Chapter 18
Interdependence of Biodiversity, Applied Ethnobotany, and Conservation in Higher Ecosystems of Northern Pakistan Under Fast Climatic Changes

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18.1 Introduction to Northern Pakistan

18.1.1 Biogeography of the Area

The northern Pakistan covers Gilgit–Baltistan, Azad Jammu and Kashmir, the upper region of Khyber Pakhtunkhwa, including Chitral, and some parts of the central and northern regions of Pakistan. The Himalayas, the Karakorum, and the Hindu Kush are famous mountain ranges and are one of the largest mountainous regions of the world which extends over an area of 132,700 km^2 and lies between 34°0′ to 36° 50′ N and 71° 12′–75° 0′ E (Hashmi and Shafiullah 2003) which give rise to a unique blend of habitats and biological communities (Sheikh 2000). The convergence of these magnificent ranges, at the confluence of Indus and Gilgit Rivers, creates a unique geographical feature on earth. The Karakoram Range covers the borders between Pakistan, India, and China, in the regions of Gilgit–Baltistan (Pakistan), Ladakh (India), and Xinjiang region (China). The range is about 500 km (311 mile) in length. The Himalayan range occupies, in Pakistan, the regions of Kashmir, Kaghan, Kohistan, Deosai, and Chilas. The Hindu Kush rises Southwest of Pamirs. Its third region lies in Pakistan and extends into Swat and Kohistan areas. On the East, it is separated from Karakoram by the mighty Indus River. Pakistan's forth major mountain range, the Suleiman range, emerges in the southwestern region of the country, mostly covering Baluchistan Province.

The greater Himalayan range runs west to east, from the Indus River valley in northern Pakistan to the Brahmaputra River valley in northern India and Tibet, forming an arc 2400 km long, which varies in width from 400 km in northern Pakistan to 150 km in the eastern Tibet. The Himalayas are bordered on the Northwest

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by the Karakoram and Hindu Kush ranges, on the north by the Tibetan Plateau, and on the south by the Indo-Gangetic Plain. The western Himalaya is dominated by Deosai plains situated at the average height of about 4114 m and covering an area more than 3000 km^2. This is so well known for its rich flora and fauna including summer flowers and endangered wildlife species. The three mountain ranges collectively contain about 25,000 species (about 10 % of world plant species), out of which around 10,000 are economically or medicinally useful (Pei 1992). Mountainous regions present a naturally conducive environment for the growth of medicinal plants. In the Himalayan ranges, at least 70 % of the medicinal plants and animals in the region consist of wild species, 70–80 % of the population depend on traditional medicines in health care (Pie and Manadhar 1987).

18.1.2 Geo-climate of Area

The mountaintops have arctic climate, while the valleys experience mild summer and cool winter (Khan 1995). The temperature in valleys ranges from extremes of almost 40 °C in summer to less than −10 °C in winter (Perkin 2003). The average rainfall is 1300 mm representing a subtropical-highland-type climate (Hamdani and Shah 2005). The flora and fauna of these ranges vary with climate, rainfall, altitude, and soils. Topography is rugged in the hills and foothills; however, in the plains it is regularly uniform. The valleys and foothills have been greatly dissected into depths and ridges because of water erosion over the time.

18.1.3 Floral Diversity

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 5600 species have been described to date in the flora of Pakistan, representing 22 families and about 150 genera (Nasir and 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. However, algae, liverworts, mosses, and lichens are poorly known. About 87 genera and 3383 species of fungi have been reported from Pakistan (Mirza and Qureshi 1978). About 80 % of endemic flowering plants are confined to the northern and western mountains of Pakistan. Families with more than 20 recorded endemics are Leguminoseae (57), Asteraceae (50), Apiaceae (34), Poaceae (32), and Brassicaceae (21). The genus *Astragalus* contains 37, the largest number of endemics (Ali 1978; Ali and Qaiser 1986).

18.1.4 Wildlife Biodiversity

The northern areas harbor many species of wildlife due to great floral diversity and variety of habitats. Kashmir grey langur, black bear, brown bear, common leopard, leopard cat, Himalayan ibex, markhor, and gray goral are some of the rare and threatened mammals found in the valleys. rhesus monkey, red fox, jackal, stone marten, yellow-throated marten, small Kashmir squirrel, giant red flying squirrel, Royle'spika, and Indian crested porcupine are commonly found in the valleys (Saddozai 1986).

18.1.5 Major Vegetation Biomes/Ecosystems

Most of the natural forest resources of Pakistan are concentrated in the mountainous regions of the north-covering Himalaya, Hindu Kush and Karakoram ranges, where more than 60% of the country's natural forest resources are found. The rest of the forestry resource is distributed among the southwestern mountains of Baluchistan, plains of Punjab and Sindh, and the coastal areas of Arabian Sea in the south. Ecologically, nine broad forest types are found in Pakistan (Champion et al. 1965).

1. *Alpine tundra*
   This biome is predicted in humid areas that have abundant precipitation to support tree growth. It covers fairly flat ground at an altitude of more than 3660 m, which is covered by snow for 5–6 m in a year. Naturally occurring grasses in these alpine pastures or meadows are *Festuca, Poa, Lolium, Eragrostis, Danthonia,* and *Phleum,* as well as many forbes, such as *Primula, Aremons, Fritillaria,* and *Gentiana*sp. The grasses and forbes are highly nutritious and are extensively and heavily grazed during summer months by herds of goats, sheep, and horses and are thus being degraded at a fast rate. Wooded tundra also has subalpine mixed forests of *Salix, Lonicera, Berberis, Conoteaster, Juniperus, Rhododendron,* and *Ephedra*.
2. *Cold conifer/mixed woodland*
   This biome contains both the boreal conifer forest/woodland and the boreal deciduous forest/woodland biomes of Prentice et al. (1992) that are dominated by cool temperate conifers *Abiesspectablis, Pinuswallichiana,* and *Juniperusrecurva,* and evergreen broad-leaved trees *Betulautilis, Salix, Vibernum,* and *Rhododendronanthopogon* sporadic single trees, in groups, or in irregular dense stands. They have a humid maritime climate with winter temperature of −2 to –15 °C or even colder (> −60 °C) with too little precipitation.
3. *Cold conifer/mixed forest*
   This biome also corresponds to the subalpine forest type and consists of dense forests with species composition, characteristics, and occurrence which are the

same as for the cold conifer/mixed woodland biome. The trees have a moderate rate of growth in this biome.

