

Introduction

Biodiversity is defined as ‘the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems’. Conservation and sustainable use of biodiversity is fundamental to ecologically sustainable development. Biodiversity is part of our daily lives and livelihood, and constitutes resources upon which families, communities, nations and future generations depend. Every country has the responsibility to conserve, restore and sustainably use the biological diversity within its jurisdiction. Biological diversity is fundamental to the fulfilment of human needs. An environment rich in biological diversity offers the broadest array of options for sustainable economic activity, for sustaining human welfare and for adapting to change. Loss of biodiversity has serious economic and social costs for any country. The experience of the past few decades has shown that as industrialization and economic development in the classical sense takes place, patterns of consumption, production and needs, change, straining, altering and even destroying ecosystems. India, a megabiodiversity country, while following the path of development, has been sensitive to needs of conservation and hence is still rich in biological resources. Ethos of conservation and harmonious living with nature is very much ingrained in the lifestyles of India’s people.

India is one of 12 megadiversity countries of the world. The innumerable life forms harboured by the forests, deserts, mountains, other land, air and oceans provide food, fodder, fuel, medicine, textiles etc. There are

innumerable species, the potential of which is not as yet known. It would therefore be prudent to not only conserve the species we already have information about, but also species we have not yet identified and described from economic point of view. *Taxus baccata*, a tree found in the Sub-Himalayan regions, once believed to be of no value is now considered to be effective in the treatment of certain types of cancer. The diversity of genes, species and ecosystem is a valuable resource that can be tapped as human needs and demands change, the still more basic reasons for conservation are the moral, cultural and religious values. The importance of biodiversity can be understood, it is not easy to define the value of biodiversity, and very often difficult to estimate it. The value of biodiversity is classified into direct and indirect values.

Biodiversity has direct consumptive value in agriculture, medicine and industry. Approximately 80 000 edible plants have been used at one time or another in human history, of which only about 150 have even been cultivated on a large scale. Today a mere 10 to 20 species provide 80%–90% food requirements of the world. The indirect values imply the functions performed by biodiversity which are not of any direct use such as ecological processes etc. In India, many rural communities particularly the tribals obtain considerable part of their daily food from the wild plants. Some examples are: *Ceropegia bubosa* in Central India and Western Ghats; *Codonopsis ovata* in Himalayan region; *Ardisia* and *Meliosma pinnata* in the North-east; *Eremurus himalaicus*, *Origanum vulgare* and *Urtica hyperborea* in Lahul-Spiti and Ladakh; *Allium carolinianum* and *Cicer microphyllum* in Kashmir and *Sesuvium portulacastrum* in Coastal areas. Similarly, a variety of faunal species, e.g.,

insects, molluscs, spiders, wild herbivores are consumed by many tribal and non-tribal communities in India.

At one time, nearly all medicines were derived from biological resources. Even today they remain vital and as much as 67%–70% of modern medicine are derived from natural products. In developing countries, a large majority of the people rely on traditional medicines for their primary health care, most of which involve the use of plant extracts (Photo 9.1).

Around 20,000 plant species are believed to be used medicinally in the third world. In India, almost 95% of the prescriptions are plant-based in the traditional systems of



Photo 9.1 *Adhotoda zeylanica*: a medicinal plant
Source MoEF Annual report 1998-99

Unani, Ayurveda and Sidha. Many indigenous medicines also utilize animals and their parts or extracts as remedies for various diseases. Diverse habitats and species also have non-consumptive use-value. Tourism, recreation and scientific research are the major examples. The indirect use-value of biodiversity includes ecosystem process of biological diversity, which provides valuable ecological services to the biosphere; some

examples are the ecosystem's ability to absorb pollution, maintain soil fertility and micro-climates, recharge ground water, and provide other invaluable services. Many plants, animals and their parts are used in rituals all over the country. To name a few: flowers of *Hibiscus*, *Datura* and *Euphorbia*; leaves of *Aegle marmelos* (bel), *Eragrostis cynasuroides* (kusa grass), rice til, chenopods, odorous roots of *Dolomiaea macrocephala* (dhup). Further, sacred values are attached to entire ecosystems, for example patches of forests were believed to be the abode of gods, and are used only for prayers and rituals. Many sacred groves still exist in different parts of India (MoEF 1999).

Pressure

Habitat destruction, overexploitation, pollution, and species introduction are the major causes of biodiversity loss in India. Other factors included fires, which adversely affect regeneration in some cases, and such natural calamities as droughts, diseases, cyclones, and floods. Habitat destruction, decimation of species, and the fragmentation of large contiguous populations into isolated, small, and scattered ones has rendered them increasingly vulnerable to inbreeding depression, high infant mortality, and susceptibility to environmental stochasticity and, in the long run, possibly to extinction.

Besides these, the failure to stem this tide of destruction results from an amalgamation of lacunae in economic, policy, institutional, and governance systems. Among others, these include.

- Management with limited local community participation and involvement and inadequate implementation of ecodevelopment programmes; poor implementation of the Wildlife (Protection) Act of 1972 as amended in 1991.

- Poor conviction rates of wildlife cases due to inadequate legal competence in the forest department, and the lackadaisical approach of courts with cases pending for years.

