Pak. J. Bot., 44: 187-194, Special Issue May 2012.

IDENTIFICATION AND CONSERVATION OF IMPORTANT PLANT AREAS (IPAS) FOR THE DISTRIBUTION OF MEDICINAL, AROMATIC AND ECONOMIC PLANTS IN THE HINDUKUSH-HIMALAYA MOUNTAIN RANGE

HASSAN SHER[1*], HAIDAR ALI[1] AND SHAFIQUR REHMAN[2]

[1]*Centre of Botany and Biodiversity Conservation, University of Swat, Pakistan.*
[2]*Department of Botany, KUST, Pakistan.*
[*]*Corresponding e-mail: hassan.botany@gmail.com*

Abstract

Study on the identification of Important Plant Areas (IPAs) was conducted in seven valleys of Hindukush-Himalayas mountainous ranges of Pakistan during 2005 and 2006. The principal aim of the study is to search new avenues for the conservation and sustainable utilization of threatened medicinal and economic plants and their habitats in IPAs. IPAs are sites of tremendous ecological and economic values that still exist in the world and are being managed on specific sites to study wild plant diversity. Several of such plants are used in the traditional medicines that are being used since the dawn of history to provide basic healthcare to people the world over. According to WHO, 80% of the human population of Africa still use medicinal plants in their primary healthcare. The popularity of herbal drugs is on the constant rise in many developed countries of the world, while in developing countries like Pakistan; medicinal plants contribute significantly to the income sources of people living in remote areas. Keeping such importance in view, the World Health Organization (WHO) launched a global vision in the form of " Global Strategy for Plant Conservation" having various targets and mile stones. Target 5 of the strategy required for the global integration of the herbal medicine in health care system with proper identification of medicinal plants and the conservation of sites where such plants are found naturally, as its basic elements. In order to contribute to the specified target, WHO advised the relevant institutions to develop research plans and conservation programmes that are focused on the Global strategy in general and target 5 in specific. While complementing the appeal and contributing to its vision, a study was conducted in various eco-systems of the Pakistan's Hindukush-Himalayas region, identifying Important Plant Areas (IPAs) for their subsequent conservation and uses for scientific purposes. Site selection for the study was based on: 1). Exceptional vegetation richness for the representative bio-geographic zone; 2). Presence of naturally occurring medicinal herbs with species of global or regional concern, and (3). Threatened habitats that are supporting plant species of medicinal and economic values. Apart from various values of the selected sites such as their scientific and economic importance, the selected sites had a treasure of indigenous knowledge related to the wise uses and conservation of medicinal plants. The study also focused on exploring the complex natural interactions between plants and other organisms; their dependence under various environmental parameters; traditional knowledge of the local inhabitants; and the significance of the landscape to Conserve such plants on long-term basis.

Introduction

Owing to over exploitation, population of medicinal plants has become drastically reduced. Forests and rangelands are the main habitats of medicinal plants in all parts of Hindu Kush, Himalaya, which are commonly exploited commercially for decades (Sher *et al,* 2005; Ahmad *et al.*, 2008, 2009). Their cultivation *ex-situ* management has been neglected in the past. The evaluation of changes in ecological conditions and their related plant life is often done on the basis of vegetation monitoring. Moreover, shift in densities, frequencies and abundances of targeted plants with a narrow ecological tolerance are frequently used as indicators for assessing change and habitat quality (Palmer, 1987).

Pakistan is divided into 9 ecological regions with about 6000 plant species. Out of this, 410 are endemic to Pakistan while about 200 are believed to be threatened because of various reasons. Amongst all the eco-regions, those that occur within the Hindukush-Himalayas are the richest from floral perspective. About 2500 plant species have so far been recorded from the Hindukush-Himalayas that include 90% of all the endemic plants, reported from Pakistan (Adnan *et al.,* 2006; Sher & Hussain, 2009; Sher *et al.,* 2004).

Pakistan is among the top eight exporting countries of medicinal and aromatic plants in the world, exporting plants worth US$ 5.45 million per year. Over 60% of the total export originates from the Hindukush-Himalayas regions of the country (Champion *et al.,* 1965; Sher *et al.,* 2005; Sher & Hussain, 2009). The destinations of such exports include Germany, USA, Middle East, India, Iran, etc. However, Pakistan also imports some of the MAPs, worth US$ 130 million, from the above countries (Sher & Hussain, 2009). Such imports have increased over the last ten years.

Studies (Adnan *et al.,* 2006; Sher, 2011) have revealed that about 70% of the MAPs that are being imported to Pakistan actually grow wild in the Hindukush-Himalayas of Pakistan but these have neither been explored fully nor their commercial and medicinal importance is known to the local communities. The potential to enhance the cover and density of most of such plants does exists, provided promoted under *ex-situ* and *in-situ* conditions and treated as a cash crop in the country. This will not only save the valuable foreign exchange but shall also open up new avenues for the income of the low income groups.

The country on the whole has serious problem with the loss of floral richness and diversity. Deforestation, followed by heavy grazing/browsing by domestic livestock; and unsustainable uses of various forms are the major factors behind the rapid loss of floral resources (Scakali, 2008).