4. *Temperate conifer/mixed forest*
   These are extensive coniferous forests that are similar to north temperate forests in Europe and North America, having commonly, more or less, pure crops of two species, and the mixtures of blue pine *Pinuswallichiana* and Deodar *Cedrusdeodara*. Winter temperatures are > −4 °C within an altitudnal range of 1800–3660 m on moderate-to-steep slopes. Other species are fir *Abiesspectabilis,* spruce *Piceasmithiana, Pinusgeradiana, Juniperusexcelsa, Quercusdilatata, Q. semicarpifolia, Populusciliata,* and *Aesculusindica*. The wood of all species is highly valued as timber. In addition, medicinal plants, mushrooms, and fodder are collected in the forests.
5. *Warm conifer/mixed forest*
   This biome is dominated mostly by warm temperature evergreen conifer trees of chir pine *Pinusroxburghii* in regions with mean coldest month temperatures of 5–15 °C and with rainfall sufficient to meet more than 65 % of the moisture requirement between 1000 and 1800 m elevation.
6. *Xerophytic wood/scrub*
   These are low forests of branchy, thorny, evergreen trees, and shrubs. Their major climatic descriptor is a long dry season tempered in more northerly parts by winter and spring precipitation and to the south by a summer monsoon of variable incidence. The dominant species are *Oleaferugiea, Acacia modesta,* and *Dedonaeaviscosa*.
7. *Grassland/arid woodland*
   This biome consists of tropical plains and has *Prosopis cineraria, Salvadora oleoides, Acacia senegal, Calligonum polygonoides, Zizyphus mauritiana*, and *Tamarix troupe* along with a number of grasses, such as *Eulaliopsis binata, Themedia anathera, Cenchrus celliaris,* and so forth.
8. *Steppe/arid shrubland*
   This biome is somewhat similar to the xerophytic wood/scrub biome. *Olea ferugniea, Pistacia* spp., *Fraxinus xanthoxyloides, Dephne mucronata, Astragalus stockii, Helliotropium* sp., and *Artemisia* spp. are found in it.
9. *Deserts*
   This is the largest type and covers most of the Indus plain, including the major deserts of Thar, Thal, and Cholistan; in total, over 11 million hectares in Pakistan. Rainfall is less than 500 mm. These deserts have been converted into agricultural land and 103,000-ha tree plantations wherever irrigation water is available. Riverine forests receiving floodwater cover 173,000 ha, and mangroves along the sea coast cover 207,000 ha. The rest of the area is used for grazing. Scattered trees and shrubs are found in it. It is similar in plant composition to the grassland/arid woodland biome.

18.2 Ethnobotanical Exploration in Northern Pakistan

18.2.1 Linkage of Traditional Knowledge with Conservation

Indigenous people and local communities in this region have since long resisted the use of art and crafts, traditional symbols, and designs; the use or modification of traditional songs; the patenting of traditional uses of medicinal plants; and the copyrighting and distribution of traditional stories. Certain communities have also sought to ensure that their traditional knowledge (TK) is used equitably—according to restrictions set by their traditions, or requiring benefit sharing for its use. In the recent years, the role of indigenous knowledge in a range of sectors is being talked about. It includes intercropping techniques, pest control, crop diversity, and seed varieties in agriculture; plant varieties and fish breeding techniques in biology; traditional medicine in human healthcare; soil conservation, irrigation, and water conservation in natural resource management; and oral traditions and local languages in education. The realization of indigenous knowledge contribution to these sectors has led to an increasing interest in it by academicians, and policymakers alike. Many government and nongovernmental organizations, as well as international organizations such as the World Bank, International Labor Office, United Nations Educational, Scientific and Cultural Organization (UNESCO), and Food and Agricultural Organization (FAO) are now appreciating the role indigenous knowledge can play in achieving sustainable development in a country. This interest is also apparent in the policies and programs of various countries.

18.2.2 Loss of TK in Northern Pakistan

In the Himalayan region, medicinal plants are used extensively for a very long time. In a recent survey conducted by World Health Organization (WHO), traditional healers treat 65% patients in Sri Lanka, 60% in Indonesia, 75% in Nepal, 85% in Myanmar, 80% in India, and 90% in Bangladesh. Pakistan has 60% of its population, especially in villages, that receive their health care from traditional practitioners (Haq and Hussain 1995). In early 1950, up to 84% of Pakistani population was dependent on traditional medicines for all or most of their medicinal use (Hocking 1958). In Pakistan, knowledge of medicinal plants is rapidly disappearing. Every year, the sum total of human knowledge about the types, distribution, ecology, methods of management, and methods of extracting the useful properties of medicinal plants is declining rapidly—a continuation of a process of loss of local cultural diversity that has been underway for hundreds of years. There has, of course, been a great growth in scientific information about medicinal plants in recent decades, but in many ways this has proved poor compensation, because such

information is accessible, in practice, only to a very few people and, anyway, rather little of it is relevant to problems of management and utilization, as encountered in the field. Among those liable to suffer most from loss of indigenous knowledge are those who live in harsh places, such as mountain ranges, and who have high degrees of dependency on their local natural environments. The cultures and economies of such people must be closely adapted to the intricacies of their local environments, if they are to prosper. Knowledge of the natural world is typically a very important part of the knowledge of rural people following more traditional lifeways. Further, medicinal plants tend to figure prominently in these galaxies. It is, therefore, not surprising that the revitalization of traditional systems of medicine can be high on the agendas of those promoting local and indigenous cultures, a political trend in many parts of the world.

18.2.3 Threats to Traditional Knowledge

Traditional and folklore medicine are commonly used from generation to generation in domestic recipes and community practices. Developed countries are also turning to the use of herbal drugs and remedies. Mostly, the elder women are keeping this knowledge which is a rich heritage in the combined family system of northern Pakistan. This knowledge is going to diminish day by day with the deterioration of cultural norms. The way elders transmit TK to their younger is not always assured. It is high time to document this source of knowledge for future generations. Although some indigenous knowledge is lost naturally as practices get modified or are left unused for long time periods, the current rate of loss can be attributed to modernization and cultural homogenization, the current educational systems that believe macro-level problems can only be addressed through the global knowledge pool, and the slow growth of institutions supporting grassroots innovations. With rapid population growth, in-migration, and government relocation schemes (in the case of large development projects), standards of living is often deteriorated. As poverty augments, short-term economic gains are chosen over environmental-friendly local practices. The introduction of monocropping patterns in agriculture and forestry results in a loss in biodiversity, thus leading to a decline in indigenous knowledge. Deforestation leads to the disappearance of several precious, yet unknown, medicinal plants, and, as a result, the knowledge associated with those plants also declines. A lot of TK is also being lost because of the communication gap, since neither children nor adults spend as much time in their communities. Because indigenous knowledge is generally transmitted orally, it is susceptible to change, particularly when people move to new regions, or when people's lifestyles tend to be different from that of their ancestors.

