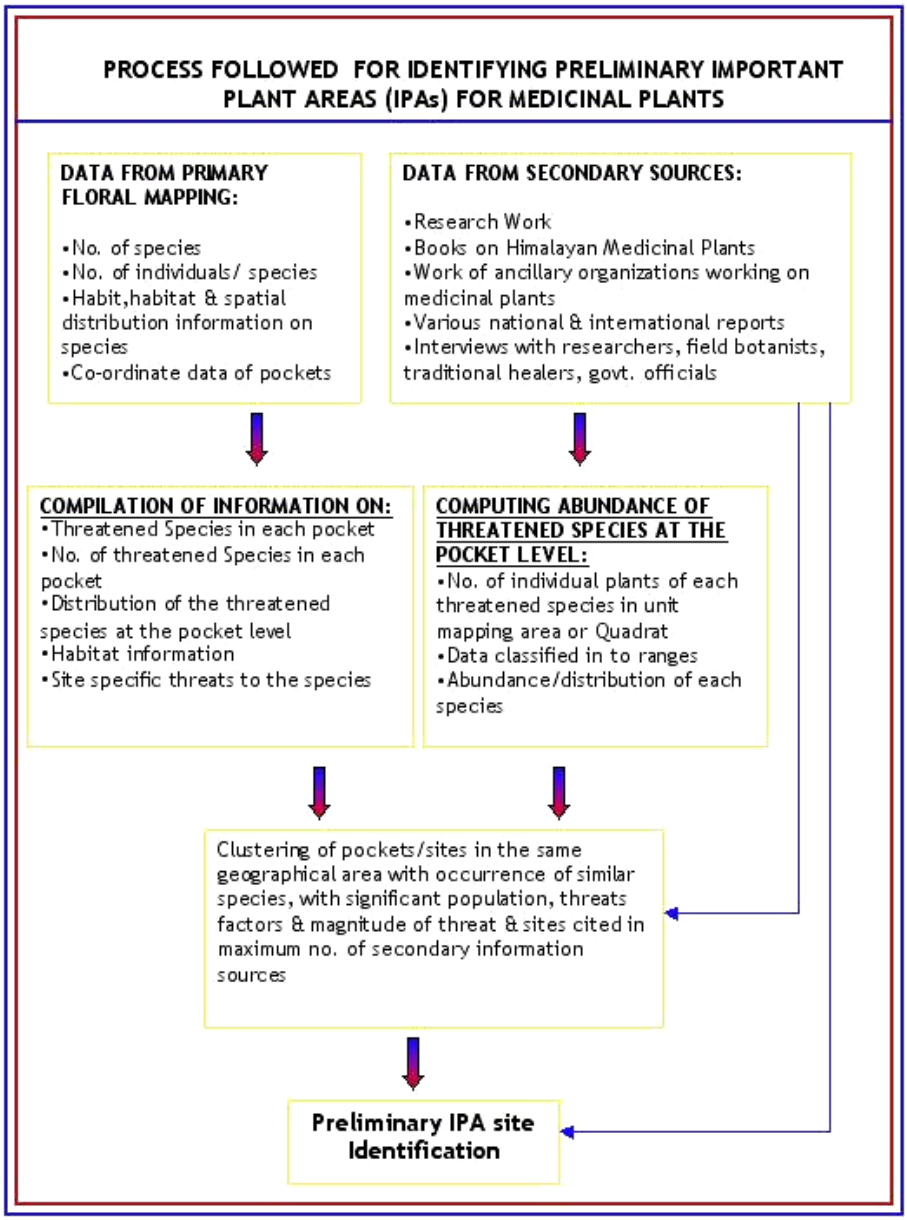
- The research institutions have included: Centre for Himalayan Bioresources, Palampur; National Research Centre for Orchids, Gangtok; RRL, Jammu; Herbal Research Development Institute, Chamoli; BSI, Kolkata/Dehradun and FRI, Dehradun.
- Universities and govt. bodies undertaking plant research in the Himalayas that have been tapped, include: University of Almora, Uttaranchal; GB Pant High Altitude Plant Physiology Centre, SKUAST, J&K; Agricultural University, Solan and DRDO, Ladakh.
- Numerous publications of the Forest Dept., Ministry of Environment and Forests, state govt. bodies on Ayurveda and other Traditional Health care systems, have been referred to.
- Works of reputed NGOs like TERI, Delhi; WWF-India, FRLHT, Bangalore; and TRAFFIC-India were consulted.
- Various works of international organizations such as Fauna & Flora International, UK; Nature Conservancy, UK; CITES; IUCN; ICIMOD, BGCI, Plantlife International, Conservational International were also referred to, in compiling this report.

The important and medicinally rich sites mentioned in the secondary literature was crossed checked in the field, wherever possible, albeit not comprehensively, through Pragya's Project Offices. Forest officers, traditional healers, local resource persons, scientists and researchers working with medicinal plants were interviewed for garnering more information on the selected sites and also for validation.

2.3 CRITERIA & PROCESS OF IPA SELECTION

The Pragya effort to establish a Conservation Grid in the Himalayas was initiated with the above process of identification & prioritization of medplants IPAs across the Indian Himalayan Region. A total of 15 IPAs for medicinal plants have thus been identified in the region through a process involving ground surveys, secondary data analysis and regional CAMP workshops.

The IPAs varys widely: in area, species concentration, ownership, etc.. Each IPA typically has a cluster of plant rich tracts and the area of an IPA, although the number of tracts within an IPA varies as per the density of such tracts within a relatively homogenous area, and the total spread and boundaries of the IPA are determined by a composite of the habitat characteristics and delineating biophysical features. While some IPAs, such as those in the western Himalayas are spread over a large area within the same agro-ecological zone, in the eastern Himalayas one the other hand, an IPA spread is lesser but spans multiple altitudinal belts and hence diverse vegetation characteristics. The number of IPAs identified in a particular region, viz, western, central and eastern Himalayas, has been to an extent determined by the area required to save or conserve the designated medicinal plant species, the floral diversity present in the region, and also on the economic value of the species. A few of the identified sites are under the government’s Protected Area system and Forest Reserves while a few sites are a mix of state owned forests and community owned land.



Based on the information available from mapping data and other secondary studies the preliminary IPAs for medicinal plants are prioritized and identified on the basis of:

i. Sites that contain globally, nationally and regionally threatened species, their concentration & richness: The ground mapping data gave the information on plant species found, number of individual plants belonging to each species, soil type, general habitat information incljuding altitudinal range, slope, aspect, land–use and threats in an unit area of 3*3 metres (1 quadrat) for nearly 2700 quadrats across 11 regions. Delineation of medicinal plants rich sites, and basic inferences on biodiversity resources of these sites, were made from this mapping data. The preliminary shortlisting of sites was done based on the following:

- *Criteria A: Presence of Threatened Species*: Site-specific occurrence of globally, nationally and regionally threatened plants species (IUCN Red listed, Indian Red Data Book listed) was gathered

from the mapping data for each pocket. The threatened species identified through the regional Conservation Assessment and Management Planning workshops conducted by PRAGYA as well other organizations (WWF-India), were also taken into consideration. Further, these data were correlated with information collected from secondary sources. Thus sites that contained such species were shortlisted for further consideration and analyses.

- *Species Concentration and Richness:* Further shorlisting of sites was carried out based on species concentration, once again as determined by mapping data and inputs from regional CAMPs. The mapping data provided the number of individual plants of each species occurring at the pocket level- there were 2-20 quadrats/pocket, the number determined through the Species-Area Curve. The concentration of each threatened species in a pocket were classified thus:

< 4 individual plants per 9 sq.mts = low
< 4-7 individual plants per 9 sq.mts = medium
> 7 individual plants per 9 sq.mts = high

Species Richness (*Criteria B*) of the identified sites was determined by the species count of each site, with special focus on the RET species. The sites having especial richness relative to the particular ecoregion it represents, have thus been identified. This analysis helped arrive at the distribution pattern of the endangered and threatened medicinal plant species, and CAMP inputs on the original habitat and degradation levels were also considered. This process helped identify the IPAs based on occurrence and concentration of such species.

Where secondary data/literature had to be depended upon, precise concentration could not be determined. The qualitative descriptions were studied and their indication of relative concentration of RET species across sites, was arrived at. In certain cases, studies that reported such relative importance of sites, could be accessed.

ii. Clustering and spread of medplants rich sites: The sites identified and prioritized through the above process were then clustered such that an area of medicinal plants conservation priority had sufficient scale to allow effective conservation of species and also to generate and absorb focused attention. An IPA thus structured would include multiple core areas as well as stretches in between with corridor potential. The parameters used for clustering were:

- *Habitat Homogeneity*: In most cases, sites that demonstrate a relative homogeneity of habitat, in terms of the ecological conditions of the sites, viz, the soil, humidity and other physical characteristics and the associated vegetation type, were clustered together. This has typically meant that a cluster adheres to a particular altitudinal band; in certain cases however, such as for the eastern Himalayas, river valley systems were used as cluster defining criteria, which has meant that multiple altitudinal bands have been included in the same cluster.
- *Biophysical Delineations & Physical Proximity*: Physical proximity of sites was also used as a factor for clustering. Typically in the mountains, physical proximity and related conditions of access are associated with the biophysical features of ranges and river valleys. To a great extent therefore, this system was used to

delineate the boundaries of a cluster, although in certain cases, a few sites that could lie just outside a particular valley or beyond a particular range, but display habitat homogeneity and adhere to the proximity principle, have been included in the cluster.
A total of 32 such clusters were identified and the final prioritization of the clusters was carried out ensuring a representation of all administrative and biophysical divisions within the Indian Himalayas, as follows:

- all Himalayan states/districts (J&K, Himachal Pradesh, Uttaranchal, Sikkim, Darjeeling, Arunachal Pradesh);
- all Himalayan ecoregions (cold, arid; alpine & sub-alpine- wet & dry; temperate & sub-temperate- wet & dry; tropical evergreen & deciduous);
- three Himalayan regions (western, central, eastern);
- three altitudinal belts (higher, middle, lower).

At the same time, number of IPAs in a particular division is relative to the area of the particular division and the species richness and diversity of the division as well. The number of tracts within one IPA also varies in keeping with the species richness and density in a particular division. Thus for instance, the western Himalayas has a lesser number of tracts within an IPA, as compared to IPAs in the eastern Himalayas.

Information availability as a criterion:

The identification of IPAs from secondary sources could not be done on the basis of parameters such as botanical richness or species diversity. These sites were in fact identified on the basis of availability of information rather than being prioritized out of a number of sites. There are many other areas as well, botanically exceptionally rich but about which very little information is available, and hence had to be excluded in the process of selection of IPA sites.

Concentration of IPAs in the High Altitude Himalayas:

A general observation about the identified IPAs may be that most of the sites are concentrated in the high altitude belt of the Himalayas. This is because the high altitude Himalaya is rich in representative (native) and endemic biodiversity elements[30-32]. The only treatise on the extent of plant endemism in the Indian sub-continent[35] puts on record 41.5% of dicot species endemic to India with highest concentration in the Himalaya (28.8%). In the Himalayan context, plant endemism was used as an important tool for determining priority conservation sites[34] and species[38] in the timberline zone of western Himalaya. Available information in temperate families reveals that in most cases, endemism at high altitude (alpine-subalpine zone) is higher compared to estimates of entire Himalayas. This feature is particularly prominent in trans/northwest and west Himalaya[30,36,37], suggesting thereby that the high altitude zone can be considered as one of the major centers of endemism. While using data on endemic diversity as one

of the important attributes of ranking priority sites in timberline zone of western Himalaya, a study[33,34] revealed that some of the relatively small, non-protected areas (Pindari: 76.7km^2 area; 39.85 endemics) with high endemic diversity ranked highest on priority. This shows that even a relatively small area can serve as a rich repository of endemic diversity. Although conservationists argue in favour of large reserves, the support for establishing smaller units is gaining ground in recent years[39-41].