Medicinal plant species constituting about 10% of all the plants found in Pakistan are severely affected by the major factors given above; and several other reasons that are more local and specific in nature. The places that are rich in medicinal plants have different problems in different sites of their occurrence. For instance, if heavy grazing by livestock is taken as top reason in one location, the problem of unsustainable harvest for commercial uses is at top in another location. Similarly, if the land tenure and resource ownership is the major root cause in one area, the lack of appropriate rules, or the poor implementation of the available rules is a major reason behind the issue in other locations (Larsen & Smith, 2004; Hameed *et al*., 2011).

The Hindukush-Himalayan tract of Pakistan is spread over the Malakand and Hazara administrative divisions of the Khyber Pakhtunkhwa (formerly known as North West Frontier Province). The region supports a diverse flora and fauna that also include several of the globally important, yet threatened species. The flora in particular consists of a number of progenitors of economically useful crops and a multitude of medicinal and aromatic plants (MAP) with tremendous potential of useful pharmaceutical applications. Presently these regions face serious threat to MAP species and its habitats spurred by demographic, economic and technological changes. Habitat degradation by domestic livelihood, forest depletion to meet the needs of local communities, and the over-harvest of MAP and other economically useful flora by traders; are some of the issues that require elaborate study and attention. Indigenous people in rural communities rely on plants for food, medicines, fuel, building materials, fiber and other products (Sher, 2011). The task of documenting the floral wealth and indigenous knowledge about the use of plants resource is vital for effective biodiversity management in general and MAP species in particular (Ali *et al.,* 2012).

With the rapidly growing population and associated poverty, indigenous people are under pressure to change their ways of thinking, making decisions and harvesting the bio-resources. This in turn has resulted in rapid deforestation, ecosystem degradation and over harvesting of the MAP species. Moreover, much of the indigenous knowledge about plants is being lost with the transformation of local ecosystem and cultures (Dana *et al.,* 2005). All of such factors have severely reduced the population status of MAP species and chances for the overall environmental sustainability of the plant resources of the Hindukush-Himalayan Region.

Although the whole of the Hindukush-Himalayan region is important for the conservation of floral resources, certain locations have strategic importance for the values that are attached to the role of its flora in maintaining water quality and quantity, providing stability to the eco-system on the whole and supporting life in its various forms, including the people that are dependent on such locations for their various needs. Details of such locations/ clusters of locations are included in the report.

Materials and Methods

A total of four valleys in the Hindu Kush while 3 in the Himalayas were selected as potential IPAs, based on the criteria laid down by Plant Life International (Anon., 2002). Comprehensive field studies were conducted throughout the study area. Various ecological habitats were investigated regarding species richness, endemism and various anthropogenic threats faced by plants in these seven areas. Transect walks were arranged along the important routes, regarding the variation in elevation and aspect of the mountains and covered nearly all slopes, aspects and altitudes. Personal observations were made in the field to note any pertinent event, which would help gain better understanding of the presence and abundance based on the ecological characteristics of the species. For finding out the conservation status, IUCN Red List Categories and Criteria 3.1 (Anon., 2001) and standard methods of Braun-Blaunquet (1932) were used. The status of commercially important indigenous species (for threatened taxa) in the selected valleys have been determined by using four parameters viz. availability, collection, part used and growth, providing a total score of each species based on this analysis, relative importance of specific medicinal plants have been classified in to various threatened categories of IUCN.

Results and Discussion

This paper communicates the important plant areas of both the Himalaya and Hindu Kush mountain ranges of Khyber Pakhtunkhwa province of Pakistan. These mountains are the richest floristic regions of Pakistan (Ali and Qaiser, 1986), containing about 45% (i.e. 2500 taxa, out of total of 5521 taxa (Ali, 2008)) of the country's species of vascular plants diversity; 10% of which are regarded as medicinal (Sher *et al.,* 2010). Out of total of 410 endemic taxa known from the country (Ali, 2008) ninety percent are found here. Beside this Pakistan ranks among the top 8 exporting countries for medicinal plants worldwide (Anon., 2000b), 60% of its production originating from the Hindu Kush-Himalaya; virtually all is wild-collected (Karkii & Williams, 1999).

Various anthropogenic pressures on wildlife especially the floral diversity are however, considerable, with a human population increasing annually at a rate of 2.1% (Anon., 2011) beside the unplanned urbanization, deforestation and overexploitation of natural resources (Ali, 2000; Anon., 2000b; Sheikh *et al.,* 2002; Eberhardt *et al.,* 2006; Schickhoff, 2006). There has been little research on the threatened plants of Pakistan (Alam & Ali, 2009; Ali & Qaiser, 2010a,b). Ali *et al.,* (2012) noted that it is important to conserve plant diversity throughout the entire Hindu Kush-Himalayan region and not just at selected sites only. Nevertheless, the seven selected sites are held as of 'strategic importance' for the conservation of medicinal plants (several other sites have been provisionally identified for later confirmation). These seven locations have been identified with reference to the IPA criteria supplied by Plant life International, beside their significance for the provision of plant resources generally (i.e. not just medicinal plants); their contributions to the provision of ecological services (such as water supplies); the extent of engagement of local people with medicinal plants; and an assessment of the practical scope for improvements in conservation. The extent of people's engagement with medicinal plants was

judged by the degree of local dependency on income from the sale of medicinal plants and estimates of the likelihood of the local people putting much effort into improving the management of these resources. All seven IPAs are valley-based and have substantial numbers of inhabitants (Table 1). Altogether, these sites contain a total of about 560 species of higher plants, about 300 of which are considered to be medicinal (though not necessarily so used locally). Several species are regarded as threatened. For example, at one site (Daral valley), four species are considered to be Critically Endangered, seven Endangered, six Commercially Threatened, six Rare and one has become locally extinct (*Saussurea lappa*). Many commercial species are becoming increasingly rare, as indicated by the greater effort now needed for their collection. For instance, it is reported that collectors must now travel for 5 hours to obtain the same quantity of *Valeriana jatamansi* as could be collected in just 2 hours, 20 years ago.