International attention has shifted to intellectual property laws to preserve and promote TK in the past years. The Convention on Biological Diversity of 1992 acknowledged the contribution TK can make in protecting species, ecosystems, and

landscapes, and, therefore, included laws pertaining to its access and use. Experience has proved that developmental activities that tend to ignore local technologies; local knowledge systems, and those which fail to formulate policies without a concern for local environment generally fail to achieve the desired outcomes. Although the TK of the Indigenous Peoples has been found to be very useful and effective, it has still been neglected by the world. There are many threats like environment, urbanization, globalization, climate change, global warming, etc. Pakistan has a very rich history of plants use in the rural areas where 80 % of the population lives. More than 95 % of the rural people of northern Pakistan depend upon folk medicine for their primary health care. The reason for this frequent use of traditional medicines is strong association of people with the local flora and the TK regarding plant use, economic and easy availability of the medicinal plants, poor access to allopathic drugs, and lower economic profile of the communities.

18.3 Threats to Biodiversity in Northern Pakistan

18.3.1 Importance of Biodiversity

The role of biodiversity is crucial in the maintenance of healthy environment and survival of mankind. Biodiversity provides free-of-charge services worth billions of dollars to mankind in the form of clean water, pure air, pollination, soil formation and protection, crop–pest control and provisions of food, fuel, fibers, and drugs. Biodiversity plays an important role in the prevention of floods, landslides, avalanches, soil erosion, wind erosion, siltation of dams, and water reservoirs. Thus, biodiversity is saving billions of rupees each year which would have been otherwise spent to control such calamities (Shah 2008). Biodiversity not only controls the global warming which adversely affects crop pattern throughout the world resulting in famine and hunger but also plays a crucial role to control and check rising of sea level which is threatening many European countries. Conservation of biodiversity is crucial to the sustainability of sectors as diverse as energy, agriculture, forestry, fisheries, wild life, industry, health, tourism, commerce, irrigation, and power (Table 18.1).

Pakistan harbors rich variety of flora and fauna which is mainly due to great variations in its temperature, rainfall, and altitude. Pakistan with an area of less than one million square kilometers consisting of desolate hot and cold deserts, forested valleys, and snow-bound mountains and deserts, rivers and lakes, and estuaries and oceans. These variations rise to the support of 188 species of mammals, 668 species of birds, 177 species of reptiles, and 6000 species of plants. Some species have very restricted ranges of their occurrence in the nature and are endemic to Pakistan (Shah 2008).

Table 18.1 Biodiversity facts and figure of northern Pakistan

Taxon	[a]Reported for Pakistan	Estimated for northern areas	Endemic to northern areas
Mammals	174	54	2
Birds	668	230	–
Reptiles/amphibians	177/22	23/6	4/2
Freshwater fish	198	20	4
Insects	>5000	?	–
Plants	>5700	?	

[a] Reported in Biodiversity Action Plan for Pakistan (2010)

18.3.2 Impact of Climatic Changes on Biodiversity

Climate change is having widespread impacts across multiple scales of biodiversity including genus, species, communities, and ecosystems (Parmesan 2006; Bellard et al. 2012). Biological responses to climate change vary widely among species and populations; some responses are positive, leading to increased growth rates or range expansions, while others are negative, resulting in localized or widespread declines (Montoya and Raffaelli 2010). Climate change is causing many species to shift their geographical ranges, distributions, and phenologies at faster rates than were previously thought; however, these rates are not uniform across species. Biodiversity is fundamental to ecosystem structure and function, and underpins the broad spectrum of goods and services that humans derive from natural systems (Naeem 2009; Mace et al. 2012). Declines or loss of any aspect of biodiversity can have direct or indirect impacts on ecosystem function, persistence, and services (Hooperet al. 2005). Plants are major regulators of global climate and are the keystone of the carbon cycle. Loss of plant species will disproportionally affect the rural poor where a large majority of whom rely on wild natural resources for medicinal purpose and daily uses. Climate change is altering the abiotic conditions that influence biological systems, and processes biological responses to climate change depend on a number of factors, including the rate, magnitude, and character of the change, ecological sensitivity, and adaptive capacity to environmental change. The combination of these factors is affecting all levels of biodiversity, such that the distribution, organization, and interactions among biota are shifting over spatial and temporal scales (Walther 2010).

There is growing consensus in the scientific community that climate change is occurring. There is unequivocal evidence that climate change is occurring and having impacts on biodiversity—the Intergovernmental Panel on Climate Change (IPCC 2007). While the absolute magnitudes of predicted changes such as these are uncertain, there is a high degree of confidence in the direction of changes, and in the recognition that climate change effects will persist for many centuries. The United Nations IPCC has concluded that the global atmosphere is warming, noting that the average global surface temperature has increased by nearly 1 °C over

the past century and is likely to rise by another 1.4–5.8 °C over the next century (IPCC 2001). Atmospheric warming affects other aspects of the climate system: The pressure and composition of the atmosphere; the temperature of surface air, land, water, and ice; the water content of air, clouds, snow, and ice; wind and ocean currents; ocean temperature, density, and salinity; and physical processes such as precipitation and evaporation.

18.3.3 Major Threats to Biodiversity

According to forests, scrubs, and planted trees on farmlands cover only 4.2 million hectares, or 4.8% of the country. If plantation and scrub forests are excluded, the coverage falls to 2.4 million hectares (2.7%). Woody biomass is declining at the rate of 4–6% per year and with consumption expected to grow in line with population growth (3% per year); this biomass could be totally consumed within the next 10 years. The list issued by the International Union for Conservation of Nature (IUCN; 1998) contained 37 species and 14 subspecies of internationally threatened or near-threatened mammals occurring in Pakistan. There are further 25 internationally threatened bird and 10 reptile species.

The magnitude and distribution of species that exist today is a product of more than 3.5 billion years of evolution, involving speciation, migration, extinction, and, more recently, and human influences. Estimates of the total number of species in existence range from 7 to 20 million, but perhaps the current best working estimate is between 13 and 14 million species (IUCN Red List (1997). Information based on taxonomic literature suggests that only 1.75 million of the species that exist have been described. Floristic diversity of the western Himalaya is declining at an alarming rate. The various threats posed to the plants of the area have been identified.

1. *Threat of habitat loss*
   Almost everywhere in the world, humans have a strong impact on the natural habitats of plants and animals—in high alpine regions as well as on coastal lines, in deserts as much as in rain forests. The forest are cut down to make space for arable land or to satisfy the industry's need for wood, and, thus, eventually our habitat, are fundamentally affected or destroyed. Of course, these changes have an impact on medicinal plants, too. Habitat destruction can affect medicinal plants in many different ways. The most direct effect is the immediate extinction of species in a certain region by destruction of the ecosystem. Obvious examples are the increasing number of "slash and burn" clearings. The soil, deprived of its natural vegetation, is prone to uncontrollable erosion, particularly if it is not allowed to regenerate back into forest. Then vegetation previously native to a certain area disappears irreversibly, and with it the medicinal plants. Inappropriate harvesting can cause a similar form of habitat destruction.

