



# Biodiversity

# Introduction

## Definition

Biological diversity or biodiversity is a term used to refer to all aspects of variability in the living world, including diversity within and between individuals, populations, species, communities and ecosystems. Often the term 'biodiversity' is used to loosely refer to all species and habitats in some given area for the variety of life. The term includes plants,

The 1992 United Nations Earth Summit in Rio de Janeiro defined "biological diversity" as "the variability among living organisms from all sources, including, 'inter alia', terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems".

animals, and micro-organisms, their genes and the systems they inhabit. Biologists most often define "biological diversity" or "biodiversity" as the "totality of genes, species, and ecosystems of a region". This definition presents a unified view of the traditional three levels at which biological variety has been identified:

- species diversity which refers to the numbers and kinds of living organisms
- genetic diversity which refers to genetic variation within species
- ecosystem diversity which denotes the variety of habitats, biological communities and ecological processes.

Species diversity - Species are defined as members of a group of organisms that reproduce between themselves. Species are grouped according to different kingdoms of living organisms. From the abundance of species in the world, only about 1.75 million species have been identified - there are many other species that are unknown and scientists estimate

Kingdom	Identified species
Bacteria	4,000
Protocists (eg, algae and protozoa)	80,000
Animals	1,320,000
Fungi	72,000
Plants	2,70,000
Total	1,746,000

that they range from 3 to 100 million. Even though extinction (such as that of the dinosaurs) is a natural process, human activities like illegal hunting, destruction of natural habitats, and overexploitation of resources have dramatically accelerated the current rate of decline. Extinction raises specific concerns because it is irreversible.

Genetic diversity - Genetics refers to the chromosomes, genes, and deoxyribonucleic acid (DNA) that determine the uniqueness of each individual and species. Colours, size, and resistance to disease are all expressions of genetic diversity. Genetic variation is important for maintaining fitness and adaptability of species to environmental change. Natural adaptation and intervention in the genetic trait with genetic technological discoveries allow species to be flexible in the face of environmental change. On the other hand, failure in adaptation and lack of genetic technology increases the risk of extinction. The loss of genetic diversity, therefore, could lead to the extinction of species.

Ecosystem diversity – An ecosystem is defined as a system of interrelationships, interactions, and processes between plants and animals (including humans) and their physical environment. It is a more comprehensive concept than a simple habitat and includes the habitat, its organisms, their interactions, and other factors—for example, nutrients, energy, and water cycles. Habitat refers to the areas in which biotic organisms live and survive in an ecologically balanced environment. Within each ecosystem, there are habitats that may also vary in size. A habitat is the place where a population lives. A population is a group of living organisms of the same kind living in the same place at the same time. All of the populations interact and form a community. The community of living things interacts with the non-living world around it to form the ecosystem. The habitat must supply the needs of organisms, such as food, water, temperature, oxygen, and minerals. If the population's needs are not met, it will move to a better habitat. Two different populations cannot occupy the same niche at the same time, however. So the processes of competition, predation, cooperation, and symbiosis occur. Biomes are ecosystems where several habitats intersect. The Earth itself is one large biome. Smaller biomes include desert, tundra, grasslands, and rainforest.

There is a close relationship between ecosystem and biological diversity. Destruction of ecosystems will have a significant impact on biological diversity or nature per se. Some groupings of ecosystems are as follows:

- i. Marine and coastal ecosystems (mangroves, coral reefs, deep sea)
- ii. Inland water ecosystems (rivers, lakes, ponds, swamps)
- iii. Forest ecosystems (tropical rainforests, boreal forests)
- iv. Dryland ecosystems (deserts, grasslands)

Some major classifications of habitats are:

i. **Terrestrial**

While 70 per cent of the Earth's surface is covered by water only 30 per cent is land.

Forest – It is estimated that the total area of land covered with forest in the year 2000 was 3,866.1 million hectares. The area represents approximately one-third of the world's land area of which 95 per cent is natural forest and 5 per cent is planted forest. Forests are critically important for maintaining biodiversity. Estimated to contain half of the world's biological diversity, natural forests have the highest species diversity and endemism of any ecosystem type. There are three major types of forest classified according to latitude: tropical, temperate and boreal forests (taiga).

Grasslands – In the past, grasslands occupied 40 per cent of the land area, but today most of it is under cultivation. All have in common a climate characterised by high rates of evaporation, periodic severe droughts, a rolling to flat terrain, and animal life that is dominated by grazing and burrowing. Some examples of grasslands are the prairies of North America, the South African veld, the South American pampas, the steppes of Europe and the savanna of East Africa.

Deserts- Desert is defined as land where evaporation exceeds rainfall. No specific rainfall can be used as criterion, but deserts may range from extremely arid ones to those with sufficient moisture to support a variety of life. Deserts occupy about one-fifth of the land

surface of the earth and are largely confined to a worldwide belt between the Tropic of Cancer and the Tropic of Capricorn. In the desert environment, species which can survive the intense heat and arid conditions have adapted through natural processes. Some of the major deserts of the world are the Sahara and Namib Desert in Africa and Gobi and Thar desert in India.

#### ii. Freshwater

Freshwater habitats, the diverse communities found in lakes, rivers and wetlands are limited, covering only about 1 per cent of the Earth's surface. Yet they are highly diverse and contain a disproportionately large number of the world's species. The majority of the world's population lives near freshwater environments and depend on them for water, food and employment.

#### iii. Marine

The marine or ocean environment occupies 70 per cent of the earth's surface. While the average depth of the ocean environment is around 4000 meters, it is in some places nearly 7 kilometers deep. The volume of surface area lit by the sun is small in comparison to the total volume of water involved. This and the dilute solution of nutrients, limits production. All the seas are interconnected by currents, dominated by waves, influenced by tides and characterised by saline waters. The primary production is considerably less than the earth's land surface. They are less productive because only a superficially illuminated area up to 100 meters deep can support plant life, mainly phytoplankton. This plant life is also patchy because most of the open sea is nutrient poor. Much of this nutritional impoverishment results from limited nutrient reserve that can be re-circulated.