Table 1. Provisional IPAs for medicinal plants in the Himalaya and Hindu Kush of Pakistan.

Name of important plant areas	Altitude (m)	Vegetation	Community
Hindu Kush range			
Utror Valley	2300-2400	Oak scrub, dry temperate conifer forest, alpine and sub-alpine meadows, cold desert	16 hamlets Population 12,000
Gurnal Valley	1400-4200	Oak and coniferous forest, alpine and sub-alpine meadows	4 villages, 9 hamlets Population 14,000
Daral Valley	1400-4500	Dry temperate, alpine and sub-alpine, meadows; oak groves	10 villages, 12 hamlets Population 15,000
Miandam Valley	1190-3600	Moist temperate broad-leaved forest, coniferous forest, alpine and sub-alpine meadows	11 villages and 15 hamlets Population 10,000
Himalaya range			
Siran Valley	1200-4800	Oak scrub, temperate coniferous forest, sub-alpine and alpine meadows	10 villages, 12 hamlets Population 20,000
Shogran Valley	1200-4800	Oak scrub, temperate coniferous forest, sub-alpine and alpine meadows	10 villages, 12 hamlets Population 20,000
Nathiagali	1800-3000	Moist temperate forest (mainly coniferous), alpine and sub-alpine meadows	12 villages Population 50,000

Detail description of the IPAs

Utrorr valley: Utrorr, the inner valley of Hindu Raj mountains in the Hindukush Range is situated between 85°-20′ to 35°-48′ N latitudes and 72°-12′ to 72°-32′ E longitudes in the northern part of Pakistan (Fig. 1). The total area of the valley is about 47400 ha. Which has about 16 hamlets, big and small, with a population of about 12000 peoples (Anon., 2000a). The elevation of the valley ranges from 2300m at a site called "Konai" to over 4000m at "Loi Pandghal".

There are no accurate records of snow and rainfall, though both forms of precipitation occur to various extents in different seasons. The area is out of the influence of monsoon. Most of the precipitation is received during winters and springs. Snow fall ranges from 2ft in the valley to 10ft on highest altitudes.

This site harbors a variety of wildlife species. Block Bear, Musk Deer, Fox, Wolf, and snow Leopard; and Monal and Koklass Pheasants, are some of the examples. Main vegetation/forest type is the dry temperate conifer forest, sub-alpine and alpine meadows and Oak-scrub.

Vegetation and flora: Utrorr valley occupies the floristically rich southern extension of Hindu Raj of the Hindu Kush series. Vegetation of the valley is diverse, representing the dry temperate, sub-alpine, alpine and cold desert vegetation zones (Champion *et al.,* 1965). Phyto-geographically, the valley is representative of the Sino-Japanese, Irano-Turanian and Euro-Sirberian floristic elements. Principal species of these regions are *Taxus wallichiana, Juglans regia, Ephedra gerardiana.* Studies have revealed that the valley has about 200 species of flowering plants, with high ethno-botanical values. Out of 200 species, 90 plant species have medicinal properties. Thirty-one species of important medicinal plants are threatened. Such species occur mostly in the high altitudinal habitats. Most of these species are perennial, yet slow growing, which require a few years, at least, of growth for reproduction.

Our preliminary search for information reveals that the forests of the valley have been subjected to major structural changes during the last few decades that has reduced the potential habitat for MAPs by about 20%. Some of the MAPs are of commercial importance such as *Valeriana jatamansi, Aconitum violaceum, A. laeve, Podophyllum hexandrum, Colchicum luteum, Dioscorea deltoidea, Ephedra gerardiana* and *Bunium persicum.*

Overgrazing, unsustainable harvesting of MAPs and over cutting of the forests, are some of the reasons for the plants to get threatened, endangered, or vulnerable. Following are some of the proposed measures that could be undertaken to mitigate the negative impacts of un-sustainable resource use practices with regards to MAP.

- Management of common property resources
- Introduction of rotational grazing system
- Introduction of rotational harvesting programmes
- Promotion of cultivation on private land
- Sustainable use and value addition
- Development of small scale enterprises from medicinal and aromatic plants material