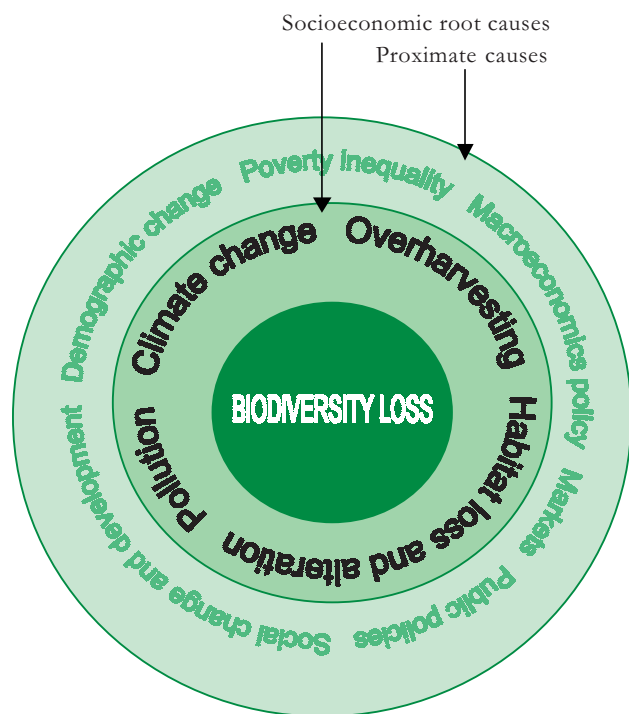


Figure 9.1 Biodiversity loss: proximate and socio-economic root causes

Adapted from: The root causes of biodiversity loss, 2000

Protected Area Network comprises National Parks and Sanctuaries which covers a mere 4.2% of the land area and is inadequate in protecting such ecologically important and fragile ecosystems such as wetlands, mangroves, and grasslands that lie outside such protected areas. The protected areas themselves are susceptible to denotification and further reduction in extent due to other pressures emanating from the industrial-commercial-political combine.

Biodiversity conservation in India is also impeded by a lack of knowledge of the magnitude, patterns, causes, and rates of deforestation and biodiversity loss at the ecosystem and landscape level. Poaching and trade in wildlife species are among the most important concerns in the management of protected areas today but information on poaching, trade, and trade routes is sketchy and current wildlife protection and law enforcement measures are inadequate and inefficient (Photo 9.2).



Photo 9.2 Lioness with family at Gir forest, Gujarat : needs conservation

Source MoEF Annual report 1996-97

Major problems with biodiversity conservation

- Low priority for conservation of living natural resources.
- Exploitation of living natural resources for monetary gain.
- Values and knowledge about the species and ecosystem inadequately known.
- Unplanned urbanization and uncontrolled industrialization.

Major biodiversity threats

- Habitat destruction
- Extension of agriculture
- Filling up of wetlands
- Conversion of rich bio-diversity site for human settlement and industrial development

- Destruction of coastal areas
- Uncontrolled commercial exploitation

This erosion of biodiversity is largely due to habitat loss caused by the expansion of various development projects such as mines, dams, and road and canal construction. It is estimated that, after Independence, the country has lost 4,696 million hectares of forestland to non-forestry purposes. While 0.07 million ha of forest land has been illegally encroached upon, 4.37 million ha has been subjected to cultivation, 0.52 million ha given to river valley projects, 0.14 million ha to industries and townships, 0.06 million ha for transmission lines and roads; and the rest for miscellaneous purposes (MoEF 1999). Habitat loss leads to the fragmentation of continuous stretches of land and consequently fragments wildlife populations inhabiting them. These small populations are increasingly vulnerable to inbreeding depression, high infant mortality, susceptibility to environmental stochasticity, and, in the long run, possibly to extinction. Apart from the primary loss of habitats, there are numerous other problems contributing to the loss and endangered status of several plant and animal species.

Habitat degradation such as changes in forest composition and quality can in turn lead to declines in primary food species for wildlife. Poaching is another insidious threat that has emerged in recent years as one of the primary reasons for extinction of species such as the tiger. Poaching pressures, however, are unevenly distributed since certain selected species are more heavily targeted than others. Population pressures and concomitant increases in the collection of fuelwood and fodder, and grazing in forests by local communities also take their toll on the forests and consequently its biodiversity. Other minor factors include fires, which adversely affect regeneration in some cases, and natural calamities like droughts, diseases, cyclones, and landslides.

India's contribution to agro-biodiversity has been impressive. India stands seventh in the world as far as the number of species contributed to agriculture and animal husbandry is concerned. In qualitative terms too, the contribution has been significant, as it has contributed such useful animal species as water buffalo and camel and plant species such as rice and sugarcane. India has also been a secondary centre of domestication for animal species such as horse and goat, and

Table 9.1 Comparative statement of recorded number of animal species in India and the World (endemic and threatened animals species for India are also shown)

Taxa	India			World	Percentage of India to the world
	Species	Endemic species	Threatened species		
Protista	2577			31259	8.24
Mollusca	5070	967		66535	7.62
Arthropoda	68389	16214 (Insects)		987949	6.90
Other Invertebrates	8329		22	87121	9.56
Protochordata	119			2106	5.65
Pisces	2546		4	21723	11.72
Amphibia	209	110	3	5150	4.06
Reptilia	456	214	16	5817	7.84
Aves	1232	69	73	9026	13.66
Mamalia	390	38	75	4629	8.42

Source MoEF 1999; Baillie 1996

such plant species as potato and maize (Khoshoo 1996). Animal species, which are reported to be threatened in India, have been listed in

Table 9.1.

India has 47 000 species of flowering and non-flowering plants representing about 12% of the recorded world's flora. Out of 47 000 species of plants, 5 150 are endemic and 2 532 species are found in the Himalayas and adjoining regions and 1 782 in the peninsular India. India is also rich in the number of endemic faunal species it possesses, while its record in agro-biodiversity is very impressive as well. There are 166 crop species and 320 wild relatives (Table 9.2) along with

Table 9.2 Wild relatives of some crops and medicinal plants

Crop	No. of wild relatives
Millets	51
Fruits	104
Spices and condiments	27
Vegetables and pulses	55
Fibre crops	24
Oil seeds, tea, coffee, tobacco and sugarcane	12
Medicinal plants	3000

Source MoEF 1999

Table 9.3 Wild relatives of domesticated animals

Group	Nos.
Cattle	27
Sheep	40
Goats	22
Camels	8
Horses	6
Donkeys	2
Poultry	18
Buffalo	8

Source MoEF 1999

numerous wild relatives of domesticated animals (Table 9.3). Overall India ranks seventh in terms of contribution to world agriculture.