### **Biodiversity in India**

Biodiversity is not distributed evenly across the globe. Certain countries, called mega biodiversity countries, lying mostly in the tropics, are characterized by high species richness and more number of endemic species. India is one of group of 16 megadiversity countries known as the Like-Minded Megadiverse Countries (LMMCs). These other countries are Bolivia, Brazil, China, Colombia, Costa Rica, Democratic Republic of Congo, Ecuador, Indonesia, Kenya, Madagascar, Malaysia, Mexico, Peru, Philippines, South Africa and Venezuela. The LMMCs hold nearly 70% of all biodiversity.

Although India has only 2.4 per cent of the world's land area, it accounts for 7-8 per cent of the recorded 1.7 million species of the world, spread over 45,523 species of plants (11.80%) and 91,307 species of animals (7.46 %) in its 10 bio-geographic regions. Nearly 6,500 native plants are still used prominently in indigenous healthcare systems. Thousands of locally-adapted crop varieties, grown traditionally since ancient times, and nearly 140 native breeds of farm livestock, continue to thrive in its diversified farming systems. The country is recognized as one of the eight Vavilovian Centres of Origin and Diversity of Crop Plants, having more than 375 wild ancestors and close relatives of cultivated plants still growing and evolving under natural conditions. In addition, 5,650 microbial species have been described in India, out of the 2,78,900 species of microorganisms at the global level

A wide variety in physical features and climatic situations has resulted in a diversity of habitats and ecosystems such as forests, grasslands, mountains, wetlands, coastal and marine (mangroves and coral reefs) and deserts.

### Importance of protecting biodiversity

Life on Earth depends on nature. Humans need the diversity of nature for important services, such as food and water resources. Nature is also a source of economic opportunities. Protecting biodiversity is thus in everybody's interest. Humans derive many essential goods from ecosystems including seafood, game animals, fodder, firewood, timber, and pharmaceutical products. Ecosystem services include

- Provision of medicines,
- Purification of air and water,
- Mitigation of droughts and floods,
- Generation and preservation of soils and renewal of fertility,
- Detoxification and decomposition of wastes,
- Pollination of crops and natural vegetation,
- Dispersal of seeds,
- Cycling and movement of nutrients,
- Control of the vast majority of potential agricultural pests,
- Protection of coastal shores from erosion by waves,
- Partial stabilization of climate,
- Moderation of weather extremes and their impacts, and
- Promotion of tourism and provision of aesthetic beauty.

Until recently, humans have not appreciated that ecosystems are fundamental to supporting life. For example, deforestation has made clear the critical role played by forests in regulating water cycles. Biodiversity guarantees the stability of ecosystems. Removing one species can affect the entire food chain and ecosystem.

Every year, the International Union for Conservation of Nature and Natural Resources (IUCN) assesses the status of threatened species and publishes the Red List of Threatened Species. The 2006 Red List as detailed in the following table shows that more than 16,000 species of animals and plants are threatened.

Organisms (by group)	Species described (number)	Threatened species (number)	Species Threatened (percentage)
Vertebrates	58,808	5,624	10%
Mammals	5,416	1,093	20%
Birds	9,934	1,206	12%
Reptiles	8,240	341	4%
Amphibians	5,918	1,811	31%
Fish	29,300	1,173	4%
Invertebrates (insects, mollusks and others)	1,190,200	2,101	0.18%
Plants	287,655	8,390	3%

## Main threats to biodiversity

The Convention on Biological Diversity recognizes five major threats to biodiversity:

- habitat change: loss, degradation and fragmentation;
- invasive alien species (bio-invasion);
- overexploitation of resources;
- pollution and nutrient loading; and
- climate change and global warming.

Other threats include biotechnology, agricultural methods, desertification, shrinking genetic diversity, biopiracy, declining forest resource base, impact of development projects and illegal trade of species

### Habitat loss and fragmentation and shrinking of genetic diversity

The most effective way to conserve biodiversity is to prevent the degradation of habitats. According to studies, habitat loss is the main threat to 85 percent of the species on the IUCN Red List. Studies reveal that urbanization (clearing land for development), deforestation and agricultural expansion have dramatically accelerated habitat loss. Pressing needs for food, fibre, shelter, fuel and fodder combined with compelling need for economic development exert enormous pressure on natural resources.

Marine and coastal ecosystems have been degraded or altered by changes in land use and habitat destruction (development, tourism, fisheries, deforestation, mining and aquaculture).

Fragmentation refers to the division (from natural causes, road construction or other human activities) of large areas of habitat into smaller patches. Fragmentation makes it difficult for isolated species to maintain large enough breeding populations to ensure their survival. It also diminishes the quality of the remaining habitats.

Inland water ecosystems can be physically altered and destroyed by dams and reservoirs, and by introducing water, drainage, canal and flood-control systems. The loss and fragmentation of natural habitats affect all animal and plant species. There is an urgent need to not only stop any further habitat loss immediately but also restore a substantial fraction of the wilderness that has been depleted in the past. Various species of plants and animals are on the decline due to habitat fragmentation and over-exploitation, e.g. habitats of Great Indian Bustard in Madhya Pradesh, Gujarat and Rajasthan, and of the Lion-tailed Macaque in Western Ghats.

The major impact of developmental activities involves diversion of forest land. Since the enactment of Forest (Conservation) Act in 1980, 11.40 lakh hectares of forest area, for about 14,997 development projects, has been approved for diversion. Against this diversion, compensatory afforestation has been stipulated for over 12.10 lakh hectares of land.

Habitat fragmentation and loss is also one of the primary reasons leading to cases of man-animal conflict. Common property resources like pastures and village forests, which served as buffer between wildlife habitat and agriculture, have been gradually encroached upon

and converted into agricultural fields and habitation. Due to this, the villagers are brought into a direct conflict with wild animals.