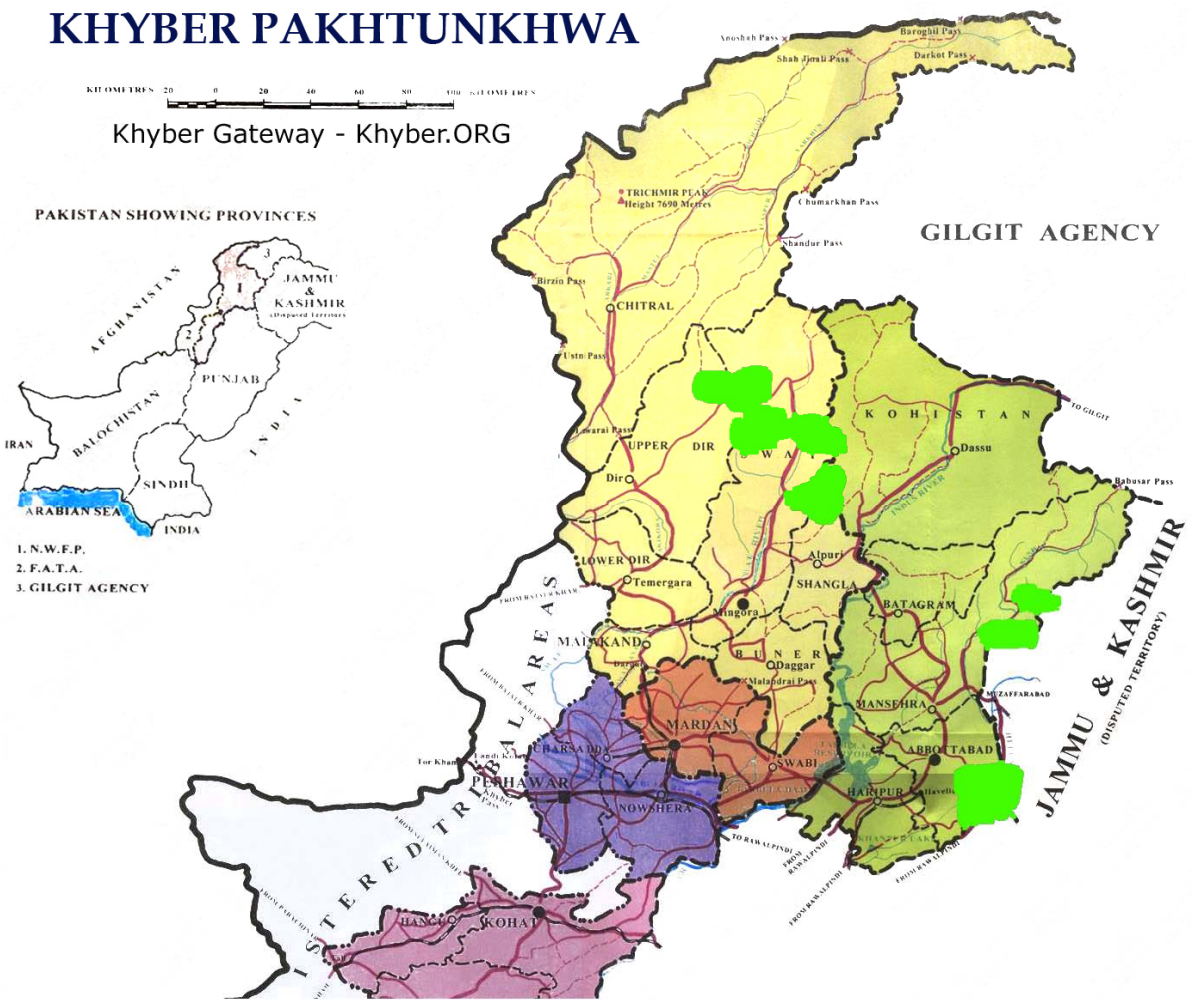

Fig. 1. IPAs labeled with light green color on the map in the Himalaya and Hindu Kush region of Pakistan.

Gurnai valley: Gurnai valley is located in the north-eastern part of the Hindu Kush mountain ranges. It lies between 34° 27′ to 34° 52′ N latitudes and 71° 26′ to 72° 48′ E longitudes (Fig. 1) and spread over approximately 42000 ha. The elevation ranges from 4600 ft to over 14000 ft. The valley consists of four big villages and nine small hamlets with a population of about 14000 people (Anon., 2000a).

The valley has little monsoon influences. The precipitation is mostly received in the form of snow during winter. The snow depth varies from area to area, with variation in altitude.

Vegetation and flora: The valley has various MAPs and wildlife species associated with semi-dry temperate, sub-alpine and alpine meadows (Champion *et al.*, 1965). Lower parts of the valley represent coniferous and oak forest while its upper reaches has sub-alpine and alpine meadows. Coniferous forest mainly comprises of *Cedrus deodara*, *Pinus wallichiana*, *Abies pindrow, Picea smithiana* and *Taxus wallichiana* with associated broad leaved species such as *Quercus dilitata, Juglans regia* and *Acer* species.

Phyto-geographically, Irano-Turanian and Sino-Japanese elements with several endemic species are dominant in the flora of the valley. About 250 species of flowering plants have been identified so far in the valley out of which, about 130 plants have ethno-botanical importance. The valley hosts a number of MAPs, some of which have big commercial value in the national and international markets. Out of 250 species, about 31 are classified as threatened in the valley due to various inimical factors. Details of the threatened species are provided in Table 2.

Conversion of forest habitats to other land uses through illicit encroachment, overgrazing by nomads, forest logging and unsustainable harvest of medicinal plants are some of the major conservation issues. Shinwari & Qaisar (2011) suggested that in order to have an effective medicinal and aromatic plants management and its sustainable utilization, it is extremely important to ensure that the benefits of the resources are fairly shared with the owner communities. The sense of ownership can only be inculcated if the communities at large see the benefits coming from the resource. Non equitable distribution of benefit often leads to unsustainable practices.

Table 2. List of Threatened MAP species in the selected valleys of both Hindu Kush and Himalayas mountains.