Difficulties in identification of IPAs:

- Most plant rich areas are located in inaccessible terrain. When accessibility becomes a problem right from the availability of information, the subsequent management of the area also becomes difficult for quite obvious reasons. The Himalaya mountain range itself is very rugged, subject to tectonic activities, full of difficult topographic conditions, and characterized by a hostile climate with frequent occurrence of natural calamities like flash floods, earthquakes and landslides. The high altitude areas in the range further, are snow-bound for more than half of the year.
- Although there is no specified maximum or minimum size criterion for identifying an IPA, boundary demarcation in these areas poses problems. It is difficult to locate contiguous stretches of rich virgin floral areas because of the characteristic undulating topography; areas in the higher reaches, especially in the cold deserts, display sparse and fragmented vegetation because of low succession rate, harsh climatic condition, and scanty moisture. Further, many sites are in strategic locations with considerable military presence and related activities like road construction.
- In the lower altitudes and Eastern Himalayas the terrain does not pose much of a problem in terms of accessability. But when these biodiversity rich areas are accessible they are open to all. Local livelihood in these areas, is to a large extent dependant on natural floral and faunal resources. Most of the identified IPA sites have a lot of human interference in the form of grazing, conversion of forest areas to agricultural land, logging and hunting, destructive harvesting. But these activities are also the sources of livelihood for the local population.
- Prior information and secondary data on species, habitat and species–habitat correlation are essential premises for identifying IPAs. But such data/ information is largely missing. The plant rich sites are difficult to locate in maps since for most of the sites, co-ordinate information is not available. There is also no standard source of information and method of threat assessment for the habitats.
- Many of the IPAs in the Himalayas fall under Protected Area Network, under community owned land as in case of Arunachal Pradesh, under restricted areas or military land. These sites are not always open to conservation interventions from outside the system. In most cases, work permits, even for scientific surveys, is restricted in these areas and the process takes considerable amount of time to materialize through the official corridors.

Most of the protected area system focus only on wildlife protection and prioritizing medicinal plants conservation within the PA system has a long way to go because there are too many stakeholders and too many things at stake.

3. IPA SITES IN THE INDIAN HIMALAYAS

3.1 WESTERN INDIAN HIMALAYAS

The Western Indian Himalayas is spread over the two northern Indian states of Jammu & Kashmir and Himachal Pradesh.

i. *High Altitude Belt:* The high altitude belt in the Western Himalayas is spread over Leh and Kargil districts in the state of Jammu & Kashmir, and Chamba, Lahaul & Spiti and Kinnaur districts in the state of Himachal Pradesh. These essentially comprise the cold arid and temperate Himalayas in north-west India. The flora of this high altitude Western Himalayan region is of three main types viz., alpine, desertic and oasitic. Shallow, skeletal dry soils with very low mineral content are found in the high altitude zone of Western Himalayas. This thin soil cover is devoid of organic matter and supports only some sparse vegetation. Thick soils are confined to valley bottoms alone. Steppe type of vegetation covers the mountain slopes up to an elevation of 3000m. In the altitudinal range of 3000-3600m, where conditions are favourable, the characteristic pine belt of the western Himalaya develops. At about 3800m to 4150m, there is a belt of *Betula utilis*, *Abies, Juniperus* and *Pinus wallichiana*. Above this region are the alpine zone meadows. The alpine herbs grow in belts along the edges of melting glaciers and do not spread to exposed slopes. The subalpine meadowlands harbour herbaceous species, such as *Gentiana spp., Taraxacum spp., Anemone spp., Plantago spp., Ranunculus spp.* etc. and many grasses, sedges and rushes, besides patches of *Iris hookeriana*. The damp places within the meadows grow *Dactylorhiza hatagirea* and many species of *Primula, Pedicularis, Anemone* and *Rumex.* Desertic flora is the dominant type that covers the upper slopes and valleys. The oasitic type comprises mesophytic plants including a few tree forms like *Juniper, Acer, Populus, Salix, Elaeagnus, and Prunus* that grow along the river margins. Temperate forests are also found, both along the main Himalayas and in the transition zone between itself and the barren cold desert areas. Dry temperate forests are found in the drier parts of the Himalayas and the barren Trans-Himalayan region.

ii. *Middle and Lower Altitude Belt:* The temperate Himalayas in the western Himalayan division comprise almost all other districts of the states of Jammu & Kashmir and Himachal Pradesh. The middle altitudes of the western Himalayas are covered with temperate forests. The altitude of this belt varies from 1800m to 3000m in the relatively wetter regions. In the wetter parts of the same region exist the temperate moist, mixed deciduous forests with broad-leaved species that thrive in the wetter climate. Individual trees in this region may attain a height of about 20 m. In the drier regions within these forests, conifers, and even patches of grasslands can be found. They usually develop in moist shady depressions and along streams and rivers. The mid altitude belt has silty loam to clayey

loam soils with dark brown colour and high organic matter. The lower altitude belt has loam to clay loam soil, greyish brown in colour and well drained.

3.1.1 IPAs in Jammu & Kashmir

The following sites have preliminarily been identified as IPAs for medicinal plants conservation in the western Himalayas:

IPA-1/WIH- Khardung la[48]:

The Khardung la stretch in Nubra block of Ladakh is very rich in medicinal plants and stretches from South Pullu through Khardung la top to North Pullu camp. The altitude of the region ranges from 3968m to 5682m at Khardung la top. The habitat is predominantly alpine with Himalayan meadow vegetation, consisting mainly of herbaceous species, with the occurrence of endangered medicinal plants like *Ephedra gerardiana, Berberis, Cremanthodium ellissi, Artemisia, Sassurea, Gentiana, Rhododendron anthopogen and Saussurea obvallata.* Some other plant species found in the region are *Artemisia spp., Aster spp, Astragalus rhizanthus, Delphinium spp., Dracocephalum spp., Euphorbia spp., Geranium spp., Lentopodium spp., Nepeta spp., Oxyria digyna, Oxytropis spp., Pedicuris longiflora, Potentilla spp., and Rhodiola spp.* Khardung La top with an approximate area of 8 sq.km has the highest concentration of medicinal plants within the stretch because of the available moisture from glaciermelt.

Ownership of the land lies with the state government. Since this is the route to Siachen glacier, a most sensitive border, there is a considerable amount of vehicular movement in the area, of army vehicles moving from Leh to the Nubra valley and back. There is also an acclimatization camp for the Indian army personnel. Road construction and military activities cause maximum disturbance to the plant habitat in this IPA. During the short summer period, temporary settlements develop near the Khardung La pass to cater to the need of tourists. There is also some amount of grazing. *Amchis* of Nubra and Indus valleys collect large amount of medicinal plants from the Khardung-la region.

IPA-2/WIH- Sapi-Penzila[48]:

This IPA stretches from Sapi la at its northernmost point in the Indus valley in Ladakh, southwards into Suru valley and the area around Panikher and further south-east across the Parkachik ridge to Penzi la. The first tract comprises Sapi, a remote village 35 km. from Shergole (30km from Kargil) with Sapi la lying at its head. The valley of Sapi, its altitude ranging from 3500 to 4100m, is renowned among the traditional healers of the Ladakh and Zanskar region, *amchi*s (traditional healers of the Tibetan system) and *hakim*s (traditional healers of the Unani system)

alike, for its medicinal plants. It is extremely rich in a number of globally threatened species like *Aconitum violaceum, Arnebia euchroma, Delphanium cashmeranium and Gentiana cashmerica.* The Suru valley, a more humid stretch of the Himalayan cold desert that is rich in several medicinal species; this tract includes the area around Panikher (3800m) and Parkachik (3900m), lying in the shadows of the Nun-Kun massifs. In the 2500-3300m altitude belt, this tract shows the following species: some tree species such as *Myricania eleganus, Ulmus, Salix, Cotoneaster* and shrubs like species of *Rhododendron, Rosa, Berberis*; herbs like species of *Bergenia, Podophyllum, Hyoscyamus, Ephedra* and *Artemisia* are common. Beyond 3300m, the area is characterized by rolling meadows full of a variety of rare medicinal herbs including *Gentiana kurrooa, Ephedra gerardiana, Aconitum violaceum, Meconopsis, Picrorhiza kurrooa, Rheum emodii, Potentilla, Bergenia, Artemisia maritima, Delphenium, Caragana, Physochlaina pracalta, Carum bulbocastanum, Orchis latifolia*. The Penzi la (4400m) pass at the head of the Suru river and the Rangdum area comprise a third tract that is especially rich in *Aconitum violaceum, Gentiana kurrooa, Rhuem australe*. The habitat is typically of Himalayan alpine meadows. The soil is of dry, sandy loam type, stony at places; it is characterised by higher soil moisture than other parts of the Ladakh Himalayas however, and the area therefore shows a higher concentration of vegetation as well as a wider range of medicinal species.

The IPA is largely under the forest department and also has several habitations in the medicinal plants rich areas. The major threats to the area are grazing by herds of pastoralists and collection by traditional healers.

IPA-3/WIH- Argi-Sarchu[48]:

The Argi-Sarchu IPA stretches north-west to south-east in the Ladakh Himalayas, at the border of Jammu and Kashmir and Himachal Pradesh, with a part of it in the Lugnak valley of Zanskar and some of it in the Changthang region of Ladakh. Argi lying north of Shingo la that separates Zanskar from the valley of Lahaul and the Changthang plateau, is a very rich site for a few critically endangered species like *Delphinium spp., Cremanthodium spp., Gentiana spp., Fritillaria cirrhosa, Incarvillea mairei, Cordyceps sinensis* and *Meconopsis aculeata.* The altitude of the tract ranges from 4571m to 4700m and is spread over an area of approximately 10 sq. km. The Sarchu plateau is a second tract and lies eastwards at the border of Ladakh at an average altitude of 4500m. This high altitude alpine habitat supports hardy medicinal herbs such as *Rheum spp, Artemisia spp.*. The vegetation is scattered, growing in patches, and more concentrated in shady depressions and along streams formed by snowmelt from the glaciers. The soil is very poor in nutrients. Climatic conditions vary from the sub-arctic to arctic, with snow covering the ground for over 6 in months a year. The growing season for the plants is thus effectively shortened. Glaciers and lofty mountains devoid of vegetation are all around each stretch of the IPA.

The ownership of the land lies with the state government. Road construction (20%) and grazing (40%) are the main threats to the medicinal plant habitats. During summers, pastoral nomads use the pastures rich in rare and endemic medicinal plants, for grazing livestock. A rangeland survey found pastoral herders with around 400-500 sheep and goats in Argi. Sarhcu is a crossroad between pastoral pathways coming from Ladakh, Zanskar and Lahaul and is therefore grazed very heavily. During the Pragya mapping exercise, surveyors met pastoralists coming from Ladakh and Lahaul with around 300 hundred large animals (yaks and dzomos). The pastoralists also build temporary settlements around the area, residing there all through the summer months.