Sacred groves, initiatives of communities for conserving biodiversity due to their religious beliefs (India has over 19,000 sacred groves) are also getting degraded or converted to plantations. Because there are several medicinal plants and wild relatives of crop plants occurring naturally in these areas, the sacred groves need to be conserved. Traditional norms and practices for conservation of neighbourhood forests and common land are also diminishing

Loss of habitats and over-exploitation have led to depletion of genetic diversity of several wild animals and cultivated plants. Shrinking genetic diversity leads to more vulnerability to diseases and pests and lesser adaptability to environmental changes. This lesson has emerged from the world-wide experience of drastically curtailed genetic diversity in agricultural biodiversity following the so-called Green and White Revolutions in agriculture-based economies, including India.

Conserving the flagship large animal species (such as the lion, tiger, rhino and elephant) has also highlighted the concern that these projects should aim at broadening the genetic base (gene pool) in breeding populations besides focusing on habitat protection. The decisive factor in saving critically endangered species is maintaining the minimum size and genetic base of inter-mating individuals rather than their total number which may include the non-breeding individuals also.

An assessment of plant genetic resources for food and agriculture illustrates this point. These resources contribute to people's livelihoods while providing food, medicine, feed for domestic animals, fibre, clothing, shelter, energy and a multiple of other products and services. India is remarkably rich in agriculturally important genetic resources. However, both the number of crops grown on commercial scale and the number of their varieties grown under different agro-ecosystems, have severely declined in recent decades reducing thereby the agricultural biodiversity maintained in diverse farming systems.

About 150 crops feed most of the human population at present, but just 12 of them provide 80% of food energy (with wheat, rice, maize and potato alone providing 60%). Also, about 30 mammalian and bird species are used extensively, but just 15 of them account for over 90 per cent of global livestock production. The Indian scenario is not very different. Choice of crops and farm livestock in agricultural production systems is now getting largely influenced by market trends and changing lifestyles, affecting the variety, taste and nutrition value of our food basket. Landraces, developed and grown traditionally by farming communities through generations, locally adapted obsolete cultivars and their wild relatives comprise crop genetic resources. These provide the building blocks used by farmers and scientists as the raw material for breeding new plant varieties and also act as a reservoir of genes sought after for manipulation using new tools of biotechnology. Indigenous cultivars, adapted to local situations are, however, mostly low yielding.

#### **Invasive alien species (bioinvasion)**

Introduced, alien, or exotic species are plants, animals or micro-organisms that have been introduced outside their natural distribution (past or present) intentionally or accidentally through human activities. Not all alien species are harmful, and many have been introduced

intentionally for the benefits they offer. As they are not indigenous to a specific ecosystem but become established in the new environment and then proliferate and spread they are considered as Invasive Alien Species (IAS). IAS that are destructive to human interests, ecosystems and environment can

- cause disease in or prey upon native plants and animals;
- change local habitat, making it inhospitable to native species; or
- reproduce faster than native species and crowd them out by inhabiting their space and eating their food.

Invasive species are the second greatest cause of biodiversity loss and that they could lead to local extinction of species.

The World Conservation Union's list of the 100 worst invasive alien species includes purple loosestrife, leafy spurge, Japanese knotweed, green crab, spiny water flea, common carp, rainbow trout, and rats. Since the 17<sup>th</sup> century, invasive species have contributed to nearly 40 percent of animal extinctions, for which the cause is known. Annual environmental losses caused by pests introduced to the United States, the United Kingdom, Australia, South Africa, India, and Brazil have been calculated at over US\$100 billion.

The most common way species are introduced is through ballast water from ships that transports an estimated 3,000 species of animals and plants every day. An example is the zebra mussel, which threatens the ecosystem of the Great Lakes in Canada and the United States by consuming the plankton that is the main food for many fish.

The major plant invasive species include *Lantana camara*, *Eupatorium glandulosum*, *Parthenium* species, *Mimosa* species, *Mikania micrantha*, *Ulex europaeus*, *Prosopis juliflora*, *Cytisus scoparius*, *Euphorbia royleana*, etc. Alien aquatic weeds like water hyacinth and water lettuce are increasingly choking waterways and degrading freshwater ecosystems. *Lantana* and carrot grass cause major economic losses in many parts of India. Highly invasive climbers like *Chromolaena* and *Mikania* species have over-run the native vegetation in North-East Himalayan region and Western Ghats. Numerous pests and pathogens such as coffee berry borer, turnip stripe virus, banana bunchy top virus, potato wart and golden nematode have invaded agro-ecosystems becoming a serious menace. In addition, illegally introduced catfishes (like the African magur) and also the big head carp are known to have adversely affected native fish diversity. The accidental entry of silver carp in Govindsagar lake led to its subsequent dominance over the native catla and mahseer fish. *Tilapia* has similarly been reported to have adverse effects on indigenous species in Vaigai reservoir in Tamil Nadu. A recent intruder, the African catfish (also called Thai magur) seem to have posed even far greater threats to native fish fauna.

India follows international quarantine regulations. However, at present there is no exclusive legislation or policy in India to deal with the invasive alien species. The Directorate of Plant Protection, Quarantine and Storage, Faridabad, Ministry of Agriculture is the nodal agency to enforce the regulations. The latest regulations are the 'Plant Quarantine Order 2003'. On preliminary assessment, 61 species of plants (including 12 species of fungi) and 14 species of insects have been identified as invasive having national distribution and 36 species having regional distribution. About 28 species native to India have been found to be invasive to other biogeographical zones. The Indian Council of Forest

Research and Education has established a 'FIS Cell' in Forest Research Institute to deal with various aspects of management of Foreign Invasive Species in the country.

#### Overexploitation of resources

With the world population currently at more than six billion people, there is an increasing need for living space and food. Traditional methods of harvesting natural resources are being replaced by intensive technologies, often without controls to prevent overexploitation. Forestry is a major source of income for some countries, but it can cause the extinction of many species if it is not managed properly. Forests face threats on account of diversion of forest land for agriculture, industry, human settlements, and other developmental projects. Construction of roads and canals, quarrying, shifting cultivation and encroachments are other threats. Degradation of forests results from illicit felling, excess removal of forest products, fodder, fuel wood, forest floor litter, overgrazing and forest fires. As a result, some of the floristic and faunal components, including many keystone and endemic forest species are now left with narrow eroding populations which need to be urgently conserved.