Species	Hindu Kush Ranges (valleys)				Himalayan Range (valleys)		
	Utrorr	Gurnai	Daral	Miandam	Siran	Shogran	Nathiagali
Acorus calamus	E	E	E	E	I	I	I
Aconitum leave	R	R	R	VR	V	V	V
A. violaceum	R	R	R	R	I	I	I
Berberis lyceum	CR	K	K	K	K	K	K
Ephedra gerardiana	CE	CE	CE	-	-	-	-
Hyoscyamus niger	CE	CE	CE	CE	-	-	-
Morchella esculenta	R	R	R	R	R	R	R
Corydalis govaniana	R	R	R	R	-	-	-
Dioscorea deltoidea	CT	V	V	V	CT	CT	CT
Podophyllum hexandrum	E	E	E	E	E	E	E
Valeriana jatamansi	CT	CT	CT	CT	CT	CT	CT
Colchicum luteum	V	V	V	V	-	-	-
Paeonia emodi	V	CT	CT	V	C	C	C
Rheum webbianum	E	E	E	-	E	E	E
Taxus wallichiana	E	CE	CE	E	E	E	E
Saussurea lappa	Ex	Ex	Ex	Ex	Ex	Ex	Ex
Atropa belladonna	E	E	E	E	V	V	V
Onosma bracteatum	E	E	E	E	E	E	E
Bergenia ciliata	C	C	V	C	C	C	C
Viola serpens	CT	CT	CT	CT	CT	CT	CT
Geranium wallichianum	V	V	E	V	V	V	V
Primula denticulata	R	R	R	R	R	R	R
Delphinium roylei	V	V	V	V	V	V	V
Bunium persicum	CT	V	V	V	-	-	-
Arnebia spp.	E	E	E	-	-	-	-
Bistorta amplexicaule	CT	CT	CT	CT	V	V	V
Thymus serphyllum	K	K	K	K	K	K	K
Hypericum perforatum	R	R	R	V	V	V	V
Polygonotum multiflorum	CT	CT	CT	CT	V	V	V
Asparagus adscendens	CT	CT	CT	CT	V	V	V
Pinus gerardiana	CE	CE	CE	-	-	-	-

Key: V=Vulnerable; E = Endangered; CE = Critically, Endangered; CT = Commercially; Threatened; C = Common; R = Rare; VR = Very Rare; I = Indeterminate; K = Insufficiently known.

Daral valley: Daral valley is located in the north-western part of Hindukush mountain ranges (Fig. 1). The valley ranges in elevation from 4600 ft at the valley bottom to over 15000 ft at the top. The communities of the valley, 15000 in number, live in ten big villages and 12 small hamlets (Anon., 2000a). It lies between 33° 19′ to 36° 46′ N latitudes and 70° 10′ to 72° 30′ E longitudes and is spread over about 39000 ha. The valley has a low monsoon influence and is surrounded by high peaks all around. This feature has profound effects on its environment. Precipitation is mostly received in the form of snow during winter and spring. Snow that ranges from 3-5m in depth normally stays up to a couple of weeks.

Vegetation and flora: The valley's vegetation is of dry temperate, sub-alpine and alpine in nature with groves of Oak (*Quercus dilatata*) and Poplar (*Populus ciliata*) (Champion *et al.,* 1965). Phyto-geographically the valley represents the flora of Euro-Siberian, and Sino-Japanese regions. The valley has about 150 species of flowering plants, out of which, about 90 plants have ethno-botanical importance. These forests have rich diversity of endemic MAPs, having high commercial value. Most of these species are included in the threatened and protected list of IUCN. Out of 150 species, 4 species are critically endangered, 7 are endangered, 6 are commercially threatened, 6 are rare, and one species *Saussurea lappa* is extinct from the valley (Table 2). The vegetation of the valley is under heavy biotic pressure with deforestation, overgrazing and terrace cultivation, as prominent features. Following are the major issues in the conservation and management of MAPs.

- Indiscriminate exploitation of MAPs for sale.
- Conversion of natural forest lands for other purposes, thereby destroying the habitats of MAPs.
- Poor harvest and plant treatment of MAPs.

Miandam valley: Miandam is located in the north east of Swat district and lies between 34° 34′ to 35° 07′ N latitudes and 72° 36′ to 73° 35′ E longitudes in the Hindu Kush mountain range (Fig. 1). The elevation of the valley ranges from 3900 ft to 12000 ft. The total area of the valley is about 36768 acres. The valley comprises of 11 big villages and 15 small hamlets with a population of about 10,000 (Anon., 2000a). The valley has some influence of monsoon while the precipitation is mainly received during winter and spring in the form of snow. Snow varies from 2 ft to 10 ft, depending on elevation.

Vegetation and flora: The valley has moist temperate environment, and varies climatically in different parts because of variation in altitude and exposure to sun. As a result thereof, the valley represents three main vegetation types: broad leaved deciduous forest; coniferous forest; sub-alpine and alpine meadows (Champion, 1965). Phyto-geographically, the valley is represented by the Sino-Japanese, and Irano-Turanian elements. The valley is home to more than 150 species of flowering plants with 120 having high ethno-botanical uses. Over and above this, 50 species have high medicinal value and are being collected from the area for commercial purposes.

Several species of MAPs are endemic to the valley and many of them i.e., 27 species are included in the various threatened categories of IUCN (Table 2).

In regards to maintain adequate cover and density of MAP species the study proposes a joint medicinal plant management approach involving the collectors, users, traders, and herbal pharmaceutical companies and resources management institutions. Furthermore, it should be integrated with the current natural resources management practices.