Other important sites[48,55]:

Although the state of Jammu & Kashmir has very many medicinal plants rich areas, the status of most is not known because of the political situation in the state. "The present status of the alpine areas in Jammu & Kashmir is not known due to insurgency. PAs such as Dachigam NP, Overa-Aru, and Kishtawar Wildlife Sanctuary are believed to afford protection to alpine habitat and fauna …" [44] Some hotspots or mega centers[55] of medicinal plants in Kashmir Himalayas reported by M.K Kaul And S.S Handa, 2001, include:

- *Gurez and Tilail valley*: Located in the Baramulla district in Jammu & Kashmir, this valley is reported to have the following species growing in it: *A. violaceum, Artemisia absinthium, A. Maritima, Atropa acuminata, Bunium persicum, Datura stramonium, Delphinium roylei, Dioscorea deltoidea, Inula royleana, Juniperus macropoda, Morina longifolia, Picrorhiza kurrooa, Rheum emodi, Senecio jacquemotianus*.
- *Karnah valley*: This valley is part of Kupwara district and some rare and lesser known medicinal species are found here. They include: *Dactylorhiza hatagirea, Gentiana carinata, Juniperus communis, Lagotis cashmeriana, Morina coulteriana, Picrorhiza kurrooa, Polygonum alpinum, Tanacetum dolichophyllum, Tribulus terrestris, Taxus baccata*.
- *Lolab valley*: This valley lies in Kupwara district and is rich in *Aconitum heterophyllum, Ajuga bractosa, Arisaema jacquemontii, Arnebia benthamii, Bergenia ligulata, Colchicum luteum, Corydalis govaniana, Delphinium denudatum*.
- *Gulmarg and Khillenmarg region*: This part of the Kashmir Himalayas has unfortunately suffered a lot due to tourist pressure. Higher reaches like Aporwat, Toshmaidan, etc., are still rich in species such as *Aconitum heterophyllum, Archangelica officinalis, Atropa acuminata, Colchicum luteum, Ferula jaeshkaena, Taxus baccata, Valeriana jatamansi*.
- *Kolahai mountains*: This is an important area for medicinal plants and has species such as *Arnebia benthamii, Bergenia ligulata, Colchicum luteum, Ferula jaeshkeana, Inula racemosa, Prangos pabularia, Valeriana jatamansi*.

There are a few other medicinal plants rich sites in the Ladakh region, although most of them display the sparse and fragmented populations typical of the cold desert region:

- *Hanuthang-Hanuyongma*: The Hanuthang-Hanuyongma area in Central Leh region is rich with *Angelica glauca, Dactylorhiza hatargirea, Artemesia spp., Ephedra spp., Gentiana kurroo, Heracleum spp., Inula racemose, Rheum spp., and Saussurea sp.*
- *Changla*: Chang la in the Durbuk block of Changthang region is rich in *Cremanthodium elisi, Artemisia spp. and Saussurea spp*.

3.1.2 IPAs in Himachal Pradesh

The following sites have preliminarily been identified in Himachal Pradesh as IPAs for medicinal plants conservation:

IPA-4/WIH- Chika-Peukar-Khangsar[48]:

The Chika-Peukar-Khangsar IPA comprises three distinct tracts, one at the northern end south of Baralachala and two flanking Tandi, the confluence point of Chandra and Bhaga river, in the narrow and rugged valley of the Bhaga river, Lahaul, Himachal Pradesh. The altitude of the site ranges from 3200m to 4200m. The Chika-Rarik-Patseo tract at the northern end of the Lahaul valley has altitudes ranging from 3310m to 3790m. This tract is rich in species such as *Aconitum heterophyllum, Dactylorrhiza hatagirea, Gentiana kurrooa, Picrorhiza kurrooa*. In the two tracts further south, tufted plants like *Sedum ewersii* and *A. kashmirica* are found growing in the rocky crevices; *Polygonum affine* forms thick mats over rocks and endangered herbaceous mesophytic species like *Aconitum violaceum* are found growing along streams. The hillslopes are covered with species like *Physochlaena praealta, Cortusa brotheri, Rhodiola imbricata, and Allium jacquemontii*. Near cultivated fields and irrigated meadows, *Codonopis ovata, Gentianopsis detonsa, Pedicularis pectinata* and *Triglochin palustris* are found. Peukar and Charji in particular, have a rich distribution of important medicinal plant species like *Aconitum heterophyllum, Arnebia euchroma, Ephedra gerardiana, Gentiana kurroa, Heracleum candicans, Meconopsis spp, Angelica glauca, Geranium pratense, Rheum australe, Anemone tetracepala, Ranunculus hirtellus, Picrorhiza kurroa and Podophyllum hexandrum. Rhododendron anthopogan, Bargenia stracheyi, Polygonatum geminiflorum, Aconitum heterophyllum, Aquilegia fragrans* and *Cousinia thomsonii* were found in Piasyo during the ground vegetation mapping; this site is very rich in *Aconitum heterophyllum* as well. *Juniperus communis, Rhodiola himalensis, Bunium persicum, Rheum emodii, Aconogonum spp* are the common species found in Tino. The Khangsar tract, separated from Peukar by a sacred mountain range locally known as Saptarishi, lies at an altitude of 3000m and is rich in *Dactylorhiza hatagirea, Podophyllum hexandrum, Heracleum candicans, Aconites, Carum*

carvi, Mentha spp..

30% of the area belongs to individual farmers and the rest is government land. Unfortunately, much of the original medplants rich area has been converted for agricultural purposes and now has apple orchards, medicinal plantations of *Inula racemosa* and *Saussurea spp*. and cash crops like potato and peas. There are reports of govt. land also being converted for cultivating peas and potatoes. Excessive grazing by sheep and road construction activities are other threats to the site.

IPA-5/WIH- Rohtang & Solang[48]:

Solang valley in the Kullu district of Himachal Pradesh lies about 15 kms from the famous hill resort of Manali, and this area, along with Rohtang pass, the gateway to Lahaul & Spiti district of Himachal Pradesh, and lying adjacent to Solang valley, is renowned for its medicinal plants. Approximately 30 sq.km of area in the Solang valley and 120 sq. km in the Rohtang area can be an important area for medicinal plant conservation and constitutes this IPA. The altitude of this area varies from 2480m at Sollang Nallah to 3979 m at Rohtang top. The 5 km stretch along the Solang nalla, a tributary to the Beas River, is rich in *Aconitum heterophyllum, Dactylorhiza hatagirea, and Picrorhiza kurroa.* On the Rohtang stretch lies Marhi, a mountain plateau surrounded by lush green meadows that gets covered with myriad wildflowers in summer; *Taxus baccata*, poplar and willow trees also dot the landscape. Rohtang top offers a range of mountain geomorphology in the form of precipitous cliffs, glaciers and glacial depositional landforms like moraines and deep ravines. Along the Rohtang pass, the exposed rock surfaces are covered by a great profusion of herbs like *Primula, Pedicularis, Androsace, Anemone, Trollius* etc. Other species found growing in the rock crevices and on hillslopes along the pass are *Gaultheria trichophylla, Cassiope fastigiata*, *Sedum* spp. etc.; species found in and around Rohtang include *Picrorhiza kurroa, Dactylorhiza hatageria, Potentilla microphylla, Bistorta affinis, Cannabis sativa, Artemisis spp., Selinium tinefolium*, and *Achellia millephonum.*

The site is under the ownership of Himachal Pradesh State Forest Department and comes under a reserve forest area. Unsustainable tourism and vehicular traffic are the main habitat threats to this area. At the peak of the tourist season, the unregulated inflow of tourists brings a very high number of vehicles and typically creates traffic congestion that in turn causes high ambient air pollution by way of high vehicular emissions. A study shows that, of 750 vehicles per day that on Rohtang top in summer, over 87% belong to tourists. Marhi is a stopover for transit visitors and tourists during summer and autumn seasons. Solang valley is also a wintersports site. The combined effect of biomass burning in the hotels as well as villages and the high number of plying vehicles in summer, is that ambient air pollution in the form of SPM increases sometimes more than its

permissible level for these sensitive areas. According to a study, 122 tonnes of solid waste accumulates in the area in the three months from April to June. There is no proper waste disposal system and waste matter is simply dumped in adjoining open lands. Every year during the monsoons, there is considerable gully erosion and floods in the valley, which wash away a lot of herbaceous medicinal plants. Extensive illegal extraction of medicinal plants and livestock grazing are significant threats as well. During the summer months traditional healers and wild plant collectors make their base near the Rohtang pass for collecting herbs and take truckloads of plant material away.

IPA-6/WIH-Malana-Parvati-Sainj valleys:

These three valleys lie on the fringe or in the precincts of the Great Himalayan National Park. One tract is that of Malana in Naggar block of Kullu district of Himachal Pradesh, a remote valley with an approximate area of 130 sq. km. Inaccessibility, because of its geographical location and the complete absence of motorable roads, and a generally precipitious terrain, makes this valley abound in biodiversity. The altitude of the valley ranges from 1500m to 3960m. The area has vast areas of Deodar and Spruce forests besides other coniferous species, acres of Rhododendron and wild bush. The Malana forests are characterized by rich species diversity, with the different species occuring in approximately equal numbers. Pine, Spruce and Deodar occur regularly along glades, interwoven with Yew and Rhododendron. Flowering species like *Iris kumaonensis* grow in the moist, shady areas, along with *Pilea umbrosa, Fagopyrum cymosum* and *Viola*, while *Lamium* and *Sedum rosulatum* are found in the drier rocky areas. Moist rocks are covered with creepers such as the vibrant *Ficus sarmentosa* while within the forest *Hedera nepalensis* is one of the prominent climbers. All over the IPA, various species of *Polygonum, Impatiens,* and *Polystichum* are found. The area is also rich in a number of medicinal plant species such as *Aconitum heterophyllum, Picrorhiza kurroa and Artemisia spp.* South of the Malana and within the GHNP lies the second tract, in Sainj-Tirthan valley, comprising the Homkhani forest (2800m)-Dhel (3737m)-Gushaini (1500m)-Nada (3300m). The Parvati valley tract runs from Manikaran-Pulga-Mantalai at the base of the Pin Parvati pass. Since both these tracts cover a large altitudinal belt, a wide range of medicinal plants grow in these tracts. Homkhani, Dhel and Mantalai are especially rich sites; the latter two are spectacular alpine meadows with Iris, Frittilaria, Gagea, Primula, Aconites, Salvia, Viola, Jurinea, and Rheum.

The people of Malana are very conscious about preserving their ecological heritage. Village rules prohibit fixing nails on trees or lighting a fire in the forests of Malana. Only dry twigs and branches are permitted to be collected from the forests. But collection of medicinal plants and herbs from the upper reaches is a source of livelihood for the nearby villagers. Since access to outsiders is limited, the collection is still within sustainable limits; with changing values and increasing market

pressures, this might not last however. The remaining tracts are protected by the state. Yet tourism, extraction for commercial use, overharvesting of NTFPs by locals, are among the threats to the tracts.

IPA-7/WIH- Rakchham-Chitkul and Rupi-Bhaba Sanctuary[48]:

This IPA is a high altitude stretch in Kinnaur district. It comprises two tracts: one in the Rakcham-Chitkul sanctuary in Sangla valley, and the second in Rupi-Bhaba sanctuary in the Sutlej valley. The altitude of the area varies from 2900m to 3450m. The forest types include lower western Himalayan temperate, upper western Himalayan temperate and dry broad scrub. The area is known for its grassy alpine meadows and is rich in **a** number of threatened & endangered medicinal plant species like *Cremanthodium arnicoides, Carum carvi, Podophyllum hexandrum, Heracleum candicans, Picrorhiza kurrooa, Rhododendron spp., Meconopsis spp., Saussurea obvallata* and *Betula utilis.* Some other species found in the area during the mapping exercise were *Betula utilis, Meconopsis horridula, Bergenia stracheyi, Bistorta affinis, Rhodiola wallichiana, Angelica glauca, Rheum spp., Silene spp.* and *Polygonatum spp.*

Although protected by the state, smaller Pas such as these suffer by being neglected by the state while also by the community. The Rupi-Bhaba sanctuary has in fact been steadily compromised on due to hydel projects under establishment in the region. There are a number of villages and settlements in the area, although majority of the landownership comes under the state forest department. Grazing and conversion of the medicinal plant habitat for agricultural purposes are also major threats. Landslides are very frequent in the area which damage the habitat as well. The collection of forest-based resources like leaf litter, fuel wood, fodder minor forest produce especially medicinal herbs and mushrooms has been reported.