2. *Exploitation of the wild stock of medicinal plants*
   Traditionally, medicinal herbs have been collected and used locally. Together with growing urbanization and the extension of trade relations accompanying urbanization, medicinal plants have entered trade on a larger scale. Medicinal plants have become a commodity and obtained an isolated value that was no longer connected to their original function. The escalation in trade volumes may also be partly due to people longing (especially in industrialized nations) for a "natural" healing through natural agents. This development has led to an exploitation of the wild stock of some medicinal plant species. This reckless overexploitation is motivated by the benefits of a short-term profit to be gained by exploiting the resource and neglects all considerations of sustainability. Overexploitation in combination with other factors has brought plant species such as *Podophyllum hexandrum, Valeriana jatamansi, Geranium wallichianum, Bergenia ciliata, Primula denticulata, and Saussurea lappa* to the verge of extinction in their native areas.
3. *Genetic erosion and changes*
   In nature, genetic changes (mutations) occur constantly; they are the basis of the evolutionary process and species development. New species develop if mutations or a series of mutations lead to the separation of mutants and nonmutants and subsequent formation of groups, subpopulations, or populations. This is a constant and value-neutral evolutionary process. Humans can also induce genetic changes by mutations. Contrary to the natural process, artificial mutations usually have a certain purpose. Induced genetic changes in medicinal plants through cultivation and development of varieties often are intended to intensify the concentration of certain compounds. The changes and the subsequent adaptation to the newly created conditions—unlike in nature—take place very quickly, often within a few years. The desired results are achieved in the beginning, but the equilibrium of the plants is often disturbed.

18.3.4 Human: A Causal Agent/ Major Threat Toplant Diversity

The following human activities can be enumerated as the principal threats to conservation of biodiversity:

1. *Grass cutting*
   The effects of grass cutting are also considerable. Usually, people cut grass and store it, to be used in winter to feed cattle. While cutting grass, seedlings are uprooted or damaged. Similarly, the eggs or sometimes young babies of pheasants are killed. Similarly, some of pheasant species are migrating due to inadequate protection. The intensive grass cutting has also effects on herbal layer and the composition is greatly disturbed.
2. *Extensive collection of medicinal plants/herbs*
   Commercial gatherers of medicinal plant material, whether for national or international trade are poor people whose main aim is earning money, and not

resource management. A major proportion of the non-wood forests products, especially the medicinal and aromatic herbs collected from the wild, is meant for export. Hence, the quantities of different forest products collected are mostly determined by the demand from abroad. As a consequence, raw materials are overharvested by the removal, for example, of mature plants, roots, tubers, and rhizomes, or by overpruning. As an outside interest dictates the price and quality of raw materials extracted, a major part of local ecosystem has suffered irreversible loss. The most detrimental effects on the herbal layer of young plants, birds, small animals and other vegetation are caused due to mushroom *Morchella esculanta* collection. This mushroom is very rare and highly nutritious and costly. This is usually collected in the breeding season of most of bird's species, which disturbs their breeding and destruction of their nests. Due to tampering of soil, heavy soil erosion is resulted. The valuable herbs and medicinal plants, collected are *Viola odorata, Podophyllum hexandrum, Geranium wallichianum, and Valeriana jatamansi* and is the major source of income for the locals especially for women. However, due to unsafe collection methodology and high collection rate the natural succession of these species is greatly disturbed and both production and species population is greatly hampered.

3. *Invasive species*
   Introduced or alien invasive species can have a significant negative impact on biodiversity. 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 shortage in timber, fodder, and fuel wood. Prominent tree species include Eucalyptus species, hybrid *Populus,* and *Robinia* species planted on farmlands and irrigated plantations. While these species do not appear to have threatened indigenous vegetation so far, the introduction of *Broussonetia papayrifera, Robinia pseudacacia, Ailanthus altissima, Cedrellatoona,* and *Eucalyptus* species in the subtropical Chir pine zone may pose threat to natural habitats in the future.
4. *Natural hazards*
   The area is susceptible to landslides which results in destruction of forests. The situation became worse on 8 October 2006 when an earthquake of 7.8 jolted northern Pakistan in which thousands of people died, their properties were damaged, and fauna and flora of the area were also badly affected. Although it was a natural calamity, but most of the deaths occurred due to landslides, because the mountains were naked, due to the ruthless cutting of the forests, so human beings themselves were responsible for this loss. Heavy snowfall and torrential rains which result in flood and landslides are of common occurrence. The occurrence of floods is common phenomena in hilly areas. In the near past, these have destroyed agricultural fields, houses, irrigation channels, and communication lines in addition to loss of human life. Avalanches and landslides are frequent in the area which causes considerable destruction to the forest. Avalanches are very common during winter season, as moving avalanches kills herbs, shrubs, and even trees. Landslides cause decrease in forest cover. A considerable damage is

caused to the upper parts of the forests on account of snow slides. The frost of severe intensity occurs in winter that kills the young plants and the growing parts of the mature ones. The hillsides are subject to erosion as a result of excessive grazing, browsing, and lopping in addition to clearing of forest land for cultivation. Besides the faulty practices of cultivation, the erosion hazard becomes more dangerous on steep slopes.

5. *Extensive trade of medicinal plant resources*
   A survey of the naturally available plant wealth of Pakistan shows that medicinal plant grow in abundance in Hazara, Malakand, Kurram agency, Murree hills, Azad Jammu and Kashmir, Gilgit–Baltistan and Balochistan, or are cultivated farmlands in Punjab, Sindh, Baluchistan, North-West Frontier Province (NWFP), and Kashmir. According to the surveys carried out by the Pakistan Forest Institute (1989), 500 t of medicinal plant are produced in Hazara and Malakand, 16 t in Murree hills, 38 t in Azad Kashmir, and about 24 t in the northern areas annually. These plants are collected from the wild, dried and processed, and sold in the local market or exported to other countries. According to a survey, crude medicinal plant materials worth more than Rs. 150 million (US$ 2.3 million) per year are used in Pakistan. Most of these plants are obtained from the wild. Pakistan exports large quantities of crude plants at very cheap prices in the international market (worth US$ 6 million). In the entire business chain, gatherers receive the least money and are forced to collect more and more plant material to survive. It is an experience shared by most other resource-rich developing countries. Pakistan obtains more than 80% of its medicaments from higher plants. Trade of crude drugs is very erratic. Prices fluctuate greatly due to variations in external and internal demands within the country. The actual supply/demand of herbs and medicinal plants is in the range of 20,000 t per annum. As regard the availability of medicinal plants collected, 37% are available in the month of August, 26% in March and April, 11% in December and January, 17% in September and November, while 9% of the medicinal plants are available throughout the year.
6. *Wild vegetables*
   Fifty-five plants reported from the area are consumed as vegetables. Bush food (Falconer 1992) in its broader sense can be used for all the edible wild plants and animals and their products like waxes honey, etc. The plants used in the form of wild fruits, potherbs, spices, cash plants, and dry fruits species supply a fraction of the food requirements of the people. The soil flourish a variety of culinary herbs among which the young fronds of male ferns locally called “Coonje” and shoots of *Medicago* species and leaves of *Rumex nepalensis, Nasturtium,* and flowers of *Bauhinia variegata* are used by most of the families as vegetable. The delicious potherb, which we observed, is *Phytolacca latbenia* whose fruits are also boiled in water and used locally as ink. A total of 56 edible mushrooms are reported from Pakistan including 3 from Sindh, 4 from Balochistan, 5 from Punjab, and 44 from NWFP, Azad Kashmir and northern areas (Phillips and Hurst 1986). Most commonly collected mushrooms is (*Morchella esculenta*). This is one of the main minor forest products which local people collect to meet