State impact

Status of biodiversity in India

India occupies only 2.4% of the world's land area but its contribution to the world's biodiversity is approximately 8% of the total number of species (Khoshoo 1996), which is estimated to be 1.75 million (As per Global Biodiversity Assessment of UNEP of 1995, described number of species so far is 1.75 million). Of these, 126 188 have been described in India. The species recorded includes flowering plants (angiosperms), mammals, fish, birds, reptiles, and amphibians, constitute 17.3% of the total whereas nearly 60% of India's bio-wealth is contributed by fungi and insects (Khoshoo 1996). Such a distribution is similar to that found in the tropics and the subtropics. Biogeographically, India is situated at the trijunction of three realms namely afro-tropical, Indo-Malayan and Paleo-Arctic realms, and therefore, has characteristic elements from each of them. This assemblage of three distinct realms probably is a fact which is believed to partly account for its rich and unique in biological diversity. Based on the available data, India ranks tenth in the world and fourth in Asia in plant diversity, and ranks tenth in the number of endemic species of higher vertebrates in the world. There are 10 biogeographical zones in India. They can be classified as under:

The Biogeographic classification of India (Rodgers and Pawar 1990)

- Trans-Himalayas. An extension of the Tibetan plateau, harboring high-altitude cold desert in Laddakh (J&K) and Lahaul Spiti (H.P) comprising 5.7 % of the country's landmass.
- Himalayas. The entire mountain chain running from north-western to north-eastern India, comprising a diverse range of biotic provinces and biomes, 7.2 % of the country's landmass.
- Desert. The extremely arid area west of the Aravalli hill range, comprising both the salty desert of Gujarat and the sand desert of Rajasthan. 6.9% of the country's landmass.
- Semi-arid. The zone between the desert and the Deccan plateau, including the Aravalli hill range. 15.6 % of the country's landmass.
- Western ghats. The hill ranges and plains running along the western coastline, south of the Tapti river, covering an extremely diverse range of biotic provinces and biomes. 5.8% of the country's landmass.
- Deccan peninsula. The largest of the zones, covering much of the southern and south-central plateau with a predominantly deciduous vegetation. 4.3 % of the country's landmass.
- Gangetic plain. Defined by the Ganges river system, these plains are relatively homogenous. 11% of the country's landmass.
- North-east India. The plains and non-Himalayan hill ranges of northeastern India, with a wide variation of vegetation. 5.2% of the country's landmass.
- Islands. The Andaman and Nicobar Islands in the Bay of Bengal, with a highly diverse set of biomes. 0.03% of the country's landmass.

- Coasts. A large coastline distributed both to the west and east, with distinct differences between the two; Lakshadweep islands are included in this with the percent area being negligible.

Apart from the biogeographic classifications described above ecosystems can also be demarcated on the basis of purely geographical or geological features like mountains, islands, valleys, plateaux, oceans; on the basis of vegetative cover like forests, grasslands, mangroves and deserts; on the basis of climatic conditions like arid and semi-arid areas, permanently snow-bound areas, high rainfall areas; on the basis of soil characteristic and other such criteria.

In some descriptions the biomes/ecosystems are clubbed together into very general habitat classifications. The main natural habitat types are:

- Forests
- Grasslands
- Wetlands
- Mangroves
- Coral reefs
- Deserts



Photo 9.3 Mixed coniferous forest
Source MoEF Annual report 1998-99

Table 9.4 Forest types – distribution and percentage

Forest type	Distribution	% of forest area
Tropical forests		
Tropical wet evergreen	North East & South, Andaman & Nicobar island	5.8
Tropical semi evergreen	South & East	2.5
Tropical moist deciduous	Central & East	30.3
Tropical littoral & swamp	Along the coast	0.9
Tropical dry deciduous	West & Central	38.2
Tropical thorn	West & Central	6.7
Tropical dry evergreen	Central & South	0.1
Subtropical forests		
Subtropical broad leaved hill forests	South	0.4
Subtropical pine	Sub-Himalayan tract	5.0
Subtropical dry evergreen	North-East & South	0.2
Temperate forests		
Montane wet temperate	Himalaya & Nilgiris (in Western Ghats)	2.0
Himalayan moist temperate	Temperate areas of Himalayas	3.4
Himalayan dry temperate	Dry temperate areas of Himalayas	0.2
Sub-alpine and alpine forests		
Sub-alpine	Himalaya	4.3
Moist alpine shrub	Himalaya	4.3
Dry alpine shrub	Himalaya	4.3

Source GoI 1999

Forests

The forest cover of the country is placed at 633 397 sq km according to the forest survey of India assessment (1997). This presents 19.27% of India's total geographical areas. India is endowed with diverse forest types ranging from the Tropical wet evergreen forests in North-Eastern to the Tropical thorn forests in the Central and Western India (Photo 9.3). The forests of the country can be divided into 16 major groups comprising 221 types. The distribution of these groups, and the percentage of total forest area covered by each are given in Table 9.4.

Grasslands

In India the spread of grassland and shrubland is put at 12% of the total landmass (Olson et al. 1983) while the planning commission (1989) and Grasslands and Fodder research Institute, Jhansi (1993) gives an estimate of about 3.7 to 3.9%.

The diversity of grasslands in India is high ranging from semi-arid pastures of the western part of the Deccan peninsula, the humid, semi-waterlogged tall grassland of the Terai belt, the rolling shola grasslands of the western ghat hilltops, and the high-altitude alpine pastures of the Himalayas.

The grass flora in India is also quite diverse, consisting of about 1256 species in 245 genera and an estimated 370 endemic species reported (Shukla, 1983). Unfortunately due to greater neglect than Forests the status of grasslands is not so well known or documented.