Other important sites:

Other medicinal plant rich sites in Himachal Pradesh are:

- *Lossar-Takcha-Kunjam*: The Lossar-Takcha-Kunjam tract in Spiti lies at the northern end of the valley at an altitude of 13,000-115,000 ft. and is rich in species like *Arnebia benthamii, Bergenia stracheyi, Ephedra gerardiana.*
- *Gue*: This site lies at the south-eastern part of Spiti valley at an altitude of 2400m and is rich in *Aconitum violaceum, Dactylorhiza hatargirea and Picrorhiza kurrooa.*
- *Chichim*: The Chichum area in Spiti block of Lahaul & Spiti district has some important species like *Dactylorhiza hatagirea, Plantago major, Geranium wallichianum, Taraxacum officinale, Artimisia vestita, Aconitum violaceum, Ephedra gerardiana* and *Arnebia euchroma.*

- *Charang*: The Charang area in Kinnaur district is rich in species like *Anaphalis triplinervis, Arnebia euchroma, Carum carvi, Heracleum candicans, Juniperus squamata, Rheum australe, Rheum moorcroftianum, Rhodiola himalensis, Saussurea costus and Saussurea royeli.*
- *Pin Valley National Park*: A total of 378 plant species have been recorded within the Pin Valley National Park in Spiti (Manjrekar, 1997), of which 8 are threatened, 3 are rare, and 11 are endemic to the Western Himalaya (Aswal and Mehrotra, 1994). The Mud stretch within the Park has the highest concentration of species.

3.1.3 Major Threats and Conservation Measures in the Western Himalayas

Major threats:

The major threats to the medicinal plants in the Western Himalayan region can be differentiated based on their area of occurence:

i. In the very high altitude belt of the far north, all along the border and at the passes: In this belt, overgrazing is leading to escalated habitat loss, since pastoralism is the major occupation of the indigenous inhabitants of these areas. Defence activities, including dumping of road building material and land digging and tarring by the Border Roads Organization (BRO), and heavy army vehicular movements in ecologically fragile areas, also results in habitat loss of the medicinal plants; further, road construction leads to landslides and soil erosion with their impacts on species populations. Since these areas also harbour certain very rare and often endemic species, collection from these parts is also very high. About 80% of the Ladakh *amchis* collect medicinal plants from the Zanskar region, and the pressure on this region is closely followed by that on the high altitude passes such as Khardung-la, Tanglang-la and Chang-la. The impacts of climate change is also severe in this very same area and there is an escalated rise in average temperatures and reduction in moisture content of the soil with a resultant fragmentation and depletion of plant populations.

ii. In the high altitude and relatively more inhabited belt: In this area, anthropogenic causes are the major threats to the habitat and thus plant populations. Unsustainable harvesting and illegal trade is severe in this belt. Apart from host community collectors wildharvesting plants for local use, there is an influx of collectors from outside the area sent in by traders from regional herb markets. The growing demand for alternative medicine in the western countries is felt severely by these slopes. Overuse for occupational purposes, viz conversion of forest land to agricultural land and excessive grazing by livestock, is changing land use and vegetation cover patterns

radically. The excessive collection of fuelwood and non-timber forest products for meeting burgeoning local requirements is a critical threat as well, for instance in the Ladakh Himalaya, a common medicinal plant, *Ephedra gerardiana,* is used as fuelwood. Development activities and tourism is also higher in these areas and growing fast. Road-building, burgeoning urbanization and construction due to infrastructure creation, are adding to habitat degradation.

iii. *In the middle and lower and by far more populated hills*: This belt is primarily affected by inappropriate development and rapid reduction of wild areas. Population increases and increasing sourcing of natural resources from the hills is leading to largescale habitat conversion and severe biotic pressures on land, including overuse and polluting of resources.

Key conservation actions[24, 25]:

The existing conservation actions, governmental, non-governmental and community based, include:

i. *Government measures*: With the enactment and enforcement of a separate Wildlife Act, known as the J&K Wildlife Act 1978, the State Dept of Wildlife Protection has established 31 protected areas distributed over 5 districts in the Kashmir region. To protect the biodiversity of Ladakh, so far three protected areas, namely, Hemis National Park (4100 sq. km), Karakoram Wildlife Sanctuary (5000 sq. km.) and Changthang Wildlife Sanctuary (4000 sq. km) have been notified. There are also five wildlife reserves - Rangdum, Sabu-Chakur, Rizong basgo, Gya-Miru and Kangri, and three game reserves - Boodh Karbu, Tongri, and Lunglang in the region. In Himachal Pradesh, the conservation of biological diversity is being given high priority by the government. As of today, the state has a total of 34 Protected Areas, covering more than 11% geographical area of the state. In the cold desert district of the state, i.e Lahaul & Spiti there are two Protected Areas, viz., Pin valley National Park (675 sq.km) and Kibber Wildlife Sanctuary (1,400sq.km). The Great Himalayan National Park is a very large park with smaller PAs encompassed within it and stretching across 3 districts of the state. This park is an example of success of self-help groups formed with the help of the forest department among buffer zone communities.
The Defence Research and Development Organisation (DRDO) laboratory at Leh specializes in medicinal plants of the region. The Govt of Jammu & Kashmir has also set up a Medicinal Plant Development Board in the state which has initiated the setting up of herbal gardens in all districts of the state besides establishing demonstration plots to create awareness among the farmers for cultivating rare species of medicinal plants towards optimum utilization of the available barren land.

ii. *Non-governmental and community measures*: There are a number of NGOs working for medicinal plants conservation in Himachal Pradesh. These include: Himachal Pradesh Voluntary

Health Association, Bharat Vikas Parishad, Sewa Bharti, Rashtiya Ayurved Parished and Rotary Club etc. These NGOs are focused on spreading awareness about the traditional health system like Ayurveda and also conducting awareness camps and workshops on various techniques of medicinal plants cultivation. Pragya has been working in the high altitude belt of Himachal Pradesh as well as Ladakh, for both ex-situ and in-situ conservation of medicinal plants. Community protection of medicinal plants rich areas and cultivation of high-value species by farmers are being promoted.

Sacred groves have not been identified in Leh district, but a few patches of Juniper trees do exist in inaccessible areas that are protected by the local people because of their religious beliefs. One such location has been designated as a Juniper Preservation Plot (JPP) by the Forest department and conservation measures have been adopted by reducing all types of biotic pressure at the site. JPP-1 is located at Tia Charchar village, Khalsi Block, near Tia Gompa, where 13 adult Juniper trees survive.

Himachal Pradesh has around 5000 documented sacred forests and alpine meadows. The Kullu valley of Himachal is called as 'Dev Bhoomi' and the density of sacred sites in this part of the Himalayas is very high. The smaller groves closer to the hamlets typically cannot sustain many species though. Shipin, about 12 km from Shimla, is believed to be the biggest Deodar grove in this district and is home to trees that are hundreds of years old. Villagers who pass through the grove dust their clothes to make sure they do not carry anything belonging to the grove. Trees in the area cannot be cut or felled, and all deadwood found in the forest is used in the temple located in the grove. The Chhakinal watershed[45] in Kullu has nine hamlets. 21.5% land in the area is demarcated as sacred and each hamlet has its own sacred grove. The Nagoni sacred forest is a 5 ha alpine meadow that is protected by the local community and is reported to have a large number of species over a small area. There are reports of an existing sacred patch of community land rich in *Dactylorhiza hatageria* in Chitkul village.

3.2 CENTRAL INDIAN HIMALAYAS

The Central arc of the Himalayas in India is located in the state of Uttaranchal and is spread across 13 districts and two physiographic divisions (Garhwal and Kumaon) of the state.

i. High Altitude Belt: The high-altitude belt of the Uttaranchal Himalayas consists of the northern parts of Uttarkashi, Chamoli and Pithoragarh districts. This area can be divided into two sub-groups: dry alpine zone, comprising the interior Himalayan ranges nearing the Tibet border, at an altitude of about 2750 to 4000 m elevation, with very low annual precipitation, the vegetation typically comprising dry alpine scrub and dwarf juniper scrub; and the wet alpine zone that is spread from an altitude of 2500 to 4000m and

characterized by high annual precipitation, with characteristic vegetation of birch-rhododendron scrub, deciduous alpine scrub and dwarf rhododendron scrub. Mountain meadow and glacial soils characterise the high altitude belt. These soils are mainly granitic sandy loam with minimal organic content. They are stony in texture, thin layered and due to heavy erosion, poor in fertility. The entire belt is rich in medicinal plants. At 2700m, the forests comprise higher level oaks such as tilonj and kharsu, giving way to rhododendron and chestnuts and grassy slopes at 3000m, and further up the forests are of fur, spruce, yew, cypress bushes and birch and blue pine. The rainshadow area, such as that of Dhauliganga valley, remains dry and dusty, but shows some good natural temperate forests of *Pinus wallichiana, Cedrus deodara, Picea smithiana, Juniperus recurva, J. communis and Betula utilis*. Above the tree line, scrubby vegetation is found on ridges, and rocky slopes of species such as *Juniperus communis, J. indica,* and herbaceous species including *Anaphalis, Anemone, Aster, Astragalus, Gentiana, Geranium, Oxytropis, Polygonum, Primula, Saxifraga, Selinum, Silen*e etc. Medicinal plants abound in the alpine meadows and the glacial moraines and include *Aconitum heterophyllum*, *Angelica glauca*, *Allium stracheyi*, *Carum carvi*, *Dactylorrhiza hatagirea*, *Nardostachys grandiflora*, *Podophyllum hexadrum*, *Saussurea costus*, *Swertia chirata*, *Picrorrhiza kurrooa*, *Polygonatum verticillatum*, *Rheum australe* and *Jurinella macrocephala*.

ii. Middle and Lower Altitude Belt: The middle belt of the Central Himalayas spreads from 1500m to 2750m elevation, making up sections of Uttarkashi through Tehri, Chamoli, Almora and Pithoragarh. This is the temperate zone which consists of two climatic zones: the dry temperate characterized by pine forests with shrubs growing as undergrowth or forming separate patches in the upper ranges; and the wet temperate region, dominated by mixed broad-leafed and coniferous species: deodar, cedar, banj oak, rhododendron, blue & chir pine, abound. Many plants of medicinal importance are found in the wet temperate region, including *Plantago ovata*, *Swertia angustifolia*, *Taxus baccata* ssp. *wallichiana*, *Valeriana wallichii*, *Berberis aristata*, *Hedychium spicatum*, *Heracleum candicans*, *Bergenia ligulata*, *Paris polyphylla*, *Curculigo orchioides* and *Carum carvi*. The soils of the mid altitude belt varies from brown forest soils to brown decidous and grey and coniferous forest soils. The lower altitude belt, stretches from 600 to 1500m; merging with the adjoining Terai, this area includes Dehra Dun, southern Garhwal (Pauri) and Nainital. This belt is characterized by a mix of alluvial and brown forest soils and sal and chir pine forests. The valleys of the middle and lower altitude belt are not characterized by as rich a variety of medicinal plants as the high altitude zone, but they also account for the biodiversity of the state. Medicinal species in this belt include: *Rauvolfia serpentina*, *Gymnema sylvestre*, *Bacopa mannierii*, *Withania somnifera*, *Emblica officinalis*, *Tinospora cordifolia*, *Solanum nigrum*, *Asparagus racemosus*, *Terminalia chebula*, *Bergenia ligulata*, *Acorus calamus*, *Valeriana wallichii*, *Hedyechium spicatum*, and *Thalictrum foliolossum, Glycyrrhiza glabra* and *Emblica ribes*.