their domestic nutritional needs and obtain additional income by selling these in the market. Households involved in collection of mushrooms can increase their incomes by adopting techniques of growing, processing, and preservation. At present, people do not have any idea about its in-house farming for sustained supply. People need to get training in growing, processing, and preservation of mushroom to increase their income.

7. *Ownership disputes*
   Another hurdle to protect the forests and reforestation are ownership disputes among the owners (landlords) and local farmers. Planting of trees for fodder or firewood is constrained by poorly defined regimes of land tenure and resource ownership, and a disparity in influence between those who are most directly concerned with wild plant resources (women) and those who make official decisions (men).
8. *Fuel wood pressure on forest resources*

One of the most serious problems in the developing world is the shortage of fuel wood and a similar situation prevails in Pakistan. As the National Conservation Strategy (NCS) points out, Pakistan is an energy-poor country. Rural dwellers have little access to commercial energy recourses and are often forced to rely upon the nations dwindling forest recourses and other biomass for fuel for cooking and heating.

18.3.5 Major Causes of Deforestation

The forests of area are cut ruthlessly, the impacts of which are visible in the form of more and frequent flash floods, loss of soil, reduced productivity of agricultural land, and reduction in freshwater sources. Some of the reasons for the decreasing forest cover in the area are:

1. *Encroachments for cultivated lands*
   People's aptitude for getting cultivation land has increased the trend of cutting trees in the recent years. The practice is very common as cultivated patches are seen everywhere in the forests of the valley. In these newly built farms, the people cultivate potatoes or other cash crops of the area. People were seen working in the fields in the forests surrounding the villages. This method of making new land patches through deforestation is very dangerous and if not checked will convert the precious forests into cultivated fields.
2. *Illicit felling and lopping of trees for fodder*
   A good number of poles and trees of coniferous species are cut every year without any restriction for making fences around the agriculture fields and the home-gardens to protect their vegetable, crops, and fruit trees from the cattle. Broad-leaved trees are also cut and lopped for fodder and firewood. The shortage of fodder and other feeding material has resulted in heavy lopping of trees for fodder. Heavy lopping of trees for fodder has manifold effects. *Quercus incana*

and *Aesculus indica* are extensively used as green fodder during winter and locally *Quercus incana* is on the verge of extinction. Similarly, other tree species like *Aesculus indica, Acer* species *Prunus cornuta,* and *Populus ciliata* are heavily pruned during the nesting periods of birds which badly effects breeding. Majority of herbivorous animals are dependent on the trees for fodder during the entire year. The growth of fodder trees is also retarded due to heavy lopping and repeated lopping results in different diseases and ultimate death of the tree. Fir trees are pruned to an extent that young crop is almost with the retarded growth. Himalayan yew *Taxus wallichiana* has also been badly lopped as fodder and is critically endangered.

3. *Over grazing and browsing*
   The forests have been considerably damaged on account of heavy grazing and browsing and the process is still going on unchecked. The damage is more visible near the habitations, water points, and rest places of cattle. The grazers have constructed their huts inside the forest. They graze and browse their animals till it becomes difficult for them to stay due to cold. Some nomadic Gujars from other areas visit these areas along with their goats and cause damage to the vegetative cover.
4. *Forest resources and their usage*
   Being unaware of the importance of conservation of forests, the local population luxuriantly uses resources thereof in an unsustainable way. In the winter season, consumption of wood increases multifold due to which huge amounts of wood of precious trees like *Abies pindrow, Cedrus deodara, Picea smithiana,* and-*Quercus dilatata* are used for burning purpose. *Pinus wallichiana* trees near the villages are invariably damaged for the extraction of torch wood. The trees get weaker at the base and are blown over by wind. The wooden planks of *Cedrus deodara* are used for making water channels through which water is brought from far flung streams in order to run turbines for the production of energy.
5. *Timber and construction material*
   The most preferred species for timber are *Cedrus deodara, Pinus wallichiana, Pinus roxburghii, Parrotiopsis, Olea, Juglans, Plectranthus rugosus, Indigofera* species, *Sophora* species, and*Quercus* species. In general, houses consume a lot of timber wood. Such lavish use of timber originated probably from early times when forests covered all the area and were cleared by early settlers to get land for farming. At present, most of the forests in surrounding villages have been severely depleted through felling trees indiscriminately, usually deodar poles for constructional purpose. Wood sleepers are loaded in the trucks within miscellaneous items and are smuggled to various parts of the country.
6. *Forest fires*
   There is no record of the extent and damage on account of fires but it appears that there have been frequent fires in some of the localities. The causes of fire are either rivalry in order to harass and damage the property of other tribes or burning wood, etc., for cooking and heating by carefree people. Fires are, however, a potential threat to the forest flora of the valley.

7. *Population explosion*
   In the last couple of decades, the population of the valley has increased multifold. During the winter season, the migration of local people from their homes to the low-lying areas decreases, which increases demands on forest resources. Similarly people from far-flung areas are continuously purchasing lands in the valley to build homes so that they could spend summer season over there. The increase in population has accordingly resulted in the deforestation with an increased rate.
8. *Agricultural appliances*
   The major occupation of local community is agriculture, and different types of traditional agriculture appliances are needed to work in the fields. These appliances are either totally made of wood, e.g., plough or handles are made of wood, e.g., axes and sickle. Thirty-seven species are utilized in making agricultural tools, which is 5% of the total reported species from the area. Ploughs, wheels, sticks, carts, sickle handles, hoe handles, pullies, knife handles, and axils are made of locally available hard and soft wood. They include *Abies pindrow, Pinus wallichiana, Quercus dilatata, Quercus incana, and Olea ferruginea*. The community is dependent on agriculture and livestock and most of cultivated fields are closer to the alpine pastures or meadows where animals graze. Therefore, the farmers have to take special measures to protect their valuable crops. For this purpose, they use spine-bearing plants around cultivated fields or make fences. Fences and hedges are made up of 19 species. They generally consist of the species, which are bushy and spiny. Such species consist of *Acacia modesta, Berberis lycium, Rosa moschata, Rubus fruiticosus,* and *Ziziphus sativa*. These plants are cultivated on the margins of the fields and form a permanent fencing or branches of these plants are fixed in mud on the margins or it performs as temporary fencing—wood pieces are also used to make permanent fences.