Wetlands

Wetlands cover 3% of the Indian landmass, or nearly 100 000 sq. Km (Olson et al. 1983). Wetlands in India harbor a vast variety of life forms that are a part of the complex food of these transitional ecosystems. About 320 species of birds are associated with the Indian



Photo 9.4 Wetlands of West Bengal
Source MoEF Annual report 1999-2000

Wetlands (Photo 9.4). Apart from birds, the wetlands support a diverse population of plants and animals including 150 species of amphibians. Wetlands are the habitat of some of the world's endangered and threatened flora and fauna. The Western and Central flock of Siberian crane, one of the most endangered cranes in the world, uses Keoladeo as its winter site. The brown antlered deer (*Cervus eldi eldi*) or 'sangai' is found only in *phumadis* (floating landmasses) of Lok Tak Lake. Gahirmatha beach is a major breeding site of olive ridley turtles. Chilka is the habitat of many threatened species such as green sea turtle, Hawksbill turtle, dugong, and blackbuck.



Photo 9.5 Waterway in the Pitchavaram mangrove forest flanked by *Avicennia* and *Rhizophora* trees
Source MoEF Annual report 1998-99

Mangroves

Government of India estimated mangrove cover of 674 000 ha, which is about 7% of the world's mangrove.

Mangroves are salt-tolerant ecosystems in tropical and subtropical regions. These ecosystems are largely characterized by assemblage of unrelated tree genera that share the common ability to grow in saline tidal zone. India harbours some of the best mangroves swamps in the world, located in the alluvial deltas of Ganga, Mahanadi, Godavari, Krishna, and Cauveri rivers and on the Andaman and Nicobar group of Islands (Photo 9.5). The total area covered by mangroves in India is estimated at about 6,700 sq km. amounting to about 7% of the Worlds mangroves.

The largest stretch of mangroves in the country lies in the Sunderbans in West Bengal covering an area of about 4,200 sq. km. The predominant mangroves species are *Avicennia officinalis*, *Excoecaria agallocha*, *Heritiera fomes*, *Bruguiera parviflora*, *Ceriops decandra*, *Rhizophora mucronata* and *Xylocarpus granatum*. Mangroves also harbour a number of molluscs, polychaetes and honeybees. The



Photo 9.6 Soft corals (*Sinularia* sp.) of Andaman and Nicobar Islands
Source MoEF Annual report 1996-97

Indian mangroves are host to 105 species of fish, 20 kinds of shellfish, and 229 crustacean species. The Royal Bengal tiger is found in the Sunderban mangroves. Different species of monkeys, otters, deer, fishing cats, snakes and

wild pigs are common. A total of 117 species of migratory and residential birds have been reported. The most common birds are flamingos, storks, sea eagles, kites, kingfishers, sandpipers, bulbuls, and whistlers.

Coral reefs

Accurate estimates of coral reef extent in the world are not available. A rough estimate puts it at 600 000 sq Km (Smith 1978) out of which 60% occurs in the Indian Ocean region and most of it in south-east Asia (Photo 9.6).

The coral reef cover in Indian waters is roughly estimated upto 19,000 sq. Km (Wafar 1992). Indian reefs belong to the following categories:

PalkBay and Gulf of Mannar	: Fringing
Gulf of Kachchh	: Fringing, Patchy
Andaman and Nicobar Islands	: Fringing
Lakshadweep Islands	: Atolls
Central West coast	: Patchy

The diversity of the Indian coral reefs is very impressive with about 200 coral species belonging to 71 genera (Untawale and Dhargalkar 1993). The richest being Andaman and Nicobar Islands which alone harbors 179 species (Subba Rao 1989).

Deserts

In India, deserts extend over about 2% of the landmass (Olson et al. 1983). Three kinds of deserts are noticeable in India:

- The sand desert of western Rajasthan and neighbouring areas.
- The vast salt desert of Gujarat
- The high-altitude cold desert of Jammu and Kashmir and Himachal Pradesh.

Desert fauna in India is also quite diverse, with about 1200 sp. of animals reported from Thar region of which 440 are vertebrates and 755 are invertebrates. Desert fox, Desert cat, Houbara Bustard and some Sandgrouse spe-

cies are restricted to the Thar area (Rodgers and Pawar 1988). In the remote part of Great Rann, Gujarat lies the nesting ground of Flamingoes and the only known population of Asiatic wild ass.

The cold deserts in India cover a vast area of 109 990 sq. Km, about 87,780 sq. km in Laddakh (Jammu and Kashmir) and 22,210 sq. Km in Lahaul -Spiti (Himachal Pradesh). The diversity of the high altitude cold deserts has been studied only recently with many insect species being endemic. Interestingly the cold desert harbors *Kiang* a close relative of the Indian wild ass found the Rann of Kachchh. Other distinctive animals include Snow leopard, Yak, Tibetan antelope, Ibex, Blue sheep, Tibetan gazelle, Woolly hare etc.