3.2.1 IPAs in Uttaranchal

The following sites have preliminarily been identified in Uttaranchal as IPAs for medicinal plants conservation:

IPA-8/CIH- Kedar-Gangotri[48]:

This IPA lies in the Tehri Garhwal Range in the Garhwal Himalayas and stretches across north-western Chamoli and north-eastern Uttarkashi. Four key tracts of medicinal plants concentration are encompassed by this IPA. The southernmost tract lies in the Kedarnath sanctuary area and covers approximately 75 sq. kms. of alpine meadows. The sub-alpine zone consists of moist coniferous forests with an admixture of decidous and broadleaved trees. Birch and silver fir forests are usually found between 2,950m and 3,600m covering the sub-alpine and the alpine zone. These alpine forests give away to alpine pastures above 4200m. Herbs of medicinal plants dominate the sub-alpine and alpine meadows. Medicinal and aromatic species found in the sub-alpine and alpine zone include *Dactylorhiza hatagirea, Anemone tetrasepala, Morina longifolia, Geranium wallichianum, Heracleum spp., D. cachmkyriana*, among others. The second tract lies north-west of the first and runs from Gangi to the base of the Khatling glacier and includes the area around Sahatratal and the alpine meadow of Panwalikantha. The altitude of the tract varies from 2589m to 3717m. The third tract lies further north and encompasses an area running from Kedartal across Gangotri and the Gaumukh glacier to Nandanvan, from an altitude of 3100m to 4400m. The fourth stretch runs from Harsil to Bhaironghati at an average of altitude of 2600m. Ground surveys in the Kedartal area have revealed an occurrence of a total of 19 medicinal plant species, of which 6 are endangered/threatened. These are *Aconitum ferox, Aconitum violaceum, Angelica glauca, Cremanthodium arnicoides, Saussurea simpsoniana* and *Selinium tenuifolium*.

This site is under the Gangotri Forest Area and Uttarkashi Forest Division and is owned by the state, although local people continue to exercise traditional rights as well. The main threats to the site are tourism, followed by hunting and grazing. There are a number of Hindu shrines around the IPA, the most important being Kedarnath and Gangotri and mass tourism related site degradation is the major threat to the site. Frequent earthquakes and landslides in this high precipitation zone also cause considerable damage. There are a number of permanant settlements in and around the site whose inhabitants depend on pastoralism, grazing their animals on the alpine meadows; they also extract minor forest products for livelihoods/sustenance.

IPA-9/CIH- Valley of Flowers and Niti Valley[48,49,50]:

This IPA stretches in an arc that runs west to east across the Alaknanda and Dhauliganga valleys. At its western side is a tract

that runs from Mana pass to the famed Valley of Flowers that lies at the head of the Bhyundar valley, and also includes Hemkund Sahib, a sacred lake to the south of the Valley of Flowers. The area is drained by the river Pushpawati, which originates from the left of the Tipra glacier near Bhyundar Khal. Forests in the National Park constitute only about 5.29 km^2 area while the alpine meadows cover 18.63 km^2. Although the National Park constitutes only 1.3% of the total geographical area of the Chamoli district, it contains almost 25% of its flora. The sub-alpine zone (<3500 msl) in this IPA stretch is characterized by typical high altitude forests dominated by *Acer caesium, Abies pindrow, Betula utilis, Rhododendron campanulatum, Taxus baccata, Euonymus fimbriatus, Syringa emodi* and *Sorbus lanata* which terminate at the tree line. Most of the rare herbs grow in unusual habitats such as rocky slopes, forest edges, and marsh meadows. Some of the common herbs in the sub-alpine zone (<3500 msl) are *Arisaema jacquemontii, Boskniakia himalaica, Corydalis cashmeriana, Polemonium caerulium, Polygonum polystachyum, Impatiens sulcata, Geranium wallichianum, Helinia elliptica, Galium aparine,* etc. The herbaceous flora of the lower alpine zone (3500-3700 msl) represents a spectacular array of multi-coloured flowers, for instance, *Saussurea obvallata, Polemonium caeruleum, Primula involucrata, Aquilegia pubiflora, Lilium oxypetalum, Epilobium latifolium,* and *Corydalis meifolia* during the growing season. The species wealth of this area exhibits an interesting cycle of growth within a short period, one set giving way to subsequent communities during different seasons. The most picturesque and species-rich meadows are located on its south-facing slopes and the entire area harbours 498 species of flowering plants. The ground surveys revealed that the Valley of Flowers itself has the highest number of threatened medicinal plant species. Of the 31 rare and endangered plant species found in the Valley of Flowers, 13 are medicinal, including *Arnebia euchroma* and *Ephedra gerardiana*. The shores of the Hemkund lake are rich in medicinal plants and is famed for the large population of *Saussurea obvallata*. The Badrinath-Mana tract is rich in *Swertia chirayita, Selinum tenuifolium, Saussurea roylei, Picrorhiza karroo, Nardostyches jatamansi, Meconopsis aculeate, Dactylorhiza hatagirea* and *Aconitum heterophyllum*.

A second tract in the IPA is the Niti valley in the buffer zone of the Nanda Devi Biosphere Reserve, which comprises several medicinal plants rich tracts. The altitude of the cluster of tracts ranges from 3200m to 4380m and has a dry alpine habitat. Ground mapping data shows the presence of a number of threatened/endangered species like *Selinum tenuifolium, Rhododendron campanulatum, Picrorhiza kurooa, Heracleum candicans, Ephedra gerardiana, Betula utilis* and *Arnebia benthamii.* The approximate area of the Niti stretch of the IPA is 35 ha. The Malari tract at its upper end measures approximate 3.5 sq. kms and is rich in *Aconitum ferox, Aconitum heterophyllum, Arnebia benthamii, Arnebia euchroma, Artemisia spp., Cremanthodium arnicoides, Cremanthodium spp., Delphinium cashmerianum, Ephedra gerardiana, Gentiana cachemirica, Meconopsis aculeata, Picrorhiza kurroa, Rheum australe, Rhododendron anthopogon and Saussurea gossypiphora*. All these species are endangered/ threatened at the global and national

level. In the alpine meadows in the site, *Danthonia cachemyriana, Saxifraga pulvinaria*, and *Carex setosa*, have been identified as high value and merit priority attention for conservation. At the south-eastern end of the Niti tract is the Dronagiri tract which is rich in *Saussurea graminifolia, Oxyria digyna, Meconopsis aculeate, Potentilla spp., Bistorta spp., Rhodiola spp. Gentiana spp. Taraxacum spp., Saussurea obvallata, Pedicularis spp., Jurinea spp., Picrorhiza kurrooa, Saxifraga spp., Rheum moocroftianum, Corydalis spp., Aconitum spp., Poygonum spp. Saussuria spp., Delphinium spp. and Heracleum spp.* Sothmost in the IPA is the Kuari pass tract that runs from Ramani to the Kuari pass and across is to Tapovan and Auli, is rich in the following: *Selinum tenuifolium, Saxifraga sps., Ephedra gerardiana, Artemisia sps., Artemisia gmelinii, Aconitum violaceum.*

This IPA lies in the protection of the Nanda Devi Biosphere Reserve and the area is besides culturally strong in community protection efforts- the famous Chipko movement was carried out by the villages in this area. Yet it is subjected to severe threats. Like other parts of Uttaranchal, this area too has several pilgrimage sites, including two of the most heavily visited, Badrinath and the sacred Hemkund Lake. The Niti stretch alone is relatively less disturbed by tourism pressures. There are several settlements within the site, but considerable land management practices have already been undertaken for the site with the help of NDBR. Grazing and NTFP collection is rampant however and there is also some amount of conversion of land to agricultural purposes. Construction activities and a hydel project in progress are causing immeseaurable damage to the habitat of the region. The area suffers very frequent landslides due to precipitation and land-use change which remove full slopes of herbaceous vegetation. Unsustainable plant exploitation also have some low level of impact on the site.

IPA-10/CIH- Gauri and Pindar valleys:

This IPA comprises the Gauri Ganga valley in Pithoragarh district of Uttaranchal, bordering Tibet and Nepal, at its eastern end, and the Pindar valley, south of the Gauri valley in the Bageshwar district, at the western end. The Gauri river originates from the Milam glacier at the northern end of the Gauri valley stretch and is fed by the waters of a mixed glacial system before it joins the river Kali. The altitude of the Gauri valley tract ranges from 3430m at Martoli, a grassy plateau above the Gauri Ganga to 3450m at Milam, the last settlement on the Indian side; a second tract lies further south and runs from Madkot at 1241m across Munsiyari at 2130m and to Lilam at 1850m. This river valley falls in the overlapping transition zone of the flora and fauna of the eastern and western Himalaya, making the region unique and biodiversity rich with more than 2,000 plant species. Mountains of gigantic height flank the valley on both sides- the right flank exhibits bugyals or alpine meadows extending up to the snow line, whereas the left bank presents woody shrubs of *Juniperus,*

Berberis, Rosa, Ribes, Salix and *Lonicera*. Lying in the sub-tropical belt, the approximate area of the region is 40 sq. kms with rich and moist riverine forests. It has about 121 species of orchids out of which many are endemic species. Alpine herbs dominate the alpine meadows, sometimes almost to the exclusion of grasses and sedges. Endangered and rare medicinal plant species found in the valley are *Picrorhiza kurroa, Angelica glauca, Podophyllum hexendrum, Gentiana kurro and Dactylorhiza hatagirea.* Phytosociological mapping exercise carried out in Milam and Martoli tracts of the Gauri river revealed the following important medicinal species in Milam: *Rumex nepalensis, Gentiana cachemirica, Ephedra gerardiana, Picrorhiza kurrooa, Aconitum heterophyllum, Angelica glauca*. Martoli was found to have the following important medicinal plant species: *Podophyllum hexandrum, Sassurea costus, Carum carvi, Aconitum ferox, Juniperus communis, Angelica glauca, Inula racemosa, etc.* The Pindar valley stretching from Dhakuri at 2690m to Zero Point at 3820m., shows temperate forests of characterized by *Acer cappadocicum, Juglans regia, Corylus jacquemontii; Sub-alpine areas with Rhododendron campanulatum, Abies pindrow, Acer acuminatum* etc., alpine scrubland comprising *Rhododendron campanulatum, R. anthopogon, Cotoneaster* spp. etc., and alpine meadows rich in *Anemone* spp., *Primula* spp., *Polygonum* spp., *Saussurea* spp.

The Gauri Ganga and Pindar valleys are among the most popular trek routes in the Uttaranchal Himalayas and resultantly, irresponsible tourism forms a disturbance. There is overgrazing during the summer season when most medicinal plant species flower. The locals are not very aware of the importance of these plants and many of these invaluable plants and their habitats get destroyed while collecting fuelwood and fodder.

Other important sites[48]*:*

The Central Himalayas belt in extremely rich in biodiversity and almost every valley and ridge harbours small medicinal plants hotspots. Some of the other medplants important sites include:

- *Bhojvasa:* This area in Chamoli district is rich in *Saussurea roylei, Rheum emodi, Ephedra gerardiana Cremanthodium arnicoides, Artemisia absinthium, Aconitum heterophyllum*
- *Burfu* **is** rich in *Arnebia benthamii (C), Dactylorhiza hatagirea, Gentiana cachemirica, Selinum tenuifolium.*
- *Tons valley & Har-ki-dun:* Upper Tons valley and Har-ki-dun at its upper end in particular in rich in medicinal plants such as *Aconitum heterophyllum, Picrorhiza kurrooa, Nardostachys grandiflora, Ocimum sp, Berberis sp, Dioscoria sp, Dactylorhiza hatagirea*. It lies within the GPV Widlife Sanctuary and National Park. The Kedar kantha region south of the Tons valley in also reputed to be extremely rich in medicinal species.
- *Dodital-Yamunotri:* The Dodital-Yamunotri route is a very popular trek for naturalists for its enormous wealth of herbs.

- *Chopta-Tungnath:* The Chopta-Tungnath stretch is reputed to be rich in medicinal species, but has a high level of threat as a result of tourism.