18.4 Conservation Strategies

18.4.1 Biodiversity Conservation in Pakistan: An Overview

Chaudhri and Qureshi (1991) indicated that as many as 709 species of the vascular plants of Pakistan, constituting about one tenth of the vascular flora, are in danger of being gradually wiped out or exterminated altogether. Martin (1995) reported that the chief threat to the trees and shrubs of the Sulaiman Ranges is the fuel shortage in the mountain, whereby, due to long and severe winters, fuel is used for heating purpose.

Shinwari et al (2000) worked out the conservation status of medicinal plants in Pakistani Hindu-Kush Himalayas. They estimated that more than 10% of the flora is threatened and 12% is used medicinally. They mentioned that the total number

of medicinal plants of the district Swat ranged from 55 to 345 species. They also reported that the natural resource base in the Hindu-Kush Himalayas is deteriorating more rapidly than in any other global region. Shinwari (1996) reported that the natural resource base in the Hindu-Kush Himalayas is deteriorating more rapidly than many other global ecosystems. Various threats which are posed to conservation of this region include fuel shortage, construction of roads and buildings, overgrazing for forage, wood cutting for timber, medicine, furniture, charcoal, etc. Shinwari and Khan (1998) investigated and listed the fuelwood species of Margalla Hills National Park, Islamabad. Thirty-five species were used among which *Acacia modesta, A. nilotica, Buxus papillosa,* and*Dodonaea viscosa* were under high fuelwood pressure. Shinwari and Khan (1999) recorded the local uses of plants of the Margalla Hills and their conservation status. They stated that *Asparagus adescendens, Berberis lyceum,* and *Viola canescens* are vulnerable to harvesting. *Acacia modesta, A. nilotica, Buxus papillosa,* and *Dodonaea viscosa* are under fuelwood pressure. *Grewia optiva* emerges as the most sustainable species. The Astore area, Gilgit, was analyzed for the conservation of plant biodiversity by Shinwari and Gilani (2003) and found that 5 species out of 34 medicinal plants were endangered, 18 vulnerable, and 19 rare. Khan et al. (1996) studied the impact of fuel shortage on conservation of biodiversity of the Hindu-Kush-Himalayan mountainous region. They mentioned that the northern area of Pakistan is endowed with immense natural resources which are being rapidly unchecked and uncontrolled. The most serious crisis to the loss of biodiversity is due to fuel shortage, which mainly comes from firewood species. Khan et al. (1996) surveyed ten strategic villages around Deosai plains through Rapid Rural Appraisal (RRA) in order to get people's perception about the floral and faunal significance of Deosai plains. They found that people are consuming the natural resources of Deosai for their short-term gains without knowing its long-term repercussions. They suggested that for sustainable and long-term conservation of alpine natural resources, there is a need to actively involve the acquiescence of local people in evaluation, planning, implementation, and monitoring processes, as they are the best judges of the area. Rehman and Ghafoor (2000) studied the human influence on the natural resources of Mount Elum, Swat. Analysis of the socio-economic profile revealed that land tenure and ownership conflicts were the basic causes of the depletion of natural resources and ecological degradation.

18.4.2 Protection and Conservation Measures

The natural resources of the area are deteriorating rapidly. Serious threats to the flora are the fuel shortages for the rapidly increasing population. Terracing of land for agricultural purposes, indiscriminate deforestation for economic reasons, and overgrazing are the other threats having resulted in a severe biotic stress. It is an appropriate time to check the existing position of the flora and to work for remedial measures for protection and conservation of the dying beauty of the area.

1. *Awareness campaign and incentives*
   To know the importance of the indigenous flora and forests for the existing ecosystem, awareness campaigns are required to be launched in the area. For successful protection and conservation measures, extending proper incentives for the local population are one of the essential prerequisites. Further, to make the area free of corruption, the locals are required to be given their free royalties. Like other forest areas in the district, some of the local elders, called Maliks, are denying due shares in royalty to common villagers of the valley.
2. *Protection against browsing/grazing*
   Being threatening to the ecosystem, the browsing and grazing rates are required to be checked properly. Permanent closure of the forests against browsing and grazing, would neither be economical nor politically practicable. The envisaged means for protection are the following:
   Those forests which are already on the verge of collapse due to overgrazing and extensive browsing are required to be banned for the purpose. For the same, proper fencing of the forest is made through barbed wire, waste wood, and branches. This can be made through consultation with the local population. The more the local people involved in the implementation, the greater will be the achievements.
3. *Protection against encroachment and illicit tree felling*
   There should be complete ban on illicit cutting of trees, encroachments, and the restoration of degraded land/ forests through establishment of community-protected areas.
4. *Soil conservation*
   There should be proper tree plantations and pasture management activities in the area. Since this is not possible without the community participation, the local population is required to be properly educated and taken into confidence for a thorough change in the area. All conservation measures are possible only when the main actors of the conservation strategies are involved fully in the process.
5. *Active government and nongovernmental organizations (NGO's) participation*
   Proper education and training are the most important prerequisites for the conservation and sustainability. The government (Forest Department) and NGO's are required to properly educate the people living in the area. This will also aid to other conservation efforts.

18.4.3 Conservation of Floristic Diversity

One of the deepest concerns in plant conservation is the large number of species under threat of extinction. Preserving the extinction of species is a top-conservation priority, because, once lost, species are gone forever. Attention is required to the management and protection of various ecosystems including in situ and ex situ conservation of species. The following conservation effort was made to conserve the floristic diversity:

1. *Ex situ conservation*
   Propagation and maintenance of different species under partially or completely controlled conditions is known as ex situ conservation. This is a method of conservation of species outside their natural habitats. It involves preservation of endangered plants in botanic gardens, gene banks, laboratories, or nurseries, so that the genetic characteristics are maintained in live organisms. Ex situ conservation approach is useful and necessary when the population of a species is likely to be extinct or it has got high education value or it is facing a high pressure in wild habitat or it is to be propagated largely for commercial, recreational, aesthetic, or other purposes. Trials were successfully carried out with the collaboration of local farmers on medicinal plants *Achillea millefolium, Atropa acuminata, Geranium wallichianum, Lavetera Cashmirana, Podophyllum hexandrum,* and*Paeonia emodi*. Seeds of important endangered tree species e.g, *Betula utilus, Prunus cornuta, Fraxinus excelsior, Acer caesium, Taxus wallichian, and Ulmus wallichiana* were collected, and nursery was raised with the collaboration of forest department. Seeds of endangered plants were collected from the wild and stored in the gene bank of Plant Genetic Resource Institute (PGRI), National Agricultural Research Center (NARC), Islamabad, Pakistan, as an ex situ conservation effort. Furthermore, nurseries of some important endangered plants were also raised with the collaboration of the forest department. The plantlets were distributed among the local community. Public awareness campaign was also launched by delivering lectures in the local schools. Religious leaders of the community were also consulted to deliver sermons regarding the importance of plants and teachings of Islam about the protection of environment and conservation of natural resources. This was an in situ conservation effort. Plantlets were distributed among the local community for plantation in their fields and pastures. The community was also informed about the recent situation of different plant resources of the area and conservation status of different endangered plant species.
2. *In situ conservation*
   In situ conservation is the best method for conserving genetic and plant resources but execution is not easy due to population pressure and resource constrains. During field research, an effort was made to inform and educate the local community regarding conservation and sustainable utilization of plants. The areas need much effort from the government and the NGOs' side, as people are very poor and illiterate. A similar artificial regeneration of *Dioscorea deltoidea, Atropa acuminata, Valeriana jatamansi, Mentha arvensis, Rheum emodi, Colchicum luteum, Digitalis pupurea, Podophyllum hexandrum, Pimpinella anisum, Catharanthus roseus,* and *Saussure alappa* has also been tested, under controlled environmental conditions, and by the application of various agrochemical, in the hill forest of NWFP (Khan et al. 1996). Most of the conservationists agree that in situ conservation is preferable as far as it is possible. There is a need to preserve habitats with their whole-diversity organisms. If habitats are managed, then plant species will manage themselves. This is probably found true in many cases. In Pakistan, in situ conservation status of Margalla Hills National Park

and Machyara National Park in Azad Kashmir has been discussed, and measures have been suggested for their improvement (Khan et al. 1996).

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. In these cases, ex situ conservation can be very useful, and may even be the only efficient way to save a species. Attention should be given to ways in which the genetic diversity of species can be preserved and maintained. The purpose of ex situ conservation is to provide protective custody to endangered species for reintroduction into damaged habitats and to enhance populations as part of ecosystem management.

In Pakistan, the ex situ cultivation of some medicinal plants like *Plantago ovata, Glycyrrhiza glabra, Colchicum luteum, Rheum emodi, Podophyllum hexandrum,* and *Dioscorea deltoidea* has been done outside from their native habitats (Khan 1957). However, ex situ conservation faces some major challenges and one of them is loss of genetic integrity of collections. The genetic decline in the quality ex situ of collections of endangered species can make it impossible for them to survive under natural conditions and, thus, render them useless for reintroduction purposes (Barrett and Kohn 1991)

The term *sircasitum* conservation has been proposed for a range of practices that are intermediate between "traditional" in situ and ex situ conservation. They are associated especially with more traditional (and biodiversity rich) agricultural systems (Hawkes et al. 2001). They include the retention of "wild" plants when land is cleared for agriculture and when crops are weeded, the growing of "wild" plants in home gardens, and the storage of crop seed in granaries for later replanting. All are common practices in the study area.

18.4.4 Threatened Flora and Conservation Status

With no link between use and responsibility, and high and probably ever-growing local demands for fuelwood, fodder, and grazing land, it can safely be predicted that the quality of the forest will decline unless systems of local resources management are improved. In the long run, there will be no benefits from resource depletion. Fewer resources will be available to the local people, leopards and rare pheasants will be lost, and the quality of the catchment will deteriorate. This will have serious consequences because millions of people in the lowlands rely on the steady flow of rivers from this and other forested area in the Himalayas. The whole threatened flora is ethnobotanically valued and is utilized for various purposes in the area. The problem of global biodiversity loss is complex but continuing losses threaten direct economic values and the integrity of ecosystems and

their function. Attention is required to the management and protection of various ecosystems including in situ and ex situ conservation of species. We should focus on hot spots that are threatened by destruction and degradation. Attentions should be given to ways in which the genetic diversity of species can be preserved and maintained.

18.4.5 Ethnobotany as a Mean of Nature Conservation

The global effort to conserve and protect the natural environment is a recent phenomenon, though efforts to conserve economically important natural resources have a long history. Humans may have been responsible for the extinction of most of the flora and fauna. Ethnobotany and conservation are inseparable and conservation is one of the most valued tasks of ethnobotanist. Besides, the in situ and ex situ conservational techniques adopted by the ethnobotanist, the local communities are educated on the importance of conservation for the prevailing ecosystems as well as their socioeconomic conditions. A number of countries have set up ethnobotanical facilities and institutions to study traditional medicines or specific projects to study plants used in traditional medicine by various people in their country. The continuation of studying plants and their uses should continue to yield nature conservation, community-based development, and improvement of modern medicine. Forest department and other government agencies view communities as the common enemy, which, of course, is self-defeating, as they could so easily become a part of the solution, rather than being perceived as the problem. From the management point of view, the forest department is hamstrung by a shortage of suitably trained personnel, meager resource allocation, the absence of a resource inventory, inadequate ecological research, etc. With biodiversity conservation traditionally figuring low in the government's priorities, the obvious solution would be to enlist the key stakeholders, namely the communities and other emerging players in the private sector. The centrality of communities to biodiversity conservation and the risk of ignoring it are self-evident. Few efforts have been directed at raising public awareness and education in areas adjacent to protected area, providing environmentally sound and sustainable development assistance to local communities, or formulating appropriate packages of incentive and disincentives. More fundamentally, awareness-raising incentives are part of a process, which entails recognition of community rights to own and control their territories.

18.4.6 Conservation Through Community Participation

Communication, education, and the raising of public awareness about the importance of plant diversity are crucial for the achievement of all the targets of a plant conservation strategy. This target is understood to refer to both informal and formal

education at all levels, including primary, secondary, and tertiary education. The Himalayan Jungle Project (HJP) has worked since 1991 with local communities in the Palas valley situated in two districts, Kohistan and Batgram of NWFP, Pakistan. It aimed at protecting one of the richest areas of biological diversity in Pakistan. Its approach was to empower and enable local communities to establish sustainable, integrated natural resource management in the valley, and, so, to reduce any obligation to degrade the natural heritage (Bass 1994). Indigenous knowledge utilization for conservation has introduced a new idea of "ethnoconservation biology"—the incorporation of indigenous conservations models into wild lands management (Balik and Cox 2005). Due to large demography and food security needs of the country, there is no alternative way in which agricultural land reserved for food crops can be utilized for growing medicinal plants. For this purpose, farmers of small holdings are needed to be motivated in an organized manner to grow medicinal plants along with traditional crops in their kitchen garden, wasteland, and bunds of cultivated field rather than promoting big farmers with plans for large plantations. This effort will be useful in poverty alleviation through community participation of rural communities. Such activities will boost up the growth and development of herbal and allied industries.

