BOTANICAL DIVERSITY IN PAKISTAN; PAST PRESENT AND FUTURE

By:

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Abstract

What so ever beneficial or dangerous it may be; the recent war against terrorism and extremism has also become a killing threat to botanical resources of North West and South West mountains in Pakistan. Moreover, Northern Mountains have lost its natural habitat due to earthquake in 2005. Pakistan with a great diversity of flora hosts around 6000 vascular plant species due to its varied climatic and edaphic factors. Four monotypic genera of flowering plants (*Douepia, Suleimania, Spiroseris, Wendelboa*) and around 400 species (7.8%) are endemic to Pakistan. Almost 80% of Pakistan's endemic flowering plants are confined to the northern and western mountains where war against terrorism and extremism is going on. About 400 species were traded in different drug markets of the country by local people of those areas before war. It was a dire need to quantify the existing herbals and their knowledge but no explorations can be made due to war.

Today the ecological trend which was already of greatest concern in Pakistan due to continuous loss, fragmentation and degradation of natural habitats further accelerated because of the political instability and natural disaster. This is affecting without exception forests, rangelands, fresh-water and marine ecosystems. Of equal concern is the continuing decline in many native species of animals and plants. The degradation of agro-ecosystems and the accelerating loss of domestic genetic diversity are areas that need to be looked into. The status of wild plants and their traditional knowledge is closely linked with socio-economic factors in the Hindukush-Himalayas region of Pakistan, the population is dense, land resources are scarce, unemployment is high and the forests are already overused. Despite all the intangible benefits occurring from the Agro-ecosystems and ethno-botanical resources are grossly under estimated and now under accelerated threat for its contribution to the betterment of the poor people of the area and maintenance of ecological balance.

Key words: Botanical Diversity, Ecosystem, Conservation, Threats

Introduction

Owing to its peculiar geographical position, Pakistan harbors a great diversity of flora. More than 6000 vascular plant species occur in this region

(Stewart, 1972), out of which 5,600 species have been described to date in the Flora of Pakistan, representing 22 families and about 150 genera (Nasir & Ali, 1970-95). Among the lower plants, there are at least 189 pteridophytes (ferns and their allies), of which 153 are Sino-Himalayan elements and 36 Euro-Siberian. While Algae, Liverworts, Mosses, and Lichens are poorly known. About 87 genera and 3,383 species of fungi have been reported from Pakistan (Mirza & Qureshi, 1978; Shah and Beg, 2001).

In a preliminary analysis of the flora of Pakistan, it has been found that the number of species per genus is much lower than the global average, indicating a high rate of diversity at the gene level (Ali & Qaiser, 1986). The flora includes elements of six phytogeographic regions being, in order of importance, the Mediterranean, Saharo-Sindian, Euro-Siberian, Irano-Turanian, Sin-Japanese and Indian. Among the lower plants, there are at least 189 pteridophytes (ferns and their allies), of which 153 are Sino-Japanese elements and 36 Euro-Siberian. Four monotypic genera of flowering plants (*Douepia, Suleimania, Spiroseris, Wendelboa*) and around 400 species (7.8%) are endemic to Pakistan. Most endemics are Irano-Turanian and Sino-Japanese.

Almost 80% of Pakistan's endemic flowering plants are confined to the northern and western mountains (Ali & Qaiser, 1986) where war against terrorism and extremism is going on. Here, two phytogeographic provinces can be distinguished: the Balochistan Province and the Western Himalayan Province. Sino Himalayan region has been identified as a center of endemism for some species such as *Potentilla* (Shah *et.al,.* 1993). Families with more than 20 recorded endemics are Papilionaceae (57 species), Compositae (49), Umbelliferae (34), Poaceae (32) and Brassicaceae (20); 31 of the endemic belong to the genus Astragalus, the largest genus in Pakistan with about 134 species. New endemics are still to be discovered.

Materials and Methods

A comprehensive review of the relevant literature and herbaria has been conducted. It has included the subject matter as well as regional studies. Most of the areas visited just before war for observation and overview of plant diversity hotspots of all botanically important areas like Shawal, (North Waziristan), Razmak, Miran Shah, (South Waziristan), Parachinar, (Kurrum Agency), Teera, (Orakzai Agency), Bajour (Khyber Agency) near Afghanistan border, Dara Adam Khel, and Fizagut, Swat, Kalam (Malakand Agency).

Results

A number of plant explorers have visited the subcontinent since the last century. It is difficult to mention all the collectors, and their work, who have visited Pakistan and Kashmir from time to time. For example, Santapau in 1958, Burkill in 1965 and Stewart from 1972 to 1982. However a few notable workers may be mentioned here with particular reference to collections of Plant species. The first

person who introduced the plants of North India to the outside world was William Moorcroft. He was a British Veterinary doctor employed by the East India Company. He collected in Ladakh (Kashmir) from 1820-1822 and sent his collections to Dr. Wallich at Calcutta who listed them in his famous Wallich Catalogue (1828 & 1849). Next to visit was William Jacquemont, a French botanist who collected in Punjab and Kashmir. His work was published after his death by J. Cambessedes and F. Decaisne (1835-1844). Royle (1833-1840) published his classic work on the natural history of Himalayan mountains and the Flora of Kashmir. Hugh Falconer (1808-1865), a palaeontologist, visited extensive parts of Northern Pakistan and Kashmir which included Hazara, Gilgit, Neelam Valley, Burzill Pass, Skardu, Shigar and Deosai plains. His valuable collections were used by J.D. Hooker (1878) for the Flora of British India. C. B. Clarke (1832-1906) collected, in the vicinity of Srinagar, quite a good number of species, later used by Hooker (1878). Thomas Thomson (1848-1852) collected in the Ladakh range, Nubra, Baltistan, Zoji, Suru, Zanskar, Rupshu and Kishtwar. His collections are deposited at Kew. R.R. Stewart collected in Kashmir, Baltistan and Gilgit between 1911 and 1962 and compiled a catalogue of vascular plants of western Pakistan and Kashmir in 1972. Other important collectors who collected in Kashmir, Gilgit and Baltistan are J. E. Winterbottom (1803-1854), Maj Clifford (1926), Walter Koelz (1895-1933), F. Schmid (1954), O. Polunin (1960), Frank Ludlow & Sherriff (1898-1967) and Janet Maxwell (1976). The first to collect plants in the district of Chitral was Maj. Giles during the Gilgit-Chitral Expedition (1885-1886) followed by Lt. Harris (1895). J. F. Duthie (1898) published a list of the plants collected during these expeditions along with other collections by Gatacre, Hamilton and Davidson. In 1952 Wendelbo published a list of plants from Tirich Mir (Chitral) based on the collections by a Norwegian expedition. In 1958 J.D.A. Stainton with S. A. Bowes Lyon made large and important collections from Chitral. Their collections are deposited in the British Museum (Shah, 1990).

Aitchison and Bengal (1878-1880) collected in Kurram Valley (Western part of Pakistan) and Afghanistan and published a list of 1250 phanerogames in 1880 including a new species, Potentilla collettiana. Later Wolf (1908) described another new species P. Kurameasis from the area based on the collections of Aitchison and Bengal. Both these species are endemic to Kurram Valley (Shah, 1990).

The first to collect plants in Waziristan was J. L. Stewart in 1860. In 1895 Duthie's Harsukh, collected about 200 species from Waziristan. The list is in the form of a manuscript in the Record Room at Kew. Later on Blatter and Fernandes (1933-1935) published a few papers on the flora of Waziristan (Shah, 1990).

Balochistan was visited by William Griffith (1839), J.E. Stock (1822-1854) and Lace (1847-1918). Lace with Hemsley in 1891 published a list entitled "A

Sketch of the Vegetation of British Balochistan". Burkill in 1909 also published a checklist of plants of Balochistan (Shah, 1990).

The Pakistani botanists N.A. Qazalbash, Sultan Ahmed, S.I.Ali, Sultanul Abedin, Eugene Nasir, Yasin Nasir, M. A. Siddiqui, M. Qaiser and A. R. Beg are amongst the most active workers. Muqarrab Shah has also collected in Gilgit, Baltistan, Kaghan, Swat, Dir, Chitran and Balochistan (1976-1981) and later in 1987 (Shah, 1990). In the recent years, several plant specimens have been collected from Margalla Hills, Prachinar-Kurram Valley, Orakzai Agency, Kohat Valley, Neelum Valley and Muzaffarabad in Azad Kashmir, Gilgit, Deosai, Skardu in Baltistan, Kaghan, Swat, Kalam and Ziarat in Balochistan by researchers of Pakistan Museum of Natural History Islamabad (Shinwari & Shah, 2007). There are a few prominent herbaria in Pakistan housing major collections such as National Herbarium NARC (RAW), Quaid-i-Azam University Herbarium (ISL), Pakistan Museum of Natural History Herbarium (PMNH), Karachi University Herbarium (KUH) and Pakistan Forest Institute Herbarium (PFIH). The largest number of collections is in Quaid-i-Azam University Herbarium (ISL).

Four phytogeographical regions have been recognized in Pakistan, which help to explain the richness of its flora. 70% species are uniregional and about 30% of the species are bi- or pluri-regional. Among the uniregionals, the Irano-Turanian element is the most common (46%), followed by the Sino-Japanese (10%), Saharo-Sindian (9.5%) and Indian (4.5%) elements (Ali & Qaiser, 1986).

Table: 1 Valuable Medicinal and Aromatic Plants of Pakistan

Botanical Name	Local Names	Use
Abies pindrow	Paludar	Timber
Aconitum heterophyllum	Atees	Astringent, tonic
Adiantum capillus-veneris	Persoshan	Expectorant, diuretic
Aesculus indica	Bankhor	Analgesic
Androsace rotundifolia	Ratana	Analgesic
Artemisia maritime	Afsantine	Anthelmintic
Asparagus adscendens	Satawar	Demulcent, diuretic
Berberis lyceum	Sumblu	Laxative
Cedrus deodara	Diar	Timber/Irritation
Dioscorea deltoidea	Kanis	Purgative, vermifuge
Ficus carica	Anjir	Purgative
Gentiana kurroo	Nilkanth	Bitter tonic
Geranium wallichianum	Rattanjot	Tonic/ Analgesic
Grewia optiva	Dhaman	Astringent, cooling
Hypericum perforatum	Bilsinna	Antidepressant
Juniperus communis	Batheri	Emolient/Fuelwood.
Mentha arvensis	Jangli podina	Carminative,stimulant
Morus alba	Shetoot	Laxative, cooling
Nepeta erecta	Badrangboya	Cardiac tonic.
Onychium contiguum	Cockpi	Decoction for fever
Oxalis corniculata	Khatti Booti	Cooling, stomachic
Paeonia emodi	Mamekh	Tonic/Analgesic
Picea smithiana	Kachal	Timber
Pinus wallichiana	Biar, Kial	Timber/Fuel wood
Pistacia integerrima	Kakar singhi	Tonic, expectorant
Plantago ovata	Isabghol	In dysentery
Plectranthus regosus	Booi	Lice killer
Podophylum hexandrum	Bankakri	Hepatic stimulant/ purgative
Punica granatum	Anar	Astringent
Rheum emodi	Revandchini`	Stomachic, in cough
Rosa burnonii	Shingari	Tonic

Botanical Name	Local Names	Use
Saussurea costus	Kuth	In cough, asthma
Skimmia laureola	Ner	Antipyretic
Solanum nigrum	Mako	Cardiac tonic
Swertia chirata	Chirata shireen	Tonic, febrifuge
Taxus wallichiana	Barmi	Anticancerous/Fodder
Thymus serpyllum	Ban-ajwain	In fever, eye-disease
Valeriana wallichii	Mushkbala	In hysteria, as sedative
Viburnum foetens	Guch	*Blood purifier.*
Viola canescens	Banafsha	Diaphoretic, diuretic
Vitis vinifera	Munaqqa	Laxative, demulcents
Withania somnifera	Asgan	Tonic, diuretic
Ziziphus jujuba	Unab	Astringent, diarrhea.

Discussions

The ecological trend of greatest concern in Pakistan today, is the continuing loss, fragmentation and degradation of natural habitats. This is affecting without exception forests, rangelands, freshwater and marine ecosystems. Of equal concern is the continuing decline in many native species of animals and plants. Some species are already extinct, many are internationally threatened, and more still are of national concern. The degradation of agro-ecosystems and the accelerating loss of domestic genetic diversity are areas that need to be looked into.

While the loss, fragmentation and degradation of natural habitats in the territory of Pakistan has been taking place for centuries, the last few decades have seen a particularly rapid acceleration in this process. This trend is most evident in the remaining upland, scrub and mangrove forests, arid and semi-arid rangelands (including sand dune deserts), inland wetlands, the Indus Delta and coastal waters. The principal cause of deforestation is the consumption of fuel wood and timber.

Grazing and Fodder Collection

The direct cause of degradation of rangelands and forests is the rapidly increasing domestic livestock population. Between 1945 and 1986, the number of cattle almost doubled, while the number of buffaloes, sheep and goats more than tripled (GoP and IUCN 1992). Overall livestock number continues to increase at a rate of 2% per year. While much of this increase has been fed by the production of fodder within irrigated areas, persistent overgrazing has reduced

forage production in rangelands to one-third the potential – a loss of almost 50 million tons per year – and in some areas to as low as 15% of the potential (GoP and IUCN 1992). The problem is particularly acute in Balochistan.

Soil Erosion

Both wind and water erosion are caused by reduction in vegetation cover, resulting from agricultural activities and overstocking. Water erosion is not only a particular problem in the Northern Areas and the NWFP, but it also affects the agro-ecosystems of the barani lands e.g. the Potwar plateau and the Sulaiman Rodkohi (traditional water harvesting system). About 11 million hectares are affected by water erosion and the consequent washing away of soil. Water erosion results in increasing sedimentation of wetlands and resulting habitat degradation.

Over-exploitation of Plants

Pakistan is rich in medicinal plants, due to its varied climatic and edaphic factors. Of the almost 6000 species of vascular plants reported to occur in Pakistan, about 1000 species have been recognized to possess phytochemical properties. Between 350-400 species are traded in different drug markets of the country and are used by leading manufacturing units of yunani and homeopathic medicines. A number of medicinal plants and their derivatives, whose cultivation is not feasible in the country, are brought in under a liberal import policy. Besides this, about 40000-50000 Tabibs (practitioner of Greco-Arabic medicine), vaids (practitioners of Ayurvedic and folk-medicine) and a number of un-registered practitioners scattered in rural and remote hilly areas use more than 200 plants in traditional and folk-medicines.

In recent years, there has been a consistent growth in the demand for plant-based drugs and products from a variety of species. This has given rise to large scale collection and habitat degradation. It has resulted in the scarcity of a number of valuable medicinal plant species, and their wide range of chemical diversity will diminish at the present scale of extraction from natural habitats.

Introduced or Invasive Species

Introduced or alien invasive species can have a significant negative impact on biodiversity. This form of ‘bio-pollution’ has increased in recent years as globalization has meant the more rapid and widespread movement of goods from one place to another, fostering the spread of organisms in ship ballast water, in containers and evening commodities. Introduced species are responsible for many recorded species extinctions, especially on islands, and are second only to habitat loss as a global cause of extinction (Simberloff, 1995). In Lake Victoria, Africa, for example, the introduction of the Nile perch, a voracious

predator, eliminated about 200 native fish species in the largest single vertebrate extinction ever recorded (Bright, 1998).

The introduction of exotic species can also be done deliberately by natural resource managers, most often to increase commercial production in agriculture and forestry. In countries such as South Africa, Chile, Taiwan, Australia, Sweden and Finland, a majority of commercially planted tree species are introduced. This has resulted in higher production of woody biomass than would otherwise have been possible using only native tree species.

The effect of exotic species on the native fauna and flora of Pakistan has not been well documented. In attempts to meet the increasing demands of a rapidly growing human population, fast growing exotics have been introduced to alleviate shortages in timber, fodder and fuel wood. Prominent tree species include Eucalyptus, hybrid poplar and Paulownia planted on farmlands and irrigated plantations. While these species do not appear to have threatened indigenous vegetation so far, the introduction of Robinia, Ailanthus and eucalyptus in the sub-tropical chir pine zone may pose threats to natural habitats in the future.

Many primitive landraces/cultivars and wild relatives of agricultural crops (such as wheat, rice, pulses, sugarcane and cotton) have suffered from genetic erosion from the introduction of HYVs of these crops, habitat degradation and the excessive use of pesticides and herbicides. As the genetic traits of local species are lost, the ability to adapt to local environments and climates and to tolerate diseases is greatly reduced.

Extreme care is required in the selection of species to be introduced to minimize impacts on native species. Introductions should be considered only if absolutely necessary and should be accompanied by strategies to assess the magnitude of any threats to indigenous species. In practical, indigenous flora and fauna should be restored to reduce native biodiversity loss.

Forests and Their Status in Pakistan

Of the 88 million hectares of Pakistan's land area, 10.4 million hectares are under the government forest departments. This includes 6.1 million hectares of rangeland, which does not contribute towards production of wood. The actual areas under forest are therefore, only 4.3 million hectares. The area of production forest is no more than 1.3 million hectares while 3.0 million hectares are protected forests. The private forests in the northern Pakistan constitute about 1.5 million hectares and situated in critical watershed areas. In spite of the fact that the forest area is highly inadequate, both forests and rangelands are not intensely managed and have low productivity. The coniferous and scrub forests constitute bulk i.e. 76% of the total forest area in the northern Himalayan-

Karakorum-Hindukush regions, which are suitable for tree growth due to climate and topography. These forests are under pressure of tree cutting for fuel wood and timber by people living in their vicinity as well as for grazing by their cattle and have therefore, depleted over the years. Further, about 20% of total watershed area is covered by those forests which produce water for domestic supply, ground water recharge, on site farming, natural vegetation growth and for generation of electricity and irrigation of farmlands in the plains. The importance of watershed is very high in Pakistan because more than 70% of the total area is arid.

Significant forest extension has not occurred in Pakistan in more than four decades in spite of best intentions and efforts on the part of provincial/regional forest departments. This is mainly due to low priority given to forestry sector in the national economic development in the past. This situation has further aggravated due to decline in the ratio between plan provisions and actual releases. Although, in monetary terms, the funds released have increased, but when one considers the gradual increase in forest are due to extension of scientific forest management to the former privately run states of Dir, Swat, Chitral and Amb in NWFP in late sixties, the escalation in labour cost, inflation etc., there has been a gradual decline in monetary resource per unit area. Consequently development efforts to improve forestry situation have been meager, scattered and patchy throughout the country during the last 40 years.

However, there are some noteworthy exceptions to above situation. Most of the productive forests and plantations are managed through management plans prepared by locally trained manpower. Pilot programmes of intensification of management of natural coniferous forests, rehabilitation of watersheds, irrigated plantations and riverain forests have been started with the assistance of international donor agencies. Promotion of tree growth on the farmlands has been successfully carried out in some localities in all provinces/regions through farm forestry programmes. This has gone a long way in meeting timber and fuel wood requirements of large sections of increasing population. General public is more aware of importance of forests now than it was in the past. Non-governmental organizations (NGO's) have taken up the cause of forestry for environmental stability and control of pollution in the country and are promoting and participating in tree planting activities (Siddiqui, 1993).

Aforestation

The economic importance of forests and plantations has gained attention in the recent past. Their social and environmental benefits are also being highlighted alongwith their role in sustainable development. Present forestry development planning is based on the National Forest Policy, the National Conservation Strategy and the proposed Forestry Sector Master Plan. One of the

main objectives of National Forest Policy, announced in May, 1991, is to increase forest areas from the existing 5% to 10% in the next 15 years. On this basis 4.5 million ha of additional area will be brought under tree cover by the year 2005. It would, therefore, be necessary to carry out aforestation and reforestation on public and private lands and by raising linear and block plantation on farmland over 0.3 to 6.35 million hectares (ha) per annum or on 1.8 million ha during the currency of Eighth Plan. This is approximately 10 times the current planting targets and would require financial outlays in the same proportion to meet the targets during Eighth Plan.

Similarly, the National Conservation Strategy has also stressed the conservation of natural resources, sustainable development and improved efficiency in the use and management of resources and proposed a number of goals. The Forestry Sector Master Plan has been prepared within the framework of both National Forest Policy and National Conservation Strategy. In the meantime, Planning Commission of Pakistan has also prepared a policy framework in the form of an Approach Paper for Eighth Plan. It provides guidelines for development planning in different sectors including forestry in the country during the plan period.

The Environment and Urban Affairs Division, the unit that is the parent department of environmental activity in the government sector is working on a massive tree planting campaign, with a target of 90 million trees to be planted in each planting season. The Environmental Protection Council proposed planting of 120 million trees in a single season but the big question was whether this was really feasible. To date, the forest department's annual tree planting drive has not been a resounding success. Trees are planted with great funfair, but their survival rate is low. The second major question was the availability of such large numbers of saplings. Therefore, after a long debate the campaign's target was revised down to 90 million in a season. The federal government has agreed to increase the amount it normally provides, while the government of Japan has agreed to give a grant to fund the remaining amount.

The next problem was that land tracts were given by the forest department (which will continue to own the property) to state corporations for block plantation. These corporations are entitled to harvest tree products provided they maintain cover. Planting along avenues, roads and roundabouts – the responsibility of municipalities who have been unable to maintain them due to paucity of funds – has been given over to corporate sponsors to plant on and maintain. Under the technical and monitoring component, graduates of agricultural universities are contracted to assist in the planning, planting and after care of trees. In addition, the general public is being involved, by encouraging students and senior citizens to take part, providing them saplings free of cost.

Encouragement is to be given through awards, medals, scholarships, certificates and even trips abroad (Zaidi, 1995).

Species Richness and Endemism

Species richness is only one measure of biodiversity but the use of this parameter to assess biodiversity is limited by the fact that many species, particularly insects, fungi and micro-organisms, remain to be identified. Little work has yet been done to evaluate other measures of biodiversity in Pakistan, including taxonomic and functional diversity, and the amount of genetic variability within species and their subdivided populations.

Because Pakistan is largely bounded by man-made borders and does not comprise an isolated entity in biogeographic terms, relatively few species are found only in this country. Thus Pakistan has relatively low rates of endemism for some species – about 7% for flowering plants and reptiles, and 3% for mammals – but higher for freshwater fish, i.e. 15%. However, the proportion of 'restricted range' species occurring in Pakistan is much higher, and for many of these species, Pakistan contains the bulk of the global population. Endemism is a relative and subjective term because political frontiers are not generally regarded as absolute criteria for endemic taxa since the particular species may spread to the adjoining countries whilst remaining restricted to a particular geographical region. So far only 7% endemic species have been reported from Pakistan. Centers of diversity of some of the alpine genera are in the Himalayan region. Four monotypic genera and around 400 species (7.8%) are endemic to Pakistan. Most endemics are Sino-Himalayan and Irano-Turanian. Almost 80% of Pakistan's endemic flowering plants are confined to the northern and western mountains. The Kashmir Himalayas in particular has been identified as a global center of plant diversity and endemism.

Species of National Concern

Lists of internationally threatened species are only the tip of the iceberg. While there is little data available to demonstrate the decline of species' population in Pakistan, the accelerating loss and fragmentation of natural habitats clearly implies such a decline is occurring. Habitat fragmentation isolates population, exposing species to a higher rate of genetic loss and to a greater risk of extinction. While a few preliminary attempts have been made to draw up national lists of threatened species, including a list of some 500 plant species believed to be nationally rare or threatened (Davis *et al.*, 1986), no comprehensive and systematic list of species of national concern has been compiled for Pakistan. Such a list would include species which are nationally rare and declining; those which are nationally rare, not declining, but otherwise at risk e.g. from population fluctuations, natural catastrophes, persecution, etc. those

which are highly localized in distribution and those which are still widespread and common but suffering significant decline.

Critically Threatened Ecosystems

In Pakistan, given the widespread historic conversion of natural ecosystems to agriculture, the already highly advanced and rapidly accelerating degradation of habitats, and the continuing depletion of populations, almost all remaining natural or modified ecosystems are now critically threatened.

To date, no systematic and comprehensive assessment with the aim of objectively ranking the biodiversity importance of Pakistan's natural ecosystems have been made. However, based on various reports (Mallon, 1991) and the opinions of recognized authorities, at least 10 ecosystems of particular value for their species richness and/or unique communities of flora and fauna are threatened with habitat loss and degradation. Given their biodiversity importance and the high level of threat, these ecosystems are considered to be of critical concern for conservation.

Activities Causing Habitat Loss

Habitat loss is the principal cause of the present high rate of global extinctions and poses a severe threat in all biomes (UNEP, 1995). There is no 'safe' level of habitat loss which would reduce the risk of extinction of some species; no network of carefully selected reserves that would suffice to protect all species.

Changes in habitat quality, while less extreme than habitat loss would still affect plant and animal populations. For many species, the consequences of even subtle changes in habitat quality can be confidently predicted from existing knowledge of their habitat requirements. Habitat fragmentation increases the risk of extinction by isolating small pockets of previously more connected populations. Small, isolated populations are more vulnerable to the loss of genetic variability and run a greater risk of extinction.

The principal cause of deforestation is the consumption of fuel wood and timber. This consumption has already been detailed in relation to trends in forest loss, fragmentation, and degradation.

Both wind and water erosion are exacerbated by a reduction in vegetation cover, resulting from agricultural activities and overstocking. Water erosion is not only a particular problem in the Northern Areas and the NWFP, but it also affects the agro-ecosystems of the barani lands e.g. the Potwar plateau and the Sulaiman Rodkohi (traditional water harvesting system). About 11 million hectares are affected by water erosion and the consequent washing away of soil. Water erosion results in increasing sedimentation of wetlands and resulting habitat degradation.

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A variety of habitats exist in the mountainous areas within very short distances. We find woodland and open sunny habitats, steep cliffs and disturbed habitats, rock slopes, steppes and alpine meadows etc. The plants differ in their ecological preference even when occurring within the same general area.

Botanical diversity Conservation

Conservationists have traditionally viewed on-site and off-site conservation as two very different and alternative approaches. In situ (on-site) conservation involves nature reserves, national parks and other protected areas. Ex situ (off-site) conservation has traditionally been the task of botanic gardens and arboreta – collections of living plants and gene-banks which usually conserve packaged seeds in long-term storage, but sometimes also tissue cultures or even DNA libraries. Most conservationists agree that in situ conservation is preferable as far as it is possible. We need to preserve habitats with their whole diversity of organisms. We must manage habitats, and then plant species will manage themselves very well. Roughly speaking, this is probably true in many cases. The preservation of diversity and quality of habitats appears to be the simplest and most efficient way to preserve species, especially if we consider not just flowering plants, but also cryptogams or non-flowering plants.

However, we have learned to our cost that we will fail to preserve particular species if we manage habitats without a special care to those species, and that some endangered species may need special tools for them to be preserved. In these cases, ex situ conservation can be very useful, and may even be the only efficient way to save species. But it is a tool, not a goal in itself.

Habitat loss is a single largest contributing factor. Overpopulation, urbanization and excessive land use has depleted the forests, the habitats and thereof the local flora. Habitat protection is the key. A plant grown in the gardens does not meet the conservation goal fully. It may have partial success but the long term goals can not be achieved.

Public support is essential. Every resident and visitor can help conserve our dwindling native plant habitats. Citizen involvement often swings the pendulum of decision making towards the conservation solution. Improved government efforts for plant conservation are dependent on active role of private citizens and volunteers. This is the primary reason why many conservation actions are so successful in Europe, Australia and America. Success in

conserving native plants will depend on our collective creativity and conviction for the conservation of habitats and rich botanical heritage.

The establishment of new populations of rare and endangered plants within their historical range is necessary. Plant reintroduction has become an increasingly common strategy for helping species recover from the brink of extinction. In general, larger populations have a greater chance of persisting per time than small populations and species with many populations are less likely to extinct than those with one or few populations. One simple assumption could be that after introduction the species will grow straight away but it may not be able to grow due to various factors like changing water table, plant microbe interaction, allelopathy, successional changes etc. Unless these factors are identified and dealt with, reintroduction is not going to work. A reintroduction can be considered truly successful only when a population is expanding in numbers and area, when individuals are flowering and fruiting, when a second and third generation of plants is appearing on their own and the population gives every indication that it will persist in to future decades. The key question is how to achieve this goal of a successfully expanding new population? What is the best way to carry out a reintroduction programme? Is it better to start an experimental population using seeds, seedlings or adults? Or is it better to use one intensively managed site or many sites? To address these and other issues, a comprehensive research programme should be initiated on life history of plant to be introduced, its dispersal and pollination mechanisms, its breeding system, microbe interaction, allelopathy etc.

Nature's gift of seed dormancy makes it possible to maintain genetically representative samples of endangered plant populations in 'suspended animation' for long periods. Storing seeds is a relatively inexpensive conservation measure, and takes so little space that millions of seeds can be stored in a small freezer. Anyone can set up a seed bank, even at home.

This seeming simplicity, however, masks some important concerns and scientific questions. (The science behind seed banking is still emerging, not always with complete agreement amongst experts). Also, saving seeds has its hidden dangers. Storing seed can create a false sense of security, leading some people to conclude that they have "saved" a species. Finally, the stored seed sample may turn out to be inadequate for the intended purpose.

Despite these and other cautions, we believe that seed banking, done correctly, has a central role in plant conservation. However, it should never be the only action taken to conserve a plant species. Rather, seed banking is one component of the comprehensive approach of integrated conservation strategies, which are rooted in conserving habitat but use all available means to conserve a

species. Seed banks are also good sources of plant material for research, when taking seeds from the wild is difficult or undesirable.

Threatened Species

Pakistan has attempted to protect its biological resources for posterity as well as for more immediate functional benefits. First, Federal and Provincial authorities have made significant attempts to protect biodiversity and natural capital. A network of national parks, wildlife sanctuaries and game reserves has been established which cover about nine million hectares. Secondly, Pakistan is a signatory to virtually all the important international agreements such as the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), The Convention on Wetlands of International Importance (RAMSAR), the World Heritage Convention and the Convention on the Conservation of Migratory species of Wild Animals. In addition Pakistan is a member of International Union for Conservation of Nature (IUCN) and International Waterfowl and Wetland Research Bureau (IWRB). These and other measures, including conservation education programmes and initiatives, the activities of non-government organizations, legal instruments and research and management activities have given several previously endangered species of animals (like Indus dolphin, marine turtle, the Sind Ibex, Markhor, one horned Rhino, Cheer pheasant etc.) a new lease of life.

So far as plant species are concerned very little has been done to protect some of really threatened species. There are few reports available which have indicated the conservation status of some plant species. Chaudhri & Qureshi, 1987 have reported 709 species of plants (about 4% of the total flora) as threatened. These studies are primarily based on the herbarium material only. Oldfield *et al* (1998) reported only two endangered trees from Pakistan.

These reports contain merely preliminary data and have no categorization based on the criteria laid down by IUCN i.e. Extinct (Ex), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Lower Risk (LR), Data Deficient (DD) and Not Evaluated (NE). In fact, earlier works of listing threatened species of plants is either fragmentary or out dated and lying with different agencies which need to be re-evaluated and updated. The use of these earlier lists as a conservation tool is limited by the fact that the status of many species remains unclear, particularly of threatened species. It is therefore, very important to have a comprehensive survey of the important vegetation zones particularly of national parks, to evaluate the conservation status of different endangered species. It is important to prepare National Red Data lists of threatened plant species based on recent IUCN categories.

Paeonea emodi (Mamekh) used to be fairly common but now is rare. If this valuable medicinal plant is reintroduced, it would be having greater chances

of survival. Same is true for maple species. *Taxus wallichiana* (Burmi) is found only in some undisturbed locations mixed with fir, spruce and blue pine. This endangered tree is valued for the extraction of cancer drug "Taxol" from its bark. This tree must be protected.

Potentilla sericophylla has been seen only in a patch. This species is critically endangered and must be protected. *Morchella esculenta* (a mushroom locally known as Guchi) is valued for its very high price. It grows on forest floors rich in humus. This mushroom is being dug indiscriminately by locals and is threatened with extinction. Efforts should be made to protect this valuable species for sustainable use.

Economic value of Medicinal Plants

Medicinal plants have a rich resource base, which is spread over a wide range of ecological zones of Pakistan. About 2000 medicinal plants species (including higher and lower plants) are known from Pakistan (Table I). Over the years medicinal plants are being utilized unsustainably by locals. In some areas the forest department auctions the collections of limited quantity of herbs to the highest bidder, with the result that the medicinal plants are collected indiscriminately (mostly rooted out) leaving little room for their regeneration. Similarly biochemists/pharmacologists/ pharmaceutical companies use tones of medicinal plants to get a few grams of alkaloids. This has resulted in the depletion of medicinal plants in those areas where they used to be abundant. The examples of *Dioscorea, Podophyllum, Paeonia,* and *Saussurea* may be cited in this connection. Infact, there is no clearly definable medicinal plant sector formulating policies that regulate the trade practices, the promotion of innovative conservation measures and the sustainable utilization of medicinal plants.

The great majority of the plants used in medicines, especially in developing countries are still collected from the wild. The demand is increasing, the habitats are declining, and so inevitably many plants are coming under threat. On the basis of evidence from studies such as those in North Africa and India and those of IUCN Medicinal Plant Specialist Group, it is reasonable to predict that 1000 or more plant species used in medicines today are threatened.

Conservationists and health experts agree that the remedy is to cultivate the plants rather than gather from the wild. Cultivation removes pressure from wild habitats. It also has health benefits, as it enables a higher degree of standardization. It makes it easier to avoid mistakes in identification and to combat adulteration. Plant conservationists should join and help create programmes on conservation and supply of medicinal plants, with emphasis on encouraging cultivation and processing. To prevent medicinal plants from becoming extinct, conservationists will have to embrace this agenda of encouraging cultivation as a form of rural development.

This aspect is also important because local consumers, industries and exporters are crazy for more herbal ingredients and such demand is likely to soar while supplies of raw material from wild sources of medicinal plants are rapidly shrinking.

In some cases, conservationists have no choice but to devise sustainable harvesting/cultivation techniques for wild and semi wild populations of medicinal plants. Difficult though it is, relying on medicinal plants from nature does have one great advantage for conservation it focuses attention back on to wild habitats and how they can be used sustainably for various purposes. The conservation of wild habitats is more immediately relevant if those habitats provide a regular supply of medicinal plants than if seeds of the plants were collected years ago and the plants are now entirely cultivated.

A World Bank report includes a study of medicinal plant use in China and India, claimed to be the best examples of where government policies integrate the use of medicinal plants into health care. In both countries the traditional medicine is still the dominant form of health care.

Precious Mushroom; *Morchella esculenta* (Local name: "Guchi" Vernacular Name: Morel)

The black mushrooms, or morels of commerce, belong to genus *Morchella,* of the class Ascomycetes, and comprising of about a dozen species, of which *M. exculenta*, *M. conica* and *M. angusticipt* are of considerable economic importance. The morels grow naturally in temperate forests of Pakistan, India, Afghanistan, China, Nepal, Bhutan, USA, and a number of European countries. Total world production is estimated at 150 tons. Pakistan and India are the main producing countries, each producing about 50 tons of dry morels (equivalent to 500 tons of fresh morels), all of which is exported. Pakistan earns US$ 5-6 million each year from export of morels.

Collection processing trade and export of morels started some 35 years ago and is now an established and stable business, both in terms of volume and value. Mingora has emerged as main trade center for whole of the country. The market is quite competitive and it is remarkable that the price differential from the collectors to the end consumers abroad is not more than three-fold.

Need for Ethno-botanical Surveys

Apart from conservation practices of plants, ethno botanical surveys are also necessary. Unfortunately not a single regional population has been subjected to a complete ethno botanical analysis and the need to do so become more apparent with each passing day. Conservationists often talk about the problems of disappearing species but the knowledge how to use these species is disappearing more rapidly than the species themselves. When we struggle to

conserve our valuable species, the knowledge about the peoples who best understand these species, is dying out and the new generation unfortunately, is not interested in these valuable herbs.

Conclusions

The status of wild plants, especially forests is closely linked with socio economic factors. In the Hindukush-Karakorum-Himalayas (H.K.H) region of Pakistan, the population is dense, land resources are scarce, unemployment is high and the forests are overused. Despite all the intangible benefits occurring from the forests, this resource is grossly under estimated for its contribution to the farming system, production of livestock, soil conservation, and regulated flow of water for downstream agricultural productivity, outdoor recreation and maintenance of ecological balance far exceeds the direct economic benefits realized from the sale of timber and other wood products.

Focus on the following points is need of the time as a future vision for plant resources of Pakistan.

- Studies on status and distribution pattern of various species with particular reference to the status of threatened species in Pakistan.
- Ethnobotanical Study of Pakistan with particular reference to local communities
- Studies on Fuel wood and Fodder species consumption
- Specific study of economically and medicinally important species e.g., *Taxus wallichiana*
- Chemical Analysis of Medicinal flora of the country
- Artificial propagation and conservation of edible Mushrooms specially *Morchella esculenta* (*Guchi)*.
- Studies on habitat types of Pakistan

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