3.2.2 Major Threats and Conservation Measures in the Central Himalayas

Major Threats:

The major threats to medicinal plants rich sites in the Central Himalayan region were analysed and revealed a near uniformity of type, across all habitats: extremely high and rapidly escalating biotic pressure of a burgeoning population and seasonal tourism, and excessive exploitation of forest wealth.

i. Population pressures and overuse of natural resources: The Central Himalayan belt has a much higher density of population than the western sector and the people are typically very poor and dependent on cultivation on terraces and pastoralism on the bugiyals (meadows). The region shows enormous habitat alteration with more and more of forest lands and mountain sides being converted to terraces. Rid of their vegetation, erosion and landslides are increasing. The meadows and forests are also under tremendous pressure from grazing, supporting as they do the rapidly growing flocks owned by the local communities. In the Kedarnath sanctuary area grazing by domestic livestock (goats, sheep and water buffalo), burning of pastures and collection of forest products and medicinal herbs are not controlled and as a result of the movement of large animal herds, the forest understorey is heavily disturbed in places. The species-composition of the alpine meadows is changing with the unpalatable species dominating and heavy fragmentation of vegetation as a result of this overgrazing.

ii. Tourism and its impacts: Medicinal plants in Central Himalayas are characterized by a narrow range of distribution, which makes them even more vulnerable; many of the medicinal plants rich sites are also major pilgrimage destinations since several holy sites of the Hindus lie in this area, and hence face a huge influx of tourists in the summer and autumn. There is excessive pressure from tourism in the Mandakini valley, notably in the vicinity of the Kedarnath Temple from where a large amount of minor forest and scrub has been reportedly removed. Similar pressures are there in the Badrinath, Valley of Flowers, Hemkund Sahib, Gangotri and many other areas as well. During the visitor season, enormous detruction takes place, with excess traffic, heavy removal of fuelwood and NTFPs and the polluting of water and waste accumulation. In the Hemkund Sahib-Valley of Flowers region for instance, in the 5-6 months' tourist season (mid-May to end-October), there is an influx of 5000 tourists/day plus an in-migrant population of labourers, guides and muleteers of about 300 plus an enhanced animal population of about 300 mules/ponies.

iii. *Excess wildharvesting for trade*: Use of forest resources is very high in this area and wildharvesting of timber and all manner of NTFPs is rampant. The region is very near and reasonably well-connected with the urban centres of northern India, and is also home to a hub of the herbal industry in Rishikesh. Though protected areas have been set aside for conserving biodiversity, most of the forest staff do not know of the ban on medicinal plants or do not recognize them. In fact, the transfer of ownership from community to the govt. has led to a considerable dilution of the feelings of stakeholdership and even increased exploitation of forest wealth by the local communities.

Conservation Measures[22]:

The existing conservation actions, governmental, non-governmental and community based, include:

i. *Government measures*: The state has 6 National Parks and 6 Sanctuaries. These include the unique world heritage site, Nanda Devi Biosphere Reserve. Though the major focus of the management of these reserves is on fauna, efforts are being made to conserve the whole ecosystem, wherein the medicinal diversity in the protected area is also conserved. Promotion of medicinal plants nurseries and cultivation of medicinal plants under the eco-development activities in areas around the PAs especially in Nanda Devi National Park, is notable.

The Joint Forest Management Programme is also being operated in Uttaranchal. There are no designated Medicinal Plant Conservation Areas in the state. But the Forest Department keeps aside Preservation Plots in various forest types for permanent protection and to permit progression towards climax forms. These areas have the potential to be designated as conservation areas for medicinal plants after ground survey.

The state government has declared Uttaranchal as a herbal state and efforts are being made to develop medicinal plant nurseries across the state. The Medicinal Plant Nursery at Muni Ki Reti, Rishikesh has germ plasm of 62 medicinal plants. There are 3 arboretums are located in the state, Kalika near Ranikhet, Forest Research Institute, FRI, Dehra Dun and GBPIHED, Kosi Katarmal, Almora.

Medicinal plant regulation is rather knotty in the state. Bhesaj Sangh is the sole designated authority permitted to collect medicinal plants in the state. There is a list of 35 medicinal plants, of which some are banned for collection, while some others are banned in some division /district for 3 to 5 years on rotation basis. But the regulators hardly comply with the regulation and restrictions observed on the ground seem far from reality. In addition to the 35 medicinal plants there is a list of 118 plants that can be collected, with due payment of royalty.

ii. *Non-governmental action*: The state of Uttaranchal has a long history of community initiated conservation actions. The famous *Chipko* (Hug the tree) movement of the 1970s exemplifies

the grassroot conservation ethos in the state. Van Panchayats and Lath Panchayats are traditional forest conservation and protection bodies unique to Uttaranchal. Lath Panchayats are traditional forest conservation systems that are rooted in the village system of Uttaranchal. These Panchayats differ from the Van Panchayats in that they have no written rules or regulations and their system of forest management is based entirely on local traditions and practices. Several Lath Panchayats have been converted to Van Panchayats. The largest number of these Lath Panchayats is found in Almora, Tehri and Chamoli districts (Agarwal, 2001**).**

The sacred groves in the hills of Garhwal and Kumaon are mentioned in old Hindu scriptures like the Puranas. The largest known sacred grove is in Hariyali near Gauchar in Chamoli district. Others include Askot, Binsar, and Gananath.There are around 17 documented sacred groves and sacred alpine meadows in Chamoli district ranging from 0.5 acres to 2500 acres in area. Prominent among them are Laxmivan, Nandaaur Ghantakaran Ki Phulwari (500 acres) in Mana, Amdar Ki Kyor, Surai Ka Ped, Panyaltha Jalsort (1250 acres) in Ansuya, and Anand Van (2500 acres) in Irani. Thal ke Dhar with an area of 1315.60 acres in Pithoragarh is another sacred grove. *(Source : RANWA, Pune and Gadgil, M., 1998)*

Some of the non governmental organizations working for medicinal plants conservation and research in the state are: Centre for Minor Forest Products (COMFORPTS), Dehradun; Society for Himalayan Environmental Research, SHER at Dehradun; Vaidya Chandra Prakash Cancer Research (VCPCR) Foundation; Foundation for Ecological Security, (FES); HESCO, Dehradun; ECOSERVE, Ranikhet and Himalayan Environment and Ecology Development (HEED), Bageshwar. Pragya has been working for medicinal plant conservation in the high altitude belt of the state in Uttarkaashi, Chamoli and Pithoragarh districts.

3.3 EASTERN INDIAN HIMALAYAS

The Eastern Himalayan region comprises of the Darjeeling Himalaya, the Sikkim Himalaya and the Arunachal Himalayas. This region is unique in terms of its biodiversity, demonstrating vegetation at the crossroads of and hence overlapping several biogeographic realms, and an anormously rich, luxuriant plant growth.

i. High Altitude Belt: Between 2700m and 3600m the forests are mainly evergreen and composed of Rhododendrons and conifers such as spruce, fir and larch, as well as deciduous broad-leafs such as birch, alder, willow and numerous alpine shrubs including *Potentilla* and *Pedicularis*. The soils are mainly light coloured, thin and sandy in the higher reaches and progressively clayey in the lower reaches of the valley. Weathering causes their structure and consistency change. Soil acidity is high due to heavy rainfall. The shrubby layer of the temperate coniferous forests is represented by *Berberis*

asiatica, B.wallichiana, Mahonia spp., Euonymus spp., Eurya acuminata etc.; the herbaceous flora occurs mostly due to heavy snowfall during winter months. The most common species belong to genera *Corydalis, Cassiope, Primula* and *Pedicularis* etc. *Rhododendron arboreum* forms scrub on steeper slopes at about 3000m. On the drier western side of the high altitude belt from 2700m to 4300m, vegetation is scarce and is in the form of bushy, low lying or creeping shrubs/bushes like *Rhododendron anthopogan, R. nivale,* shrubby junipers with pine, silver fir and wild berries. Above 4,600 m there are Himalayan meadows up till the perpetual snow line. Grasslands are frequent at 2700m altitudes and above. Various species of *Aconitum* grow abundantly on the forest floor underneath the rhododendrons at high altitudes; *Arisaema spp.* may be found in open spaces. In the open meadows, on gentle mountain slopes, a few species of the genera like *Ranunculus, Anemone, Delphinium, Rhus, Potentilla, Primula, Fragaria, Cassiope* and *Allium* etc. are seen. *Nardostachys jatamansi, Picrorrhiza kurrooa, Podophyllum hexandrum, Taxus wallichiana, Ephedra gerardiana* constitute the most important medicinal plants of the alpine zone.

ii. Middle & Lower Altitude Belt: The Middle Altitude Belt has an abundance of evergreen medium-sized tress abundantly covered with mosses and are covered with epiphytic growth of Lichens, Bryophytes, Ferns, Peperomias, Aroids and orchids. The forests are also thick with a prolific growth of small herbs, shrubs and ferns on the forest floor. Several medicinal plants like *Artemisia vulgaris, Rubia cordiflora, Panax pseudo ginseng, Dioscroea deltoidea, Digitalis pupurea* are quite common in the temperate and sub-temperate zones. The tropical zone is also quite rich in medicinal flora wherein species like *Costus speciosus, Alstonia scholaris* and *Abroma augusta* grow in good numbers. The subtropical forests that occur between altitude 900-2000m are floristically rich in species diversity. The prominent herbs are *Anaphalis adnata, A. busua, Inula cappa, plantago major, Polygonum spp., Potentilla spp., Viola spp*. and a number of terrestrial orchids like *Habenaria, Malaxis* and *Diplomeris* etc. In the Lower Altitude Belt, largely evergreen species and sometimes decidous trees too, occur; epiphytes and climbers occur in large numbers. Pine forests with species like *Pinus wallichiana, P. merkusii* occur in rainshadow areas between 1000-1800m elevations. Amongst the available shrubs and herbs of the species of *Rubus, Ajuga, Desmodium, Coriaria, Luculia, Prunella, Potentilla* etc. are more prominent. The lowland tropical evergreen forests of Namdapha in Arunachal Pradesh are perhaps the largest remaining Dipterocarpus forests in the whole of India. The forest floor of these tropical evergreen forests is covered by a rich groth of herbaceous flora especially during the rainy season, some common herbaceous elements being *Begonia* spp., *Chirita* spp., *Polygonum* spp., *Oxalis corniculata* and *Floscopa scandens* etc. Soil in the lower and middle hills are either loams or sandy loaams mixed with pebbles. Soils in the valleys are clayey alluvium rich in organic content.

3.3.1 IPAs in West Bengal and Sikkim

The following sites have been preliminarily identified in the Darjeeling and Sikkim Himalayas as potential IPAs for medicinal plants conservation:

IPA-11/EIH- Dzongri-Phedang and Sandakphu[48]:

This IPA comprises two tracts and stretches across the northern part of the district of West Sikkim and the northern-western part of Darjeeling district. The first comprises the Yuksam, Bakhim, Phedang and Dzongri area in West Sikkim district. Beginning from Yuksam at 1757m, the medicinal plant rich site stretches right up to Geochela at 5,000m. It displays a wide variety of habitats from the warm temperate broadleafed forests at the southern end to cool temperate sub-alpine forests at the northern end. The rhododendron forests around Bakhim and Tsokha, and the alpine meadows of Phedang, Dzongri, Zemathang and Samati lake, are especially significant. The tract is rich in a number of critically endangered and endangered medicinal plants like *Crementhodium spp, Aconitum spp., Rheum australe, Primula spp., Potentilla spp., Rhododendron spp., Saxifraga spp., Rhododendron anthopogen, Saussurea costus, Picrorhiza kurrooa, Potentilla coriandrifolia* and *Bergenia strachii.* The forests and alpine meadows of this area are among the most biologically diverse in India, containing over 30 species of rhododendrons, 400 species of orchids and many other flowering plants. The second tract comprises the biodiversity rich tract in North Bengal region wherein lies the Darjeeling Himalayas. The tract extends from 2394m to 3636m. *Aconitum, Picrorhiza, Nardostachys, Dactylorhiza* and other RET species are found in abundance in the tract. *Taxus baccata* is also found in the area, although grossly reduced because of over-extraction.

Most of the area comes under the Khangchendzonga Conservation Area- the first tract lying in the southwestern part of the Khangchendzonga Biosphere Reserve and the second in the Singalila National Park. Both tracts are very popular trekking destinations - within the former is Sikkim's major trekking route, the Yuksam-Dzongri-Goechhala trail, and within the latter Darjeeling major one, the Tonglu-Sandakphu-Phalut trail. The Himalayan Mountaineering Institute conducts its training camps for amateur mountaineers in the area which causes considerable damage along the trekking corridor. There are several small settlements within the tracts and grazing, firewood extraction and fodder collection too take their toll on the vegetation and are causing habitat degradation. A study conducted found more than half the tree woody species were used as firewood, and more than a third were were used for fodder and timber as well; the area also showed a steep increase in the extraction/use of forest products over the last few years. Tea gardens in the Darjeeling region use herbicides and other chemicals which cause untold damage.