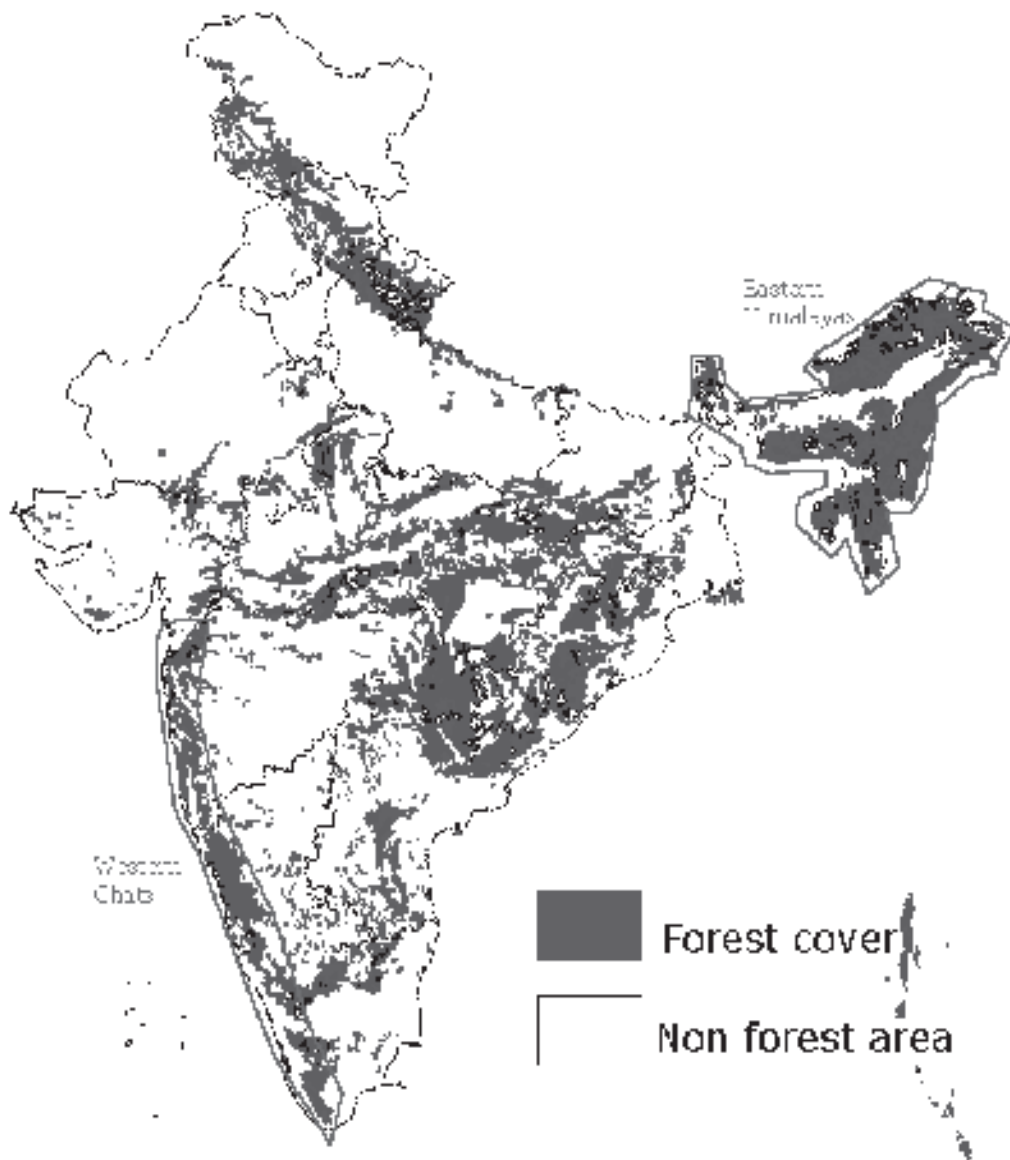
Biodiversity hotspots

Biodiversity hotspots are areas that are unusually rich in species, most of which are endemic, and are under a constant threat of being overexploited. Among the 18 hot spots in the world, two are found in India. These are two distinct areas: the Eastern Himalayas and the Western Ghats and are also depicted in the National forest vegetation map of India. Together these 18 sites contain approximately 49 955 endemic plant species, or 20% of the world's recorded plants species, in only 746 400 sq km or 0.5% of the earth's land surface.

Eastern Himalayas

Phytogeographically, the Eastern Himalayas forms a distinct floral region and comprises Nepal, Bhutan, neighbouring states of east and north-east India, and a contiguous sector Yunnan province in south western China. In the whole of Eastern Himalayas, there are an estimated 9000 plant species, with 3500 (i.e. 39%) of them being endemic. In India's sector of the area, there occur some 5800 plant species, roughly 2000 (i.e. 36%) of them being endemic.

National forest vegetation map of India with Biodiversity hotspots



Map 9.1 National forest vegetation map of India with biodiversity hotspots

At least 55 flowering plants endemic to this area are recognized as rare, for example, the pitcher plant (*Nepenthes khasiana*).

The area has long been recognized as a rich centre of primitive flowering plants and the area is recognized as 'Cradle of Speciation'.

Species of several families of monocotyledons, Orchidaceae, Zingiberaceae and Arecaceae abound in the area. Gymnosperms and pteridophytes (ferns) are also well represented in the area.

The area is also rich in wild relatives of plants of economic significance, e.g. rice banana, citrus, ginger, chilli, jute and sugarcane. The region is regarded as the centre of origin and diversification of five palms of commercial importance namely, coconut, arecanut, palmyra palm, sugar palm and wild date palm.

Tea (*Thea sinensis*) is reported to be in cultivation in this region for the last 40,000 years. Many wild and allied species of tea, the leaves of which are used as substitute of tea, are found growing in the North East in the natural habitats.

The 'taxol' plant *Taxus wallichiana* is sparsely distributed in the region and has come under red data category due to its over exploitation for extraction of a drug effectively used against cancer.

As regards faunal diversity, 63% of the genera of land mammals in India are known from this area. During the last four decades, two new mammals have been discovered from the region: Golden Langur from Assam – Bhutan region, and Namdapha flying squirrel from Arunachal Pradesh indicating the species richness of the region.

The area is also a rich centre of avian diversity – more than 60% of the Indian birds are recorded in the North East. The region also has two endemic genera of lizards, and 35 endemic reptilian species, including two turtle. Of the 204 Indian amphibians, at least 68 species are known from North East, 20 of which are endemic.

From Namdapha National Park itself, a new genus of mammal, a new subspecies of bird, 6 new species of amphibia, four new species of fish, at least 15 new species of beetles and 6 new species of flies have been discovered (Babu and Arora 1999).