Nathiagali: athiagali is part of Galis Reserved Forests and lies between 34^{o} 01' to 34^{o} 3.8' N latitude and 73^{o} 22.8' to 73^{o} 27.1' E longitude (Fig. 1). The area is spread over 3,312 ha, which has 12 villages in its periphery with a population of about 50,000 people (Anon., 2000a). The altitude varies between 1,800 and 2,980m, "Miranjani" being the highest peak with an altitude of 2,980m. The valley lies within the effective reach of monsoon and receive precipitation in the form of snowfall in winter and rain fall in summer.

The valley hosts a variety of wildlife species. Rhesus Monkey, Common leopard, Yellow-throated martin, flying squirrel, Koklas and Chakur are some of the wildlife species, associated with the Himalayan Moist Temperate Forest, sub-alpine and alpine meadows.

Vegetation and flora: Ecologically, the valley is a representative of the Himalayan Moist Temperate and sub-alpine conifer forests (Champion, 1965). Phyto-geographically the valley is dominated by Irano-Turanian and Saharo-Sindian floristic element. The forests of the valley hosts 264 species, many of them are of medicinal and economic importance. Investigations have revealed that about 25 species are included in the threatened and protected list of IUCN. Heavy deforestation, free grazing, and large quantities of fuel and fodder collection are some of the factors affecting the regeneration capacity of MAPs.

Siran and Shogran valleys: The two valleys i.e., Siran and Shogran are located in the northern Himalayan mountain range (Fig. 1). Although these valleys are geographically isolated a and located far from each other thus independent from each other but since both have common flora; and similar problems and issues, these are being described as one unit. About 20,000 people, live in both the valley in 10 big villages and 12 small hamlets (Anon., 2000a). The total area of the valleys is about 35000 ha. Elevation of the sites varies from 4000 ft to 16000 ft.

Climate of both the sites is moist temperate with sufficient monsoon rains in summers and snow in winters. The entire eco-system is exposed to extreme biotic pressures; however, some of the forests, being in the protected category, is still safe from heavy degradation and is a major seed source for areas that are now devoid of major vegetation.

Vegetation and flora: The vegetation of the valleys is a combination of the moist and dry temperate coniferous types of vegetations. Oaks, open scrub, sub-alpine and alpine forests are the main vegetation types (Champion *et al.,* 1965).

Phyto-geographically the valleys have the representation of Saharo-Sindian, Sino-Japanese, Irano-Turanian and Indian elements, which are dominant in the flora of the valleys. Studies have shown that Siran has about 123 species, while Shogran hosts 117 species having high ethno botanical and medicinal importance. Several of them are endemic to each valley. Out of the reported species a total of 24 MAPs are classified as threatened in the *IUCN Red List* (Table 2).

Lack of alternative sources of fuel, fodder and energy, inappropriate and over collection of MAPs, and lack of awareness are some of the worth mentioning factors resulting in rapid degradation of these resources. Keeping in view the magnitude of the current conservation issues, the study suggests capacity building of the collectors with regards to pre and post harvest treatment of MAPs, provision of alternative sources of fuel and energy and target specific public environmental education and awareness campaign to undo the negative impacts of unsustainable practices.

Major threats to MAPs in selected IPAs: The current endeavour reported the following threat to MAPs in selected IPAs.

- Deforestation
- Overgrazing
- Over harvesting of MAPs
- Non sustainable practices

Some of the specific root causes are as under:

- Lack of education and awareness
- The need to establish MAPs gardens.
- Lack of incentives for *in-situ* and *ex-situ* conservation of MAPs,
- Lack of MAPs as a subject in schools.

Exceptional ethno botanical richness of the selected IPAs: Ethno botanical database generated by WWF and others revealed that the targeted valleys have rich diversity of floral elements, many of which have high medicinal, economic and other ethno botanical values. Investigations have revealed that certain plants are used to cure various ailments of both human and livestock since centuries. They are also used as timber, firewood, fodder, food, fruit and row materials to make handicrafts and tools in the targeted valleys. Hundreds of plants in the targeted valleys have been identified and documented.

However, the local indigenous knowledge of various uses of plants has still to be documented in many areas of Hindu Kush and Himalayas, including the targeted valleys to avoid its loss.

Studies conducted by different workers (Adnan *et al*., 2006; Sher *et al.,* 2005; Sher & Hussain, 2009; Sher *et al.,* 2004) on the ethnobotany of the targeted valleys have shown that almost 560 plants species, have one or the other uses, thus have ethno botanical importance. Out of these, about 300 species have medicinal uses, 50 are multipurpose species), 20 have timber values, 35 are used as fire wood, 10 are wild vegetable, 15 are wild fruits, 15 are used in making handicraft and tools, 10 are used to enhance viscosity of mud, 5 are used for cleaning floors, 10 are used to make fences/hedges of agricultural land, 10 to deter evils and bad spirits 5 are repellents, and 5 are used by honey bees species. In addition, 10 plants are being considered poisonous while the uses of 70 are still unknown.

It is generally concluded that the targeted valleys are traditionally rich in traditional usage of plants, and in the forest products and that, except a few species, men are more aware of plants of ethno botanical value than women. There are still some species not known for their uses.

Presence of threatened MAP species in the selected IPAs: The available information revealed that about 30 plant species, found in the selected sites, are classified as threatened and present in appendix 1 and 2 of CITES (Anon., 2011).