IPA-12/EIH- Lachen & Lachung[23, 53,48:]:

This IPA lies in the north-western part of the district of North Sikkim and comprises two tracts, viz, the Lachung-Yumthang-Goechela tract and the Lachen-Thangu-Chopta tract. Both tracts display important medicinal plants like *Dactylorhiza hatargirea, Aconitum ferox, Primula spp., Gentiana spp., Rhododendron spp. and Potentilla spp.* The Lachung tract stretches from 2750m at its lower end to about 4500m at its upper end. The first tract also includes the Shingbha Rhododendron Sanctuary in the Yumthang Valley of Lachung which has been mapped to contain 24 species of rhododendrons. The Lachen tract, although far more sparsely covered with vegetation than the Lachung tract, reportedly contributes the largest share of medicinal herbs in the region. The Thangu stretch and Chopta valley within the tract are especially rich in RET species. The Reserve Forests of Yangri, Dambochi, Thangu, Deothang, and Chuthang are rich in *Aconites*; those of Gochung, Che-chung Lhaka, and Yamshok are rich in *Picrorhiza kurrooa*; those of Moguthang, Gochung, Yamshok, and Che-Chung Lhaka are rich in *Nardostachys jatamansi*. The habitat is of the cool temperate sub-alpine and alpine forests.

The Lachung and Yumthang valley have been popular tourist destinations for a while and the Lachen tract too is being developed for tourism. Land ownership in the area is of mixed type. A traditional form of self-government called the Dzumsa system exists in the area and the elected heads (Pippon) of these bodies control the access and use rights to forests in the area; studies have shown that the system is not free from the malaise of overuse of forest wealth for individual gains however. Majority of the population in the higher altitude habitations practice transhumant pastoralism and overgrazing is degrading and leading to fragmentation of the high altitude pasturelands. Army presence in the area is quite significant and road building and vegetation clearing by the army is high.

Other Important sites[23,48]:

Given the rich biodiversity of the Sikkim bioregion, there are several sites especially within the protected areas that can be considered as potential sites for medplants conservation:

- *Dzongu Reserve*: The Dzongu Reserve for the Lepcha people near Mangan in North Sikkim is another biodiversity rich stretch. Its altitude stretches from 3000ft to 8000ft. The Lepchas use a number of the wide variety of medicinal plants that grow in the thickly forested region for their traditional medicine.
- *Neora Valley*: Located in Kalimpong sub-division of Darjeeling district, this is a stretch of virgin forests extending from an altitude of 600 ft to that of 10600ft. Part of the newly declared national park by the same name, the tract is famous for its orchids and medicinal plants. A habitation in the stretch goes by the name Jaributi that may be translated as ‘medicinal plants’.

3.3.2 IPAs in Arunachal Pradesh

The following sites have been preliminarily identified in Tawang district of Arunachal Pradesh as potential IPAs for medicinal plants conservation:

IPA-13/EIH- Dirang-Tawang[48]:

The IPA comprises several tracts spanning the alpine and temperate belt across the districts of Tawang and West Kameng. The first tract, that of Thingbu-Mago-Luguthang, lies in the north-eastern part of Tawang district, covers an altitude band of 3030m to 4200m.. The vegetation is mainly of the herbaceous type with a few alpine shrubs. The Thingbu-Mago area has species such as *Dactylorhiza hatagirea, Ephedra gerardiana Rheum australe, Rhododendron anthopogon Picrorhiza kurrooa, Gentiana Phyllocalyx.* Thingbu is rich in *Ephedra gerardiana, Circium folconeri, Anaphalis triplinervis, Cirsium falconeri, Dactylorhiza hatagirea, Heracleum lallii, Nepeta connata, Panax pseudo genseng, Plantago major, Potentilla peduncularis, Primula glomerata, Rumex nepalensis, Swertia petiolata, Taraxacum officinale.* Species found near Mago include: *Allium wallichii, Ephedra gerardiana, Epilobium laxum, Nepeta connata, Allium sp, Anemone rupicola, Arisaema jacquemontii, Dactylorhiza hatagirea, Gentiana tubiflora, Geranium polyanthes, Geranium pratense, Mentha lngifolia, Mentha longifolia, Plantago major, Potentilla peduncularis, Primula glomerata, Rheum australe, Rhodiola heterodonda, Rhododendron anthopogon, Taraxacum officinale, Thalictrum reniforme.* Luguthang is a very rich site with several medicinal species including a number of *Saussurea spp.*, viz *Saussurea obvallata, Saussurea gossypiphora, Saussurea nepalensis,* as well as *Aconitum ferox, Dactylorhiza hatagirea, Meconopsis aceculata, Ephedra gerardiana, Berberis spp., Rhododendron anthopogon, Picrorhiza kurrooa, Nardostachys jatamansi, Gentiana Phyllocalyx*. The diversity in the area is indicated by the fact that the mapping exercise carried out found 80 species in an area of 297sq. mts. in Luguthang. The second tract lies south-east of Tawang and south of the first tract and comprises the Geshela-Manmagyelam-LGG-Sarchu-Subhash Hut-PTTso area. The region is very rich in floral diversity and around 70 species of plants were recorded here during the mapping exercise. Geshela is rich in medicinal plant species like *Aconitum heterophyllum*, *Aconitum hookeri Carum carvi Gentiana phyllocalyx Rhododendron anthopogon Saussurea spp. and Innula spp.* Manmagylum has medicinal plant species like *Aconitum heterophyllum, Carum carvi, Rhododendron anthopogon, Saussurea obvallata, Inula spp. and Saussurea spp.* The Red listed plant species commonly occurring in this site include *Aconitum heterophyllum Aconitum ferox, Carium carvi, Aconitum gammiei, Aconitum hookeri, Rhododendron anthopogon.* The LGG area is rich in *Aconitum spp*. Other Red listed plant species found occurring there include *Aconitum spp. Aconitum ferox, Carium carvi, Rhododendron anthopogon* and *Saussurea obvallata.* A third tract with the same vegetation characteristics comprises the area around Sela and

Bangajang. A set of tracts in the adjoining Dirang region of West Kameng district include: Senge and Nyukmadung, Mandalaphudung, and Chander-Thungri. These tracts are rich in temperate plants including conifers, rhododendron, and the high value *Taxus baccata*.

Grazing is rampant in the region and the Mago-Luguthang area especially is home to pastoral groups; logging is also common, by inhabitants and the army. Most of the land is either under community control for in this state, the community has primary rights and ownership on all forests. A Biosphere Reserve, the Tsangyang Gyatso World Peace Park, is proposed to be established covering the particular IPA.

IPA-14/EIH- Upper Siang & Dibang:

This IPA comprises multiple tracts in the Mouling National Park and Dihang-Dibang Biosphere Reserve that ranges in altitude from 500 to 4000m. The conducive climate fosters a vegetation that is luxuriant in its density and most varied in its species content. The area ranges from low to mid elevations and has very high levels of humidity, both due to the high rainfall as well as the continual spray that cloaks the lower reaches of the valley which cuts real low and deep into the Himalayas. Thus while the lower reaches of the tract display tropical, wet, evergreen forests, much of it primary forests, the higher reaches show temperate vegetation. One tract is that of Pemako valley in Upper Siang, which stretches across Tuting-Dewakota-Gelling-Kapangla-Bishing in the Indo-China border where the river Siang enters India, the Yingkiong-Ekodumbing-Riutala (3600m) circuit via Tashigaon and Singha and the Tsitapuri lake area. The tract runs across several mid-altitude passes, viz, the Abroka la (3030m), and on to others at the Indo-China border viz the Kangri karpo la and the Andra la; these areas are rich in *Aconite spp, Meconopsis spp., Primila spp, Coptis teeta*, *Zanthoxylum spp*., and numerous species of orchids and rhododendrons; the *Rhododendron pemakoense* is endemic to this and the eastern Tibet region. Another set of tracts lies in Upper Dibang district flowing from Anini at its southern end, along one tract to Andra pass at the northern end, and along another tract to Bruini at the northern end. The following species occur in the area: *Aconitum spp., Rheum emodi Wall., Podophyllum hexandrum, Berberis spp, Halenia spp., Taxus baccata, Gaultheria fragrantissima, Nardostachys jatamansi, Picrorhiza kurrooa, Coptis teeta, Acquilleria malaccensis, Piper brachystachyum, Plectranthus japonica*, etc.

Like the rest of Arunachal, land ownership in the region is of a mixed type, with both community and forest department ownership. Several habitations exist in the IPA and the people practice ‘jhum’ cultivation; areas along the Pasighat-Tuting stretch for instance is dominated by jhum fields, fallows, and patches of disturbed mature forests along the ridges and hills. This, along with the exploitation of timber – many timber yielding plants grow in the forests of this IPA – and of high-value medicinal

plants, and the growing use of minor forest products, is leading to degradation of the IPA.

IPA-15/EIH- Western Lohit-Changlang[44]*:*

Several tracts across two Protected Areas in the easternmost corner of India - the Kamlang Wildlife Sanctuary and the Namdapha Biosphere Reserve - comprise this IPA, spanning the Lohit and Changlang districts in the state. They include the tropical wet evergreen forests at Deomali-Namsangmukh, Namsai, Tengapani-Madhupan & vicinity and Demwee-Sewak Pass-Tiding tracts in Arunachal Pradesh. The first tract spans the border of Lohit and Changlang districts; the second tract is in Lohit district, east of Tezu, the district headquarter, along the Tezu-Hayuliang Road. The vegetation in the first area is broadly tropical wet evergreen type, dominated by Dipterocarps like *Dipterocarpus retusus* and *Shorea assamica.* It may be noted that this forest type in India occurs only in this region. This also offers habitat to some of our rare plants like *Sapria himalayana, Cyathea spp., Angiopteris evecta, Dischidia bengalensis, Beilschmedia deomalica, Picrasma javanica, Griffithia sp., Gnetum gnemon* etc. Some of the important medicinal plant species found in this region are *Piper sp., Acorus sp., Paedria sp., Costus sp., Terminilia chebula, T. bellirica, Oroxylum indicum* etc. The Demwee-Sewak Pass-Tiding tract lies in the tropical semi-evergreen belt and ascends to the subtropical belt at Sewak pass. The road to Hayuliang bisects the proposed site. The hills are clothed with dense vegetation, typical of tropical and sub-tropical zones. Medicinal plants species found in the area are *Costus speciosus, Terminalia chebula, T. bellirica, Gmelina arborea, Cinnamomum spp., Litsea sp., Oroxylum sp.*

These forests have important plant groups like timber, bamboos, cane, medicinal plants, other NTFP, wild edibles and crop relatives and many rare and endangered plants. Dipterocarps, considered one of the most important raw materials for plywood and wood based industries, grows in these forests. There are many wood based industries nearby. Since the area is partly in the plains, considerable tracts of forest lands have been converted to agricultural and urban land for the emerging townships like those of Deomali, Namsai, Lathaw and other centers. There are limestone deposits near Tidding that are also being exploited though currently at a limited scale. There is also a growing demand for timber and other NTFP from the nearby settlement areas.

Other important sites[48]:

Almost all forested stretches of the Eastern Himalayas are rich in medicinal plants. Some of the other important medicinal plants sites are cited below:

- *Dzongdoperi*: This stretch lies in the Zemithang circle of Twang district and is rich in *Aconitum hookeri*, *Dactylorhiza*

hatagirea, Meconopsis aculeate, Saussurea costus, Saussurea nepalensis, Rheum australe.