Photo 9.7 The Malabar Tree Nymph (*Idea malabarica*) found only in wet evergreen forest of the Western Ghats
Source MoEF Annual report 1997-98

Western ghats

The Western Ghats region is considered as one of the most important biogeographic zones of India, as it is one of the richest centres of endemism. Due to varied topography and micro-climatic regimes, some areas within the region are considered to be active zones of speciation.

The region has 490 arborescent taxa, of which as many as 308 are endemics this endemism of tree species shows a distinct trend, being the highest (43%) in 8N-10°30'N location and declining to 11% in 16N - 16°30'N location.

About 1 500 endemic species of dicotyledonous plants are reported from the Western Ghats. 245 species of orchids belonging to 75 genera are found here, of which 112 species in 10 genera are endemic to the region (Photo 9.7).

As regards the fauna, as many as 315 species of vertebrates belonging to 22 genera are endemic, these include 12 species of mammals, 13 species of birds, 89 species of reptiles, 87 species of amphibians and 104 species of fish.



Photo 9.8 *Renanthera imschortians*: a highly threatened species of orchid commonly known as “Red Vanda”

Source MoEF Annual report 1998-99

The extent of endemism is high in amphibian and reptiles. There occur 117 species of amphibians in the region, of which 89 species (i.e. 76%) are endemic. Of the 165 species of reptiles found in Western Ghats, 88 species are endemic.

Many of the endemics and other species are listed as threatened (Photo 9.8). Nearly 235 species of endemic flowering plants are considered endangered. Rare fauna of the region includes: Lion Tailed Macaque (Photo 9.9), Nilgiri Langur, Nilgiri Tahr, Flying Squirrel, and Malabar Gray Hornbill (Babu and Arora 1999).

Biodiversity contribution to Indian economy

Biodiversity products have obtained a commercial value and have been increasingly exchanged in the markets having a monetary value, from which their share in the national economy can be judged. In the Indian context it is difficult to put a value on diversity as such because the marketable products are of various kinds both legal and illegal e.g wood and non-wood products from forests where wood comprises the major commercial produce is both legally exported as well as illegally smuggled out of the country. Many non-wood forest produce and the illegal produce is not accounted for in the official documents.



Photo 9.9 Lion-tailed Macaque: an endangered species

Source MoEF Annual report 1999-2000

The contribution of natural and agricultural biodiversity in terms of crops, live stock, fisheries etc is very substantial in terms of commercial value.

Such biodiversity has a major contribution to make to the Indian GDP (gross domestic product). The large economic implications of biodiversity in its wild and domesticated forms is the rice improvement programme. Rice accounts for 22% of the total cropped area and 39% of the total area under cereals, which reflects its importance in the country's struggle to attain self-sufficiency in food. When the rice crop was doomed due to the grassy stunt virus in the 1970s, one single gene from the wild strain of rice, namely *Oryza nivara* from Uttar Pradesh, showed resistance to this virus and proved vital in the fight against the virus.

With respect to the commercial value of the plant species of medicinal value, the world trade is of several billion dollars and this is growing. The export market for medicinal plants has also increased. India's foreign exchange reserves from horticultural products are from high yielding varieties (ICAR 1999). Increased production of oilseeds also helped in saving large amounts of foreign exchange spent on edible oil import.

The aforesaid pressures will lead to loss of biodiversity in India and will also result in considerable drop in Indian GDP and foreign exchange earnings from horticultural products, oil seeds, oil meal, and oil cake will drop down to a great extent.

Response

The Ministry of Environment and Forests (MoEF) is the nodal agency in the Government of India for planning, promotion, coordination, and overseeing the implementation of the environmental and forestry programmes. The MoEF is also the focal point for implementation of the Convention on Biological Diversity. The mandates of the Ministry inter alia include survey of flora, fauna, forests and wildlife, and conservation of natural resources (Photo 9.10). These objectives are supported by legislative and regulatory measures. A number of institutions



Photo 9.10 Black buck: needs conservation
Source MoEF Annual report 1997-98

affiliated with the Ministry are involved in the work related to various aspects of biological diversity. Survey and inventorization of the floral and faunal resources are carried out by the Botanical Survey of India (BSI) established in 1890, and the Zoological Survey of

India (ZSI) established in 1916. The Forest Survey of India established in 1981 assesses the forest cover, with a view to develop an accurate database for planning and monitoring purposes. The Wildlife Institute of India undertakes studies of endangered species of animals and critical ecosystems. Over 47,000 species of plants and 89,000



Photo 9.11 Pitcher plant: an endangered species
Source MoEF Annual report 1997-98

animals species have been recorded by the BSI and ZSI respectively.

The Survey organizations have published over the years, documents on flora and fauna at country, state and in some cases district levels and for selected ecosystems. Besides, extensive reports on inventories of resources indicating level of biodiversity in selected areas have also been brought out. The Surveys have also published Red Data Books on endangered species (Photo 9.11). The voucher specimens are preserved in Central National Herbarium (CNH) of BSI and National Zoological Collection (NZC) of ZSI.

The Forest Survey of India publishes every three years, a State of Forest in India report based on remote sensing and ground truth data.



Photo 9.12 A herd of Cheetal at Bandipur Wildlife Sanctuary
Source MoEF Annual report 1999-2000

Existing policy response

In situ conservation (within natural habitat)

Some important measures taken are as follows:

- Approximately 4.2% of the total geographical area of the country has been earmarked for extensive in situ conservation of habitats and ecosystems. A protected area network of 85 National Parks and 448 Wildlife Sanctuaries have been created (Photo 9.12). The results of this network

have been significant in restoring viable population of large mammals such as tiger, lion, rhinoceros, crocodiles, elephants, etc.