Most of the threatened MAP species are of commercial value in the targeted valleys and collected in quantity. This has reduced the availability of such species by about 1/3^{rd,} as compared to 20 years ago. This information is based on the fact that the collectors now have to travel 5 hrs to collect the same quantity of MAPs, *Valeriana* for example, as they used to collect in 2 hours about 20 years ago.

The authors have analyzed that there are four major forest types with in the selected sites, where MAPs are abundantly found. Each species in such forest types has a minimum optimum and maximum ecological range where it flourishes. The plants generally grow to their maximum in their optimum ranges. Within this range the plants produce the maximum percentage of active chemical ingredients. The minimum and maximum growth ranges could be affected by the population distribution as well as chemical constituents in plants.

Valeriana jatamansi, Podophyllum hexandrum, Colchicum luteum, Bistorta amplexicaule, Dioscorea deltoidea and many others are either locally extinct or rare in the foot hills and alpine pasture. However, because of their absence from two major habitats, pressures from the community is increasing on the left over habitat.

There are three types of collectors in the selected valleys: the nomads: permanent residents of the foothills: and the outsiders who come to these valleys for collection of MAPs.

Distribution of MAPs in different sites of each selected IPAs: The MAP species are found in almost all habitats throughout the selected valleys, i.e. from temperate forests to sub-alpine and alpine pastures and meadows. Most of the important MAPs are found in the coniferous zone, however, the distribution is influenced by altitude, aspect and the slope. The pattern of distribution and availability of targeted plants were found to be quite variable according to differences in harvesting intensity, grazing, habitat loss and coniferous vegetation (Sher *et al.,* 2004; Watkinson and Ormerod; 2000). These factors have adversely affected the natural regeneration and seriously reduced the availability of MAP species in particular sites of the selected valleys. As a result the indigenous plant species are becoming rare and sparse in the selected valleys. Secondly the number of endangered species is increasing steadily due to environmental degradation, and indiscriminate collection of MAP species.

Conclusion and Recommendations

Hindukush-Himalayas mountainous ranges host many endemic and endangered species of MAPs, many of them have high pharmaceutical and economic value. Indigenous knowledge behind the uses, collection and management of MAP species is fast eroding. One reason for this is the lack of awareness among the local community regarding the economic and medicinal importance of MAPs. Another factor contributing in the declination of MAPs cover and eroding of indigenous knowledge is the inadequacy of the MAPs market and lack of government support. The approach to improve or restore the ill effects of resources misuse and economic degradation should be in multiple directions, from improving the economic standard to changing the attitudes of the local people should be adopted in future. The population sizes and potential density of MAPs are fast decreasing; adequate size of *in-situ* conservation plots is urgently required for the better management of MAP species. One important lesson learned from the current study is to establish community-based companies that depend on local biodiversity and can be adopted as a strategy to provide more equitable returns to community groups and hence incentives for conserving the resource base. This type of efforts may help in better understanding of local plant resources and potential MAPs. Lack of knowledge regarding the local potential at the national level would eventually lead to the genetic erosion of MAP species and the related indigenous knowledge system. In order to ensure the management and conservation of MAP diversity, documenting of indigenous knowledge system and its constant and consisting support is essential.

Acknowledgements

We express our sincere thanks to Plant Life International for the financial support of the present study. Our special thanks also go to Dr. Alan Hamilton and Liz Radford of Plant Life International for technical support and advice. We greatly thank the local communities for their willingness to protect the site from nomadic grazing.

References

Adnan, S.M., A.A. Ashiq, L.K. Abdul and K.S. Zabta. 2006. Threats to the sustainability of ethno-medicinal uses in northern Pakistan; a case history of Miandam valley, District Swat, NWFP, Pakistan. *Lyonia*, 11(2): 91-100.

Ahmad, I., M. Hussain, M.S.A. Ahmad and M. Hameed. 2008. Spatio-temporal effects on association of plant species in soone valley of Pakistan. *Pak. J. Bot.*, 40(5): 1865-1876.

Ahmad, I., M.S.A. Ahmad, M. Hussain, M. Hameed, M.Y. Ashraf and S. Koukab. 2009. Spatio-temporal effects on species classification of medicinal plants in Soone valley of Pakistan. *Int. J. Agri. Biol.*, 11(1): 64-68.

Alam, J. and S.I. Ali. 2009. Conservation Status of *Astragalus gilgitensis* Ali (Fabaceae): A Critically Endangered Species in the Gilgit District, Pakistan. *Phyton. (Horn, Austria)*, 48(2): 211-225.

Ali, H. and M. Qaiser. 2010a. Contribution to the Red List of Pakistan: a case study of *Astragalus gahiratensis* Ali (Fabaceae-Papilionoideae). *Pak. J. Bot*., 42(3): 1523-1528.

Ali, H. and M. Qaiser. 2010b. Contribution to the Red List of Pakistan: a case study of *Gaillonia chitralensis* (Rubiaceae). *Pak. J. Bot., Special Issue* (S.I. Ali Festschrift). 42: 205-212.

Ali, H., M. Qaiser and K.B. Marwat. 2012. Contribution to the Red List of Pakistan: a case study of *Delphinium nordhagenii* (Ranunculaceae). *Pak. J. Bot*., 44(1): 27-31.

Ali, S.I. 2000. Impact of environmental degradation on biodiversity. *The Proceedings of the Pakistan Academy of Sciences*, 37: 93-97.

Ali, S.I. 2008. Significance of flora with special reference to Pakistan. *Pak. J. Bot*., 40: 967-971.