Even though forestry is the second largest land use in India after agriculture, covering approximately 23.57 per cent (recorded forest area) of the total geographical area, the contribution to the Gross Domestic Product from forestry is minimal. An estimated 41 per cent of the country's forest cover has been degraded to some degree. As much as 78 per cent of forest area is subject to heavy grazing and about 50 per cent of the forest area is prone to forest fires. Domestic demand for timber and fuelwood is well above the sustainable level. The rich diversity of medicinal plants (over 6,500 species) in the country needs conservation and sustainable utilization, as their habitats are either degraded or the species are being over-exploited. In fact, nearly 90 per cent of the medicinal plants in trade are harvested from the wild. The medicinal plants constitute critical resource for health care of rural communities and for the growth of Indian herbal industry.

The five grassland types in India (namely, Sehima-Dicanthium type, Dicanthium-Cenchrus-Lasiurus type, Phragmites-Saccharum- Imperata type Themada-Arundinella type and Temperate-Alpine type) too are under severe threat. There is dearth of both trained manpower and targeted research on grasslands and their carrying capacities. Similarly, the wetlands and coastal and marine ecosystems such as mangroves and coral reefs are also facing threats from increased resource use, pollution, reclamation and illegal poaching.

Although seafood is the primary source of protein for many coastal peoples, (especially the poor), they have not been the main factor in the demise of the global fishery. Much of the global catch is for luxury foods or is processed into livestock feed. As the top predators are depleted, progressively smaller or alternative species are being taken. Some fishing equipment (for example, equipment used for bottom trawling) and destructive fishing practices (for example, blast fishing) can be threats to marine species. The threats include entanglement and drowning in fishing nets (for example, of dolphins and sea turtles). In

addition, illegal exploitation of resources (illegal logging, fishing, poaching) can add an additional burden on the environment and its biodiversity.

Unsustainable exploitation of biodiversity resources, particularly by developed countries, have serious adverse impacts, both local and global. The global impacts are largely manifest in developing countries, and may further accentuate poverty in these countries. Failure on the part of developed countries to provide incentives for conservation in the form of financial resources, technology transfer and scientific cooperation, as envisaged under the Convention on Biological Diversity, further dampen the conservation efforts in the developing countries.

#### Pollution and nutrient loading

Pollutants affect the health of species directly (for example, when they breathe) or indirectly (for example, when they eat). Pollutants drift with prevailing water and air currents and are often deposited far from their original source or across geopolitical borders. Pollutants such as pesticides or chemicals directly affect the food chain. Fertilizers such as nitrogen, sulphur, and phosphorus that increase agricultural productivity run off into natural ecosystems and cause nutrient loading. Excessive nutrients negatively affect the ecosystems' nutrient cycles, their functioning, and, ultimately, the species they contain. Species that need low levels of nitrogen, such as temperate grasslands, are particularly vulnerable. Eutrophication (the depletion of oxygen from an environment due to over-dense flora), nutrient pollution, and sewage are threats to freshwater and marine ecosystems, as they threaten the survival of many aquatic organisms. Pollution (including eutrophication and oil spills) in water and on land significantly threatens the health of species and contributes to the destruction of biodiversity.

#### Climate change and global warming

Many animals, plants, and their communities survive and prosper in areas where they are best adapted to the climate. They are affected by even small changes in the climate. Climate change, on account of build-up of greenhouse gases in the atmosphere leading to global warming, poses another significant threat to biodiversity, ecosystems, and the goods and services they provide. The Earth is warming faster than at any time in the past 10,000 years. In its fourth assessment report (2007), the Intergovernmental Panel on Climate Change (IPCC) determined that

- the Earth's mean surface temperature increased by 0.74 degrees Celsius over the last century,
- the 1990s were warmest on record so far,
- some precipitation patterns have changed, and
- the global sea level has risen by an estimated .17 metres during the 20 th century.

Studies show that climate change has a significant impact on biodiversity—leading to the extinction of species and the destruction of habitats. Some species will move to more suitable areas, where they may interact with new species, but others will disappear altogether. There are indications that the projected changes in temperature and CO<sub>2</sub>

concentration may alter growth, reproduction and host-pathogen relationships in both plants and animals. It is believed that the ecosystems with undiminished species diversity, and species with their genetic diversity intact, are likely to be in a much better position to face the impact of climate change. Global warming can result in a rise in the sea level, which may threaten vulnerable habitats, including mangroves, coral reefs, and coastal wetlands. Recent empirical evidence and predictive modelling studies show that climate change will speed up the decline of certain populations.

Changing wind patterns, ocean currents, pH levels, and temperatures affect oceanographic processes and affect marine biology in ways that have not been quantified in models.

The Intergovernmental Panel on Climate Change in its summary report released in February 2007 has estimated huge loss of biodiversity for biodiversity-rich megadiverse countries such as India, because of higher greenhouse gas emissions. Targeted research on impacts of climate change on forest types, eco-sensitive zones, crop yields and biodiversity is required under the changing climatic regime. Similarly, scientific studies have brought out that strong interlinkages exist between desertification and biodiversity loss. This calls for undertaking focused research on the impact of desertification, as also synergizing efforts to combat desertification and promote biodiversity conservation.

### Illegal trade of species

Another threat to biodiversity is the illegal trade of animal and plant species. Species are exported for a variety of reasons. For example

- some plants and animals are exported for medical purposes,
- other plants and animals are exported for collections (for example, orchids),
- fish are exported for aquarium markets, and
- birds are exported as pets (for example, parrots).