- The Indian Council of Forestry Research and Education (**ICFRE**) has identified 309 forest preservation plots of representative forest types for conservation of viable and representative areas of biodiversity. 187 of these plots are in natural forests and 112 in plantations, covering a total area of 8,500 hectares.
- A programme entitled “**Eco-development**” for in situ conservation of biological diversity involving local communities has been initiated in recent years. The concept of eco-development integrates the ecological and economic parameters for sustained conservation of ecosystems by involving the local communities with the maintenance of earmarked regions surrounding protected areas. The economic needs of the local communities are taken care of under this programme through provision of alternative sources of income and a steady availability of forest and related produce.

Table 9.5 Biosphere reserves set up

Name of the site	Date of notification	Location (State)
Nilgiri	01.08.86	Part of Wynad , Nagarhole, Bandipur and Madumalai, Nilambur, Silent Valley and Siruvani hills (Tamil Nadu)
Nanda Devi	18.01.88	Part of Chamoli, Pithoragarh, Almora Districts (Uttar Pradesh)
Nokrek	01.09.88	Part of Gora Hills (Meghalaya)
Manas	14.03.89	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamrup and Darang district (Assam)
Sunderbans	29.03.89	Part of delta of Ganga & Brahamaputra river system (West Bengal)
Gulf of Mannar	18.02.89	Indian part of Gulf of Mannar between India and Sri Lanka (Tamil Nadu)
Great Nicobar	06.01.89	Southern most islands of Andaman and Nicobar (A&N islands)
Similpal	21.06.94	Part of Mayurbhanj district (Orissa)
Dibru-Saikhowa	28.07.97	Part of Dibrugarh and Tinsukia district (Assam)
Dehang Debang	02.09.98	Part of Siang and Debang valley in Arunachal Pradesh
Pachmarhi	03.03.99	Parts of Betul, Hoshangabad and Chindwara districts of Madhya Pradesh
Kanchanjanga	07.02.2000	Part of Kanchanjanga Hills and Sikkim

Source MoEF 2000



Photo 9.13 Den of the Royal Bengal Tiger of Sundarbans Biosphere Reserves
Source MoEF Annual report 1999-2000

- To conserve the respective ecosystems, a **Biosphere Reserve Programme** is being implemented. Twelve biodiversity rich areas of the country have been designated as Biosphere Reserves (Table 9.5) applying the diversity and genetic integrity of plants, animals and microorganisms in their totality as part of the natural ecosystems, so as to ensure their self-perpetuation and unhindered evolution of the living resources (Photo 9.13).
- Programmes have also been launched for scientific management and wise use of fragile ecosystem. Specific programmes for management and conservation of wetlands, mangroves, and coral reef systems are also being implemented. 21 wetlands, 15 mangrove areas and 4 coral reef areas have been identified for management. National and sub-national level committees oversee and guide these programme to ensure strong policy and strategic support.
- Six internationally significant wetlands of India have been declared as “**Ramsar Sites**” under the Ramsar Convention. To focus attention on urban wetlands threatened by pollution and other anthropogenic activities, State Governments were requested to identify lakes that could be include the National Lake Conservation Plan. The activities of the NLCP include

formulation of perspective plans for conservation based on resource survey using remote sensing technology and GIS studies on biodiversity and related ecological matters, prevention of pollution from point and non-point sources, treatment of catchment, desilting and weed control.

- Wild Life Protection Act is in the final stage of revision and provisions have been made for conservation reserves and com-

Table 9.6 World heritage sites

Site	Location
Kaziranga National Park	Assam
Keoladeo Ghana National Park	Rajasthan
Manas Wildlife Sanctuary	Assam
Nanda Devi National Park	Uttar Pradesh
Sundarban National Park	West Bengal

munity reserves to allow restrictive use to make it more people oriented. Presently Biodiversity Act which is in the final stage, has got the component of National Biodiversity Authority to control access to genetic resources form international community. There will also be State Biodiversity Boards to control access to domestic consumers.

- Under the World Heritage Convention, five natural sites have been declared as “**World Heritage Sites**”, the name of which are under:
 - The Tura Range in Gora Hills of Meghalaya is a gene sanctuary for preserving the rich native diversity of wild Citrus and Musa species.
 - Sanctuaries for rhododendrons and orchids have been established in Sikkim.
 - Large mammal species targeted protection based on the perception of threat to them have been under implementation.
- **Project Tiger.** A potential example of an highly endangered species is the Indian Tiger (*Panthera tigris*) The fall and rise in the number of Tiger’s in India is an index of the extent and nature of conservation efforts. It is estimated that India had about 40 000 tigers in 1900, and the number declined to a mere about 1 800 in 1972. Hence, Project Tiger was launched in 1973 with the following objectives:
 - To ensure maintenance of available population of Tigers in India for scientific, economic, aesthetic, cultural and ecological value
 - To preserve, for all times, the areas of such biological importance as a national heritage for the benefit, education and enjoyment of the people
 - At present there are 25 Tiger Reserves spreading over in 14 states and covering an area of about 33 875 sq km and the Tiger population has more than doubled now due to a total ban on hunting and trading tiger products at national and international levels and the implementation of habitat improvement and anti-poaching measures (MoEF 2000)



Photo 9.14 Herd of elephants of North-east India
 Source MoEF Annual report 1998-99

- **Project Elephant** was launched in 1991-92 to assist States having free ranging population of wild elephants to ensure long term survival of identified viable populations of elephants in their natural habitats (Photo 9.14). Major activities of Project Elephant are:
 - Ecological restoration of existing natural habitats and migratory routes of elephants
 - Development of scientific and planned management for conservation of elephants habitats and value population of wild Asiatic elephants in India
 - Promotion of measures for mitigation of man-elephant conflict in crucial habitats and moderating pressures of human and domestic stock activities in crucial elephant habitats
 - Strengthening of measures for protection of wild elephants from poachers and unnatural caused of death
 - Research on Project Elephant management related issues
 - Public education and awareness programmes
 - Eco-development
 - Veterinary care

- Rhinos have been given special attention in selected sanctuaries and national parks in the North East and North-west India. All these programmes, though focussed on a single species, have a wider impact as they conserve habitats and a variety of other species in those habitats.