Anonymous. 2000. Biodiversity Action Plan for Pakistan: Framework for Conserving Our Natural Wealth. IUCN, Rawalpindi, Pakistan.

Anonymous. 2000a. Census Report of District Swat. Population census organization, Statistical Division Govt. Pak, Islamabad, 10-89.

Anonymous. 2000b. Market survey of medicinal plants in major cities of Pakistan. Technical report submitted to Swiss Development Cooperation. Intercooperation, Switzerland. 52-65.

Anonymous. 2001. IUCN Red List Categories and Criteria: Version 3.1 IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

Anonymous. 2002. Identifying Important Plant Areas. Plantlife International. Plantlife 21 Elizabeth Street London SW1W 9RP.

Anonymous. 2008. IUCN Revised Red Data List of Plants. Gland Switzerland. pp.44-211.

Anonymous. 2011. Checklist of CITES species (CD-ROM). CITES Secretariat, Geneva, Switzerland and UNEP-WCMC, Cambridge, United Kingdom.

Anonymous. 2011. Population Growth (Annual %). Http:// data.worldbank.org/indicator /SP.POP.GROW [accessed 16 June 2011].

Braun-Blaunquet, L. 1932. Plant Sociology: the study of plant community (Translated by G.D.F. Fuller and H.S. Cornel, 1965). McGraw Hell Book Co. Inc. New York, 439.

Champion, H.G., S.K. Seth and G.M. Khattak. 1965. Forest Types of Pakistan. Pakistan Forest Institute Peshawar, 111-144.

Dana, L.R., W. Peter, A.J. David, E.A. Kowalsk and D.L. Dilchar. 2005. Correlation of climate and plant ecology of leaf size and shape: potential priorities for the fossil record. *American Journal of Botany*, 92(7): 1141-1151.

Eberhardt, E., W.B. Dickore and G. Miehe. 2006. Vegetation of Hunza Valley: diversity, altitudinal distribution and human impact. In: Karakorum in Transition: Culture, Development and Ecology in the Hunza Valley (Ed.): H. Kreutzmann, pp. 109-122. Oxford University Press, Karachi, Pakistan.

Hameed, M., M. Ashraf, F. Al-Quriany, T. Nawaz, M.S.A. Ahmad, A. Younis A. and N. Naz 2011. Medicinal flora of the Cholistan desert - A review. *Pak. J. Bot.*, 43(SI): 39-50

Karkii, M. and J.T. Williams. 1999. Priority species of medicinal plants in South Asia. Report of an expert consultation on medicinal plant species Prioritization for South Asia: IDRC New Delhi; India: 214-265.

Larsen, H.O. and Smith L.K. 2004. Alpine medicinal plant trade and mountain livelihood strategies, Geographical Journal. 169(3): 243-254.

Palmer, M.E. 1987. A critical look at rare plant momthoring in the United States. Biological conservation, 39: 113-127.

Scakali, M.S., H. Bahadir and M. Ozturk. 2008. Eco-physiology of *Capparis spinosa* L. A Plant suitable for combating desertification *Pak. J. Bot*., 40(4): 1481-1486.

Schickhoff, U. 2006. The forest of Hunza Valley: scarce resources under threat. In: *Karakorum in Transition: Culture, Development and Ecology in the Hunza Valley*. (Ed.): H. Kreutzmann, pp. 123-144. Oxford University Press, Oxford, UK.

Shankarnarayan, K.A. 1977. Impact of overgrazing on the grassland. *Annals of Arid Zone*, 16: 349-359.

Sheikh, K., T. Ahmad and M.A. Khan. 2002. Use, exploitation and prospects for conservation: people and plant biodiversity of Naltar valley, north-western Karakorum, Pakistan. *Biodiversity and Conservation*, 11: 715-742.

Sher, H. 2011. Ethnoecological Evaluation of some medicinal and aromatic plants of Kot Malakand Agency, Pakistan. *Scientific Research and Essays*, 6(10): 2164-2173.

Sher, H. and F. Hussain. 2009. Ethnobotanical evaluation of some plant resources in Northern part of Pakistan. *African Journal of Biotechnology*, 8(17): 4066-4076.

Sher, H., M.N. Alyemeni and H. Sher. 2010. Forest Resource Utilization Assessment for economic Development of rural community, Northern parts of Pakistan. *Journal of Medicinal Plants Research*, 4(12): 1197-1208.

Sher, H., Z.D. Khan, A.U. Khan and F. Hussain. 2004. Ethnobotanical study on some plants in village Tigdari, District Swat, Pakistan. *Acta Botanica Yunnanica*, 10(5): 42-54.

Sher, H., Z.D. Khan, A.U. Khan and F. Hussain. 2005. *In-situ* conservation of some selected medicinal plants of Upper Swat, Pakistan. *Acta Botanica Yunnanica*, 27: 27-36.

Shinwari, Z.K. and M. Qaisar. 2011. Efforts on conservation and sustainable use of medicinal plants of Pakistan. *Pak. J. Bot*. (Special Issue), 43: 5-10.

Tansley, T.A. and H. Adanson. 1946. Plant Ecology. McGraw Hill Book Co. New York. 601-604.

Watkinson, A.R. and S.J. Ormerod. 2000. Grasslands, grazing and population dynamics of *Vulpia ciliata*: editors introduction. *J. Applied Ecology*, 37(6): 233-236.

(Received for publication 16 April 2012)