Exporting these species is only considered illegal under certain circumstances. However, the export of some species—often those that are believed to cure diseases or enhance health (for example, some people believe that the horn of a rhinoceros can be used to improve one's health)—is always illegal. In many countries, the trade of species can boost the economy. However, exporting some species could threaten their survival.

To address this issue, many countries signed an international agreement in 1975: the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

### Biotechnology

Advances in biotechnology have made it possible to transfer genes from one species to another. Genetic modification could help provide more food for the growing population. Development and introduction of transgenic or genetically modified organisms, developed through the use of r-DNA technology, are already in the process of revolutionising all facets of human life, be it agriculture, industry or health care. However, this technology is still relatively new and many scientists are concerned about its potential side effects on human

health (for example, food allergies) and on the environment (for example, biodiversity risks). In particular, genetically modified organisms (GMOs) that are accidentally released into the natural environment could affect biodiversity by reproducing (mating) with native species and causing a reduction in genetic diversity. For example, if the modified genes made them stronger than native species, individual species with the introduced genes could successfully compete for resources with native species and may eliminate the natural genetic diversity.

New plant varieties developed using rDNA techniques, commonly referred to as genetically engineered (GE), genetically modified (GM) or transgenic plants, have been and are being developed with the aim of: enhancing productivity; decreasing dependence on the use of agricultural chemicals; modifying the inherent properties of crops; and improving the nutritional value of foods and livestock feeds. As more GE plants are released and the resultant food products are commercially available and are traded across various countries, concerns have been expressed about their safety. With this increased awareness, the concept of food safety assurance (i.e., that a food is safe for human consumption according to its intended use) has assumed importance as with any method of genetic manipulation, including genetic engineering of plants, there is a possibility of introducing unintended changes along with the intended changes, which may in turn have an impact on the nutritional status or health of the consumer.

Significant investments in biotechnology research have been made in India and many research projects are at advanced stages of development. About 20 recombinant therapeutics and a transgenic crop, Bt cotton, have already been approved for commercial use in the country. The area under Bt cotton cultivation has increased substantially in the last six years. Further, 11 transgenic crops are under various stages of field trials. A multi-tiered mechanism is already in place in India to evaluate and regulate such organisms and their products. However, the long-term impact of introduction of transgenics on biodiversity, particularly on genetic diversity of domesticated animals and crops, is far from clear. The sheer magnitude of potential benefits of transgenics, and the perceived fears of their possible harmful consequences, call for urgent steps to review the existing mechanisms and protocols for biosafety assessment of transgenic organisms on a continuous basis. The application of Genetic Use Restriction Technologies (GURTs) or terminator technologies is prohibited and import of GURTs based products is also banned in India. Hence, there is a need to further develop state-of-the-art containment facilities and diagnostic tools for GURTs in the country. Policies and programmes, aimed at securing biotechnological capacity building of the country for realizing the actual and potential value of biodiversity, along with its conservation, also need to be strengthened.

To address the human health safety of foods derived from GE plants, there is a need to adopt a systematic and structured approach to their risk analysis. Risk analysis is a science based process comprised of risk assessment, risk management and risk communication and is an analytical tool to systematically evaluate safety concerns addressing human health

safety of GM foods within a framework for decision making. It also provides further basis for reviewing the safety evaluation parameters as and when further information becomes available.

In India, the manufacture, import, use, research and release of GMOs as well as products made by the use of such organisms are governed by the rules notified by Ministry of Environment and Forests (MoEF), Government of India on December 5, 1989 under the Environmental (Protection) Act 1986 (EPA). These rules and regulations, commonly referred to as Rules 1989, cover the areas of research as well as large-scale applications of GMOs and products made therefrom throughout India (MoEF 1989). The regulatory agencies responsible for implementation of the Rules 1989 are MoEF and the Department of Biotechnology (DBT), Government of India, through six competent authorities:

- Recombinant DNA Advisory Committee (RDAC);
- Review Committee on Genetic Manipulation (RCGM);
- Genetic Engineering Approval Committee (GEAC);
- Institutional Biosafety Committees (IBSC);
- State Biotechnology Coordination Committees (SBCC);
- District Level Committees (DLC).

The Ministry of Health and Family Welfare (MoHFW) is primarily responsible for ensuring the availability of food that is safe. In 2006, the Food Standards and Safety Act, 2006 was promulgated. This Act will be implemented by the Food Safety and Standards Authority and includes genetically modified foods within the definition of food under the Act. Other government departments have also undertaken steps to address the safety assessment of foods derived from GE plants and recombinant microorganisms. In 1990, DBT issued rDNA guidelines covering research in biotechnology, field trials and commercial applications (DBT, 1990). DBT also brought out separate guidelines for research in transgenic plants in 1998 (DBT, 1998). The Bureau of Indian Standards (BIS) has also initiated a program to develop draft Indian standards for GM foods.

The Indian Council of Medical Research (ICMR), in its capacity as the scientific and technical advisory body to MoHFW, has formulated guidelines to establish the safety assessment procedures for foods derived from GE plants taking into consideration the international Guideline for the Conduct of Food Safety Assessment of Foods Derived from Recombinant-DNA Plants (CAC 2003b).

### Agricultural and aquaculture methods

Overgrazing can deteriorate a grasslands system until the ground becomes barren and the original water cycle is disrupted. Rainwater washed away the soil because of scarcity of vegetation. In desert grasslands, overgrazing also affects the natural vegetation. Natural grasslands have been drastically altered by general agricultural practices. The expansion of agriculture, since the 1970s, has involved cultivating marginal areas and clearing important natural habitats, such as forests and wetlands. In some countries, deforestation and

irrigation may cause the water tables to rise, leading to an accumulation of salts at the surface, which is a major problem for agriculture and the local population. This phenomenon can eventually lead to desertification.

The rapid growth of aquaculture has caused the loss of many coastal ecosystems. Effluents from aquaculture facilities can be pollutant-heavy and can degrade the surrounding habitats and species. Diseases and parasites can be transmitted to wild stocks when farmed fish escape.

### Desertification—spread of deserts

Desertification refers to the degradation of land in arid, semi-arid, and “dry sub-humid” areas brought about climatic variations, human activities and other factors. According to the United Nations Convention to Combat Desertification (UNCCD), about 3,600 million hectares, 70 percent of the world’s drylands (excluding hyper-arid deserts), are degraded. Human activities have contributed to desertification through deforestation, over-cultivation, overgrazing. Deforestation is especially problematic in the margins of the sub-Saharan Africa because of the need of fuelwood.

### Biopiracy

Biopiracy, the unfair exploitation of a country’s biological resources, is a new concern. The global market value of pharmaceuticals derived from genetic resources is estimated at between US\$ 75,000 and US\$ 150,000 million annually. Biopiracy takes advantage of knowledge—often the traditional knowledge of native peoples—that is not protected by the system of intellectual property.

The most controversial aspect of biopiracy is access to genetic resources and the distribution of derived benefits. Fair and equitable sharing of the benefits from genetic resources can encourage conservation and the sustainable use of biodiversity. Around the world, networks are being created to counteract the unauthorized use of genetic resources in pharmacy and medicine. It has been proposed that biopiracy should be regulated by an international regime, within the framework of the Convention on Biological Diversity. The regime would include mechanisms to ensure that holders of traditional knowledge receive a fair share of the benefits.

Traditional knowledge is the sum of what is known about innovations and practices of indigenous and local communities around the world. Today, there is a growing appreciation of the value of such knowledge. It is not only valuable to those who depend on it in their daily lives; it is also valuable to modern industry and agriculture. Many widely used products, such as plant-based medicines and cosmetics, are derived from traditional knowledge. It can make a significant contribution to sustainable development. Most indigenous and local communities are in the same areas as the vast majority of the world’s plant genetic resources; their members have used biodiversity in a sustainable way for thousands of years.

The patent on the "use of turmeric in wound healing" which was granted to two U.S. based Indians in 1995, but was subsequently revoked after the Council for Scientific and Industrial Research (CSIR) successfully challenged it, is one of the many examples of how patents are being sought over various aspects of biological resources and products derived from the same. Patents, by definition, cannot be granted over something that is obvious; that is known or anticipated by prior use; that is a product of nature, and not a product of human creativity. However, laws of different countries vary in the criteria used for assessment of the degree of human innovation that is required for qualifying for a patent.

Some of the other recent examples of patents granted over "inventions" based on biological resources pertain to

- Composition of jamun, bitter-gourd, gur-mar and eggplant for treatment in diabetes.
- Various products obtained from the neem tree.
- Other plant products like the Himalayan Wild Apricot found only in the Himalayas, the fruit of which yields jam, chutney and juice and the fruit kernels yield Apricot Oil, and. Aloe Vera
- Varieties of basmati which have the characteristics of growing in temperate climate in the absence of sunlight.
- Composition of methi as a tonic to bring down blood glucose levels.
- Compositions comprising of kala jeera or kalonji for increasing immune functions, and in the treatment of diabetes, hepatitis, and asthma.

NGOs and institutions in India are attempting to document the knowledge, skills and techniques of local communities related to biological resources through the Community (or People's) Biodiversity Register, in the belief that such documentation would be a deterrent to biopiracy; as well as for instilling a greater sense of pride among local communities over the knowledge they possess. The Register processes documents of community and individual knowledge of occurrence, practices of propagation, sustainable harvests and conservation, as well as economic uses of biodiversity resources. All information accumulated in the Register can be used or distributed only with the knowledge and consent of the local community, so that it is in a position to refuse access to the register and to set conditions under which access would be allowed. The fear about biodiversity registers is they may place knowledge hitherto regarded as "secret" by communities, in the public domain, and that once this is done, it would be an open invitation for corporate and research interests to freely use it. On the positive side, these registers are expected to function as tools to establish claims of individuals and communities over knowledge and uses of biodiversity resources, and to bring to them an equitable share of benefits flowing from the use of such knowledge and resources. This, however, can be achieved only when legal mechanisms of control over the register are put in place, which is not yet the case.

### **Methods of protecting and conserving biodiversity**

Human activity is the main cause of biodiversity loss. Therefore, the solution to the problem is in the management of resources and human development, in which the government plays a central role. It uses public policy tools to regulate human activities, such as urbanization,

resource extraction, and agriculture, which will help to protect the environment and biodiversity.

There are several ways to protect biodiversity. One is to create protected areas, such as national parks and conservation areas. Properly managed, protected areas provide a refuge for species and their ecosystems. This is known as in-situ conservation or “the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings.” In particular, conservation efforts are important in areas called biodiversity “hotspots.” These areas are Earth’s richest and most endangered habitats. Hotspots are regions that harbour a great diversity of endemic species and, at the same time, have been significantly affected and altered by human activities. To be declared a hotspot, the region has to have lost 70 percent or more of its original habitat. To date, Conservation International has identified 34 biodiversity hotspots where 75 percent of the planet’s most threatened mammals, birds, and amphibians survive within habitats that cover just 2.3 percent of the Earth’s surface. Such areas must be protected against illegal activities such as burning, cultivating, hunting, and poaching. Conservation should focus on critical, unique, and representative habitats that may then be considered protected areas.

Where in-situ conservation is not possible, the alternative is to have ex-situ conservation. Ex-situ conservation is “the conservation of components of biological diversity outside their natural habitats,” such as zoos for living animals and related species, botanical gardens for plants, and gene banks to preserve species. These measures may provide insurance against extinction. Re-integrating animals and plants in nature is not always successful, because they are no longer accustomed to living in their natural ecosystems. Measures must be taken to prevent the introduction of invasive alien species through trade routes.

Countries will have to reassess the way they are managing their resources. They will have to revise their river management, forestry, fisheries, and agricultural practices. Governments must consider biodiversity when making decisions that affect land use and exploitation of resources. Governments use a variety of public policy tools to support protective measures. Chief among these tools are international and regional environmental agreements, legislation, and funded programs

Another way to protect and conserve biodiversity is to increase public awareness of biodiversity and ecosystem issues. Public education is often a requirement under international agreements. Research and monitoring is essential in protecting biodiversity. There is a need to increase the knowledge and understanding of biodiversity, its value, and the threats to it. Assessing the status of biodiversity (genes, species, and ecosystems) is a major challenge. More information must be available on the gain and loss of crop varieties and the change in status of species, threatened or not, to preserve the biological balance. The status of habitats, ecosystems and threats must be covered in the main agenda for ecological meetings today, so that recovery and restoration efforts will show results tomorrow.

According to the Secretariat of the Convention of Biological Diversity ways to slow the loss of biodiversity include:

1. Sustainable and efficient agriculture. Improve the efficiency of land use, water, nutrients, and chemicals in agriculture, aquaculture, and plantations.
2. Landscape-level planning. Protect areas that are rich in biodiversity and produce essential ecosystem services. Use lands that are already converted, including degraded lands, to expand agriculture, aquaculture, and plantations.
3. Sustainable consumption. Limit over-consumption of energy, timber, and food (especially meat) by affluent sectors of society.
4. Over-exploitation of wild resources. Stop over-fishing and destructive fishing practices. Expand protected marine areas. Stop harvesting endangered species and populations.
5. Critical ecosystems. Protect and restore those ecosystems that provide resources for the poor, allow adaptation to climate change, and provide critical ecosystem goods and services.

### **Major challenges to maintaining biological diversity**

One of the challenges to conservation of biological diversity is the increasing demand for resources caused by rapid population growth and increased consumption. This issue is widely debated in the developed countries. However, in the developing countries, this question seldom arises due to the fact that they are still struggling to become a developed nation, and hence the issue of survival is more talked about than the issue of biological diversity. The main concern is to raise the level of awareness so that the importance of ecosystems and the diversity of living organisms is known along with the need to protect it or survival of mankind.

A second challenge is to increase the capacity to document and understand biodiversity, its value and the threats to it. Today, with increased awareness among the scientists, the challenge to document biological activities and the threats to them has been quite demanding. More research needs to be conducted to in this area.

The third challenge is to assess the status of biodiversity (genes, species and ecosystems). Lack of information on the gain and loss of crop varieties, changes in status of species for example, as documented in the IUCN Red List, or national species-at-risk lists has to be addressed and understood to know the performance in preserving the biological balance. Status of habitats, ecosystems, threats such as coral bleaching and loss of tropical rainforests have to be the main agenda in ecological meetings. Recovery and restoration efforts will take time to show results.

### **Biodiversity legislation in India**

#### **Introduction**

In the backdrop of varying socio-cultural milieu and often conflicting demands of various stakeholders, both in the developed as well as in the developing nations, there was an urgent need for augmenting and accelerating the efforts for the conservation and sustainable use of biological diversity, and for fair and equitable sharing of benefits arising from the utilization of genetic resources. Thus, at international levels, bilateral or multilateral agreements exist between governments in order to conserve the natural heritage. At national levels, governments have imposed rules and regulations to protect and conserve biological diversity.

### **International Conventions on Biodiversity**

Some of the important international legislations on biodiversity are summarized below:

#### **Convention on Biological Diversity**

In 1992, the global community met in Rio de Janeiro to discuss global problems concerning the environment and development in a conference called “the Earth Summit”. It brought together people with different interests from 180 countries. The negotiations resulted in an agreement known as the Convention on Biological diversity. The agreement was the first global agreement to address all aspects of biodiversity: genetic resources, species and ecosystems. It was the first agreement on the conservation and sustainable use of biodiversity. The phrase “sustainable use” means “the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs of present and future generations.” The Earth Summit was an initiative to ensure that the Earth’s natural resources will be available for future generations.

Article 8 of the agreement provides the main set of Convention obligations, recognizing in situ conservation as the primary approach. Each party is required to establish protected areas, to conserve biodiversity, to restore degraded ecosystems and to promote the recovery of threatened species. The article also emphasizes the need for parties to control the risks posed by organisms modified by biotechnology and to prevent the introduction of invasive alien species that threaten ecosystems, habitats or species.

The Convention also requires governments to develop national biodiversity strategies and action plans because the responsibility for achieving the goals rests largely with the countries themselves. The Convention also requires each government to report on how it is meeting the goals.

Knowing that the forces threatening the world’s biodiversity are global, success depends on the combined efforts of the world’s nations. Yet much of the burden falls upon the developing countries, especially those in the tropics because of the high levels of biodiversity found there. Yet developing countries in particular have special needs. They have less facilities, equipment, trained staff and resources available to devote to conservation. Financial support is essential for enabling developing countries to meet these

objectives. The Global Environment Facility is the financial mechanism of the Convention. India ratified the CBD in February 1994.

### The Cartagena Protocol on Biosafety to the CBD

The Conference of the Parties to the Convention on Biological Diversity adopted a supplementary agreement to the Convention known as the Cartagena Protocol on Biosafety on 29 January 2000 in Montreal, Canada. The Protocol is the first legally binding international agreement governing the transboundary movement of living modified organisms (LMOs) resulting from modern biotechnology. It seeks to ensure an adequate level of safety in the transfer, handling and use of LMOs which may have adverse effects on the conservation and sustainable use of biologic diversity, also taking into account potential risks to human health. The Protocol came into force in September 2003. India ratified it in September 2003.

### Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. CITES was drafted as a result of a resolution adopted in 1963 at a meeting of members of IUCN (The World Conservation Union). The text of the Convention was finally agreed at a meeting of representatives of 80 countries in Washington DC, USA, on 3 March 1973, and on 1 July 1975, CITES came into force. India became a party to the Convention in July 1976.

CITES is an international agreement to which States (Countries) adhere voluntarily. Although CITES is legally bounding on the signatories (parties) to the convention, it does not take the place of national laws. Rather it provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES is implemented at the national level. CITES has been among the largest conservation agreements in existence, with 164 parties at present.

Annually, international wildlife trade is estimated to be worth billions of dollars and to include thousands of live plants and animal specimens as well as products derived from them. Levels of exploitation of some animal and plant species is high and the trade in them, together with other factors such as habitat loss, is capable of heavily depleting their populations and even bringing some species close to extinction. Many wildlife species in trade are not endangered, but the existence of an agreement is necessary in order to safeguard these resources for the future. Because the trade in wild animals and plants crosses national boundaries, the effort to regulate it requires international cooperation to safeguard certain species from over-exploitation. CITES was conceived in the spirit of such cooperation. Today CITES accords varying degrees of protection to more than 30,000 species of animals and plants, whether they are traded as live specimens, fur coats or dried herbs. Not one species protected by CITES has become extinct as a result of trade since the Convention came into force.

### Convention on Wetlands of International Importance

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The official name is “The Convention on Wetlands of International Importance especially as Waterfowl Habitat.” There are presently 138 Contracting parties to the Convention, with 1314 wetland sites, totaling 111 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance. One of the obligations under the Convention is to designate at least one wetland for inclusion in the List of Wetlands of International Importance (the “Ramsar List”) and to promote its conservation, including where appropriate, its wise use. Selection for the Ramsar List should be based on the wetland’s significance in terms of ecology, botany, zoology, limnology or hydrology. The Contracting parties have adopted specific criteria and guidelines for identifying sites that qualify for inclusion in the List of Wetlands of International Importance. India became a signatory to the Convention in February 1982.

### United Nations Convention to Combat Desertification

Desertification is the degradation of land in arid, semi-arid and dry sub-humid areas. It is caused primarily by human activities and climatic variations. By limiting desertification, important habitats and their biological diversity can be protected. In June 1994, in Paris, the United Nations Convention to Combat Desertification was signed and it came into force in December 1996. As on date, 190 governments are parties to the Convention. The Convention aims to promote effective action through innovative local programmes and supportive international partnerships. This Convention is closely linked with the issue of global climate change and loss of biodiversity. India ratified the Convention in December 1996.

Other major multilateral environment agreements ratified by India are given in the table below:

MEAs	Year	Entry into force	Date of ratification by India	Issues covered
Convention for the Protection of World Cultural and Natural Heritage	1972	17.12.1975	04.11.1977	Protection and conservation of cultural and natural heritage
Bonn Convention on Migratory Species of Wild Animals	1979	01.11.1983	01.11.1983	Conservation, management and wise use of migratory species of wild animals and their habitats
Vienna Convention for Protection of the Ozone Layer	1985	22.09.1988	18.03.1991	Protection of atmospheric ozone layer above the planetary boundary layer.
Montreal Protocol on Substances that Deplete the Ozone Layer	1987	01.01.1989	19.06.1992	Protection of atmospheric ozone layer above the planetary boundary layer.

Basel Convention on Transboundary Movements of Hazardous Wastes and their Disposal	1989	05.05.1992	24.06.1992	Regulation of transboundary movements of hazardous wastes and their disposal.
United Nations Framework Convention on Climate Change (UNFCCC)	1992	21.03.1994	01.11.1993	Changes in the earth's climate system due to anthropogenic interference.
Kyoto Protocol to the UNFCCC	1997	16.02.2005	26.08.2002	Quantified emission limitation and reduction commitments for Annex I Parties.
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	1998	24.02.2004	24.05.2005	Promoted shared responsibility and cooperative efforts among the Parties in the international trade of certain hazardous chemicals, in order to protect human health and the environment from potential harm and to contribute to their environmentally sound use.
Stockholm Convention on Persistent Organic Pollutants	2001	17.05.2004	13.01.2006	Protect human health and the environment from persistent organic pollutants.

Some other international organizations/agreements which have bearing on biodiversity to which India is a Party include Commission on Sustainable Development, World Trade Organisation, International Treaty on Plant Genetic Resources for food and agriculture and UN Law of the Seas. A 'Global Tiger Forum' of tiger range countries has been created for addressing international issues related to tiger conservation. India has also actively supported numerous regional and bilateral programmes on biodiversity. The Ministry of Forest and Environment (MoEF), the nodal Ministry for the CBD and other biodiversity related conventions, is also the nodal agency in the country for the United Nations Environment Programme (UNEP), South Asia Cooperative Environment Programme (SACEP), International Centre for Integrated Mountain Development (ICIMOD) and IUCN. It has institutionalized the process for developing the country's position on major issues for negotiations under different international conventions.

India has established National Clean Development Mechanism Authority (NCDMA) for according host country approval to CDM projects as mandated under the Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC). One of the criteria used for

approval of CDM projects is impact on biodiversity. Host country approvals have so far been accorded to 404 CDM projects facilitating investment of more than Rs, 22,000 crores. The Government has set up an 'Expert Committee on the Impacts of Climate Change' on 7th May 2007, to study the impacts of anthropogenic climate change on India and to identify the measures that may have to be taken for addressing vulnerability to anthropogenic climate change impacts. A high level coordination committee chaired by Prime Minister, namely, 'Prime Minister's Council on Climate Change' has been set up on 6th June 2007, to coordinate national actions for assessment, adaptation and mitigation of climate change.

In this context, the MoEF is continuously taking steps to harmonise national policies and programmes in implementation of various multilateral environment agreements, based on active involvement of various stakeholders.

### **Biodiversity legislation in India**

In India, various Acts and Rules have been enacted from time to time for biodiversity conservation, some of which have been framed pursuant to India's ratifying certain international conventions. The subject relating to environment and forests is on the concurrent list of the Constitution of India. Both Central and State Governments legislate and formulate policies and programmes on this subject. Major Central Acts having direct bearing on biodiversity issues are: Indian Forest Act 1927, Wildlife (Protection) Act 1972, Forest (Conservation) Act 1980, Environment (Protection) Act 1986, and the Biological Diversity Act 2002. In addition, there are several other Acts which have relevance to biodiversity. These Central Acts are supported by a number of State laws and statutes as provided under