Photo 9.15 Joint Forest Management

- The Ministry of Environment and Forests constituted the National Afforestation and Eco-development Board (NAEB) in August 1992. National Afforestation and Eco-development Board has evolved specific schemes for promoting afforestation and management strategies, which help the states in developing specific afforestation and management strategies and eco-development packages for augmenting biomass production through a participatory planning process of Joint Forest Management and microplanning (Photo 9.15).

Ex-situ conservation (outside natural habitats)

To complement in situ conservation, attention has been paid to ex-situ conservation measures. According to

currently available survey, Central Government and State Government together run and manage 33 Botanical Gardens. Universities have their own botanic gardens. There are 275 zoos, deer parks, safari parks, aquaria etc. A Central Zoo Authority was set up to secure better management of zoos. A scheme entitled Assistance to Botanic Gardens provides one-time assistance to botanic gardens to strengthen and institute measure for ex-situ conservation of threatened and endangered species in their respective regions.

Recent conservation initiatives

Several recent initiatives of the Indian Government have focused on wetland, mangroves and coral reef management. In 1998-99, an amount of Rs. 140 lakhs were released to the State Governments for the preparation of management action plans for Pongdam in Himachal Pradesh, Wullar in Kashmir, Loktak in Manipur, Rudrasagar in Tripura and Kolleru in Andhra Pradesh. Additionally, one more wetland has been identified for conservation, i.e. Rudrasagar from Tripura, thus increasing the list to 20 wetlands for intensive conservation in the country. Additionally, a wetland strategy has been drafted.

The National Committee on Conservation and Management of Mangroves and Coral Reefs in September 1998 recommended the establishment of an Indian Coral Reef Monitoring Network to develop Action Plans for important coral reefs of the country. Preparation of these plans is already underway. Moreover, financial assistance from UNDP/GEF has led to a PDF-B project on strengthening the Gulf of Mannar Biosphere Reserve. The ZSI (Zoological Survey of India) has initiated another UNDP/GEF project relating to management of Andaman's coral reefs.

Policy gaps

- Lack of policies for protection of wetlands, grasslands, sacred groves and other areas significant from the point of view of biodiversity.
- Lacunae in economic policy, institutional and governance system
- Inadequate enforcement of existing laws
- Poor implementation of wildlife protection act 1972 as amended in 1991
- Inadequate implementation of eco-development programmes
- Need for enhanced role of NGOs and other institutions
- Need for political commitment and good will.
- Need for providing Institutional Structure
- Need for more sectoral financial outlay
- Human resource development - limited local community participation

Knowledge/information/data

- Documentation of biodiversity is an urgent requirement as latest statistics and data on floral and faunal biodiversity of India has not been compiled and documented.
- The information and data should be made available to the scientific and socio-economic agencies to support the evaluation/revision of the policies.
- Lack of knowledge of the magnitude, patterns, causes and rates of deforestation and biodiversity laws at the ecosystem and landscape level.
- Information on poaching trade and trade routes is sketchy and current wildlife protection and law enforcement measures are inadequate and inefficient procedure.
- Biodiversity Act /Bill should not override the provisions of Wildlife Protection Act.

Policy recommendations

- Most of the legal provisions pertain mainly to use/exploitation of biological resources, rather than their conservation. Even Wild Life Protection Act 1972, focuses on protection rather than conservation. Protection under Wild Life Protection Act is largely directed towards large animal species (charismatic terrestrial species) rather than the large spectrum of fauna and flora also found in the marine realm.
- Hence the existing laws relating to biodiversity shall be examined in order to bring them in tune with the provisions of convention to reflect current understanding of biodiversity conservation.
- Need for comprehensive legislation on biodiversity conservation and use especially fisheries policies, which is generally ignored.
- Formulation of policies for protection of wetlands, grasslands, sacred groves, marine flora and fauna and other areas significant from the point of view of biodiversity.
- Improving policy environment.
- Passage of biodiversity bill.
- A presence of a biodiversity cell in all development departments impinging on land and water.
- Documentation of biodiversity.
- Increase allocation of financial resources for conservation of biodiversity.
- Integrating conservation with development
- Incentives and disincentives for improper use of biodiversity
- Biodiversity Act / Bill should not override the provisions of Wildlife Protection act.
- There should be continuous monitoring of biodiversity use for review of results of implementation of policies and programmes.

References

- Babu, G.V.S.; Arora, S. (1999) *Hotspots of Biodiversity*. New Delhi: Ministry of Environment and Forests. 4–5 pp
- Baillie, J. (1996) *IUCN of Threatened Animals: analysis*. Switzerland: The World of Conservation Union IUCN
- Khoshoo, T.N. (1996) 'Biodiversity in the Indian Himalayas: conservation and utilization'. In *Banking on Biodiversity*, edited by Sheggi P Kathmandu: International Centre for Integrated Mountain Development
- MoEF (1999) *National Policy and Macrolevel Action Strategy on Biodiversity*. New Delhi: Ministry of Environment and Forests, Government of India
- MoEF (2000) *Annual Report (1999-2000)*. New Delhi: Ministry of Environment and Forests, Government of India
- GoI (1987) *Mangroves a status report*. New Delhi: Government of India
- GoI (1990) *Wetlands of India: a directory*. New Delhi: Government of India
- Olson, J.S.; Watts, J.A.; Allison, L.J. (1983) *Carbon in live vegetation of major world ecosystems*. Oak Ridge National Laboratory: WCMC 1992
- Subba Rao, N.V. (1989) *Fauna of Andaman and Nicobar Islands: Diversity, endemism, endangered species and conservation strategies*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd
- Wood, A.; Pamela, S.E.; Johanna, M. (2000) *The Root causes of biodiversity loss*. United Kingdom: Earthscan Publications