- *Doimara-Sessa:* This stretch located in West Kameng district is rich in orchids of all varieties including several that are medicinal.
- *Mithumna-Mailang:* This stretch is very rich in temperate flora and many rare plants, particularly epiphytes.

3.3.3 Major Threats and Conservation Measures in the Eastern Himalayas

Major Threats:

The damage to the eastern Himalayas as in the case of the central Himalayas comes from anthropogenic interventions.

i. Overuse and inappropriate use of natural resources by local communities: Forests are central to people's livelihoods and serve as the major source of food, fuel and medicinal herbs and plants [51]. Extensive use of the forests for NTFPs and biomass by the population is a major habitat destruction agent. Although at present the livelihood dependence of people on medicinal plants does not seem to be substantial, the overall reduction and degradation of the habitat is leading to increasing depletion of medicinal plants as well.
There is lot of habitat destruction through *jhum* cultivation. Traditionally, many of the tribal communities of the north-eastern region have practiced this form of zero-tillage cultivation. Selected forest areas are cleared of their existing foliage, by first slashing and then burning it. Cultivation is undertaken directly without any formal preparation and after using a site for about 2-3 years, when the yield of the site begins reducing, the site is abandoned and a new site selected for cultivation, leaving the first to regenerate and coming back to cultivating it after a few years. The increasing population and hence increased pace of forest clearance, along with the slower regeneration as a result of climate change, is resulting in rapid degradation of the Eastern Himalayan forests however: the earlier 15–20 year cycle of shifting cultivation on a particular land has reduced to 2–3 years now. This has resulted in large-scale deforestation and loss of biodiversity, soil and nutrient loss, and invasion by weeds and other species.

ii. *Community control and low state intervention*: The state is unique in having preserved the customary rights of various tribes over land, water and forests. Each tribe as a community, exercises control over the natural resources within their surroundings. There are no written land records of ownership in the state. Alhough there are strong customary laws for conservation and protection of biodiversity, the traditional institutions and laws are fast losing their hold with deleterious effects, and in the absence of state control as well,

irresponsible users have a field day. There is a tendency to resist any move to develop protected areas. Many parts of the state are inaccessible, and while this can be a source of protection for the high valued endemic flora and fauna, most of the times it results in acts of logging and illegal harvesting getting unreported. In fact the state's economy revolves around forests. Increasing local populations, migration from the plains, roadside labour etc are all doing their mite to contribute to defforestation.

iii. Irresponsible development and behaviour of state agencies: Because of the strategic location of the state there is considerable presence of armed forces and para military forces, their temporary settlements and construction activities destroying the habitats of the medicinal flora. Construction of roads in the high Himalayas has been a serious threat, as in the case of northern Sikkim where para military forces have caused extensive habitat destruction while making roads (Sathyakumar, 1999). The relict vegetation is used as firewood for heating coal tar. These activities are adversely affecting the areas that already have scanty natural vegetation.

Conservation Measures[23, 26]:

i. Government measures: The state of Sikkim is very well placed in terms of institutional arrangements and the state's commitment to initiate long term conservation and sustainable utilization initiatives in the field of medicinal plants[23]. 28% of the state of Sikkim (2049 sq. km) lies within protected areas, a proportion that compares favorably with other countries within the EHR. Most of this protected land lies within Kanchandzonga[52] National Park (1784 sq. km). Five alpine, wildlife, and rhododendron santuaries protects an additional 256 sq. km. Currently there are 6 additional protected areas: Kitam Sanctuary13 sq. km, Pangolakha National Park, 108 sq.km, Tholung Wildlife Sanctuary, 230 sq. km, Dzongri Wildlife Santuary, 468 sq.km, Nimphu Wildlife Sanctuary, 167sq.km, Kanchandzonga National Park *(International Biosphere Reserve Extension),* 946 sq.km, proposed under the biodiversity "hotspot" program. If approved, these will extend Sikkim's protected area system to total size of 3871 sq.km (53% of Sikkim's total area). Sikkim is the only state with an Ecclesiastical Department which is entrusted with the responsibility of the upkeep of the monasteries and other places of worship, and almost all gompas (monasteries) and other religious institutions are responsible for a considerable degree of biodiversity conservation as well in the form of sacred groves/spaces.

Arunachal Pradesh has 2 National Parks, 7 Wildlife Sanctuaries, 2 Biosphere Reserves and 1 Orchid Sanctuary; 1 additional Biosphere Reserve is proposed. Namdapha National Park in Tirap district with an area of 1985.23 sq. kms is perhaps the widest diversity of habitat of any of South Asia's protected areas. It is unique, with its elevation varying between 200 to 4500 mts. The Dihang-Dibang Biosphere Reserve is another large and newly created

reserve. People living in the vicinity of the Dihang Dibang reserve area have been restricted from entering in the forests in order to reduce the pressure on the natural forests area. Forests of the state are legally classified and notified as reserved forests, protected forests, anchal and village forest reserves, national parks and wild life sanctuaries under the relevant provisions of Assam Forest Regulation 1891, Anchal and Village Forest Reserve Act 1978 and 1981 and the Wildlife (Protection) Act 1972. Unsurveyed forests where status of right and ownership is not settled are classified as Unclassed State Forests (USF). The USF is an ambiguous term and there is not much departmental control over these lands. The Reserved Forests are scientifically managed. To ensure people's participation people friendly afforestation programmes like Apna Van have been implemented. In the Apna Van scheme, the department provides funds and technical support. This has been well received by the public.

ii. *Non-governmental action*: Natural landscapes have been consecrated as sacred forests, sacred lakes, sacred boulders, stones and sacred spaces, by local communities in the eastern Himalayas. These traditional beliefs are slowly eroding under the onslaught of modern education, consumptive livestyles and other western influences, however.[28] According to a study there are 56 sacred groves or 'Debisthan' reported from Sikkim. These forest patches are repositories of rich biodiversity including medicinal plants. Khetchipuri sacred grove in West district, Mt. Mainam, Rabong, Tendong sacred groves in South district, Churten sacred grove in East district and Kabi sacred grove in North district, are a few good examples where a variety of precious elements of flora and fauna are well protected. *Cyathea spinulosa* and *C. gigantia* – the tree-ferns which are under threat due to a high demand of their trunks in orchid-culture and trade, are well protected in Churten sacred-grove; *Camellia kissi* - the wild-tea - is common in the protected woods around Khetchipheri Lake; *Dendrobium nobile* the state flower of Sikkim is also quite common Kabi sacred grove. The highlands of Demojong below the Khangchendzonga peak are the most sacred site for the Sikkimese Buddhists, and all comprised in them are protected therefore. Arunachal Pradesh has 65 documented Gompa forests or sacred forests attached to Buddhist monastries ranging from 0.01 sq.km to 3 sq. km in area. Tawang district alone has 38 gompa forests, and there are another 24 in West Kameng district.
The Khangchendzonga Conservation Committee, a community-based organization in Yuksam in West Sikkim, is working on issues related to eco-tourism, conservation of natural resources, etc., by providing training to community stakeholders, educating visitors, monitoring resources and advocating for appropriate policy changes. There are also a number of NGOs working for the conservation of medicinal plants in Sikkim. Some of the non-governmental organizations working for medicinal plants and natural resources conservation in Sikkim are Ashoka Trust For Research in Ecology and the Environment (ATREE); Chagpori Tibetan Medical Institute; Eco-tourism & Conservation Society of Sikkim "ECOSS", East Sikkim; Green Circle, East Sikkim; Human Development and Nature Conservation Society, East Sikkim. Non-governmental organizations working in Arunachal Pradesh in the

field of medicinal plant conservation include: WWF-India, Itanagar; OSA- Orchid Society of Arunachal; Arunachal Pradesh Vikash Parishad; Oju Welfare Association, Naharlagun; Indigenous Human Rights Organization, Naharlagun; Voluntary Health Association of India; PRAYAS-Itanagar; Arunachal Pradesh Women Welfare Society, Itanagar; V.K.V. Organization, Arunachal Pradesh; R.K.Mission, Arunachal Pradesh; Himalayan Indigenous Medicinal and Aromatic Plant Research & Development Society, Itanagar; Herbs for Better Health, Roing, Dibang Valley. Pragya works for medicinal plant conservation across the eastern Himalayas stretch – exclusively in its high altiude areas, comprising North Sikkim, West Kameng and Tawang.

4. CONCLUSION

The WHO estimates that more than 80% of the world's population rely either solely or largely on traditional remedies for health care. Rural communities continue to rely on locally produced, plant-based remedies, some from home gardens, but many from forests, alpine pastures and other multiple-use habitats. Despite their recognized importance, the existence of medicinal plants in their natural habitats is threatened by the destruction of natural ecosystems.

Though much information exists on the species diversity in medicinal plants, relatively very little is known about the distribution, abundance, ecology and genetic diversity of the great majority of medicinal and aromatic plants. Identifying priority species for conservation and understanding the management requirements for the medicinal plants in their natural habitats are constrained by the limited capacity for and attention to basic field research. To develop a sound research strategy and program for medicinal plant conservation and utilization, there is a need to fully document the medicinal plant species, where they are located, their existing population, place(s) of conservation and their known traditional uses. Analytical studies need to be carried out to identify the most valuable populations within the community because the quality of products produced by different populations varies and there are close links between the genotypes and ecological variables under which they grow.

Protected Areas and IPAs

Protected areas also tend to focus on the larger and the more charismatic of the species that inhabit this earth. Thus wildlife receives much more attention and protection than do the shrubs and herbs. The PAs in the Himalayan region besides, are inadequate and often poorly managed. Of the 75 protected areas in the IHR, only a few, and the higher reaches of some located in lower regions, are in the high altitudes. The PAs are poorly managed because of their extreme remoteness. What is more critical is that hardly four of them are interconnected by natural corridors; extremes of weather in the Himalayas imply that vegetation & animals need contiguous habitats in order to maintain adequate & viable populations. Certain in-situ conservation zones can be demarcated in already created sanctuaries, national parks and biosphere reserves, and enrichment plantation measures for in-situ gene pool creation of the herbal species can be started.

The IPAs identified in this report follow the cluster approach. This essentially implies that several core areas for medicinal plants conservation have been identified within a larger area of the same/similar habitat with a degree of physical proximity and delineated by a set of biophysical features. Effective

conservation could focus on protection of the identified core areas and developing corridors between multiple core areas within an IPA. It must be noted that many of the IPAs include sites that are currently part of some PA, clustering them with others that lie outside it.

Non-formal Protection Measures

Non-governmental organizations and local communities too could undertake such protection and corridor development work. This is in alignment with the decisions & work programmes of CBD-COP7, and the priority action of addressing strategic weaknesses of PA systems through informal approaches to site conservation through local & national civil society means.

Pragya has launched an intervention for establishing a 'Conservation Grid' across the Indian Himalayas. This aims to establish community protection for several of the core areas identified across the Himalayas. Three pilot Community Protected Areas have been established in Lahaul & Spiti district in the western Indian Himalayas, under this intervention, for the protection of medicinal plants hotspots: Chika and Khangsar in Lahaul and Lossar in Spiti. Chika with an approximate area of 1 ha is rich in *Aconitum* spp. The land belongs to a number of local community farmers. The site has been fenced and no disturbance is done to the site. Khangsar with an area of 2 hectares is rich in *Dactylorhiza hatageria*. The area has also been fenced. Grazing or harvesting is not allowed in this site. The Lossar site in Spiti is spread over a hill with an approximate area of 1 hac. It has some important medicinal plant species like *Arnebia benthamii, Bergenia stracheyi* and *Ephedra gerardiana.* The land is govt. owned. Neither agricultural nor any other horticultural activities are practiced in the area. As a consequence of these conservation measures in the above sites, the population of the threatened medicinal plants has increased, which is a very positive sign. The local community has become aware of the value of these species and the need for germplasm conservation. There is increased interest to dedicate more community and individual land rich in medicinal plants for conservation purposes. In-situ patches like these, even if area covereage is less, it will go a long way in conserving the invaluable herbal wealth when replicated at a larger scale.

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