18.4.7 International Conservation Efforts in Pakistan

Pakistan has been playing a very important role internationally as far as conservation of biodiversity is concerned. From 1970 to1995, Pakistan signed a number of international conventions governing biodiversity which are as follows:

- The Convention on Biodiversity signed in 1992 and ratified it in 1994
- Convention on International Trade in Endangered Species (CITES)
- RAMSAR Convention (Pakistan was Chairman of the standing committee for the year 1987–1990)
- World Heritage Convention
- Convention on the Conservation of Migratory Species
- International Waterfowl and Wetland Bureau
- In addition, Pakistan is a member of the World Conservation Union (IUCN) and the International Waterfowl and Wetland Research Bureau (IWRB).

18.4.8 National Parks and Protected Areas of Pakistan

Over the past three decades, a total of 14 national parks, 99 wildlife sanctuaries, and 96 game reserves have been established, covering an area of 9.17 million hectares, or 10.40 % of the total land area. In this respect, Pakistan lags behind many other Asian countries (including India, Nepal, Sri Lanka, and Bhutan) in term of the national land area that has been designated for conservation (Shinwari et al. 2003).

Table 18.2 National parks of Pakistan. (Source: The IUCN Directory of South Asian Protected Areas 1990 and The Nation May 8th 2003)

	National Park	Region	Size ha	Year
1.	Ayubia	North-West Frontier Province	3312	1984
2.	Central Karakorum	Northern areas	973,845	1995
3.	Chinji	Punjab	6070	1987
4.	ChitralGol	North-West Frontier Province	7750	1984
5.	Deosai plains	Northern areas	363,600	1993
6.	Handrap Shandhoor	Northern areas	51,800	1993
7.	Hazarganji-Chiltan	Baluchistan	15,555	1980
8.	Hingol	Baluchistan	699,088	1997
9.	Khunjerab	Northern areas	227,143	1975
10.	Kirthar	Sindh	308,733	1974
11.	LalSuhanra	Punjab	51,588	1972
12.	Machiara	Azad Jammu and Kashmir	13,593	1996
13.	Margalla hills	Islamabad	17,386	1980
14.	Sheikh Buddin	North-West Frontier Province	15,540	15,540
15.	Lulusar lake	North-West Frontier Province	12,026	2003
16.	Saif-ul-Malook lake	North-West Frontier Province	75,058	2003

IUCN International Union for Conservation of Nature

The main objective of a national park can be defined as the scientific reserve/strict nature reserve to protect nature and maintain natural processes in an undisturbed state in order to have ecologically representative examples of the natural environment available for scientific study, environmental monitoring, education, and for the maintenance of genetic resources in a dynamic and evolutionary state (Table 18.2).

In Pakistan, several sites and areas have been declared protected by IUCN and are given under the control and supervision of various government departments like forest, wildlife, etc. Protected areas are managed mainly for ecosystem, conservation, and recreation. It is interesting to note that out of the total of 16 protected areas, nine are found in NWFP and northern areas.

18.4.9 Concluding Guidelines for Biodiversity Conservation

To supplement the xonservation and improvement efforts the following are some recommendations (Fig. 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7, 18.8, 18.9, 18.10, 18.11, 18.12, 18.13, 18.14, 18.15 and 18.16):

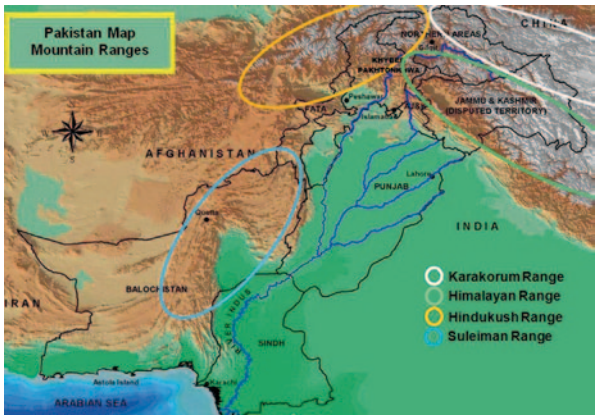

Fig. 18.1 Mountainous ranges of northern Pakistan. (*Source*: http://www.pakistangeographic.com/mountains.html)

Fig. 18.2 A panoramic view of Lake Saif-ul-Malook (Elevation 10,200 ft.)

Fig. 18.3 Floral view of River Kunhar (Elevation 9000 ft.)

Fig. 18.4 Berberis lyceum Royle: A medicinal shrub

Fig. 18.5 Alpine pastures of Deosai, Skardu

Fig. 18.6 A rich temperate forests of Ayubia National Park

Fig. 18.7 Land terracing: A common threat

Fig. 18.8 Roads expension

Fig. 18.9 Unsustainable trade of medicinal plants

Fig. 18.10 Extensive collection of *Skimmia laureola*

Fig. 18.11 Debarking of *Juglans regia* L. for herbal trade

- Habitat loss is a single largest contributing factor for the loss of various species—protect the habitat and the species will protect themselves. Let the species grow themselves without any interference.
- Adopt measures and provide facilities for research on indigenous plants that are threatened.
- Develop proper legislation to protect threatened species.
- Seed banks for important threatened species should be established.
- Indigenous broad-leaved tree species like *Fraxinus excelsior, Acer* sp., *Quercus baloot, Quercus incana, Cornus macrophylla, Betula utilus, Celtis australis, Ulmus wallichiana, Acer caesium, Prunus cornuta,* etc., should be planted in the coniferous forests.
- Efforts should be made for the conservation of medicinal plants via in situ and ex situ conservation, TK of plants lies with the old people that must be scientifically documented.
- Intellectual property rights of the communities concerned having indigenous TK, must be protected.

Fig. 18.12 Earthquake hazards

- Involve local peoples in maintaining their natural resources through a sustainable use program. In this connection, a mass education program should be initiated on maintaining the ecosystems, wildlife, and forests at large.
- The forest department should depute well-trained staff for proper management of the area.
- A crash program is required to have sufficiently trained work force (plant taxonomists and ecologists) to obtain a scientifically accurate data.
- The productivity of existing fuelwood resources can be improved through conservation and management.
- Supply alternative energy resources to local communities to avoid extensive fuelwood cutting.
- Awareness among the people about the conservation of this depleting natural gift should be created through public awareness, media, NGOs and forest department.

Fig. 18.13 Illegal timber trade

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Fig. 18.14 Fuelwood consumption

Fig. 18.15 Extensive cutting of *Taxus wallichiana* as fodder

Fig. 18.16 Overgrazing by nomads in alpine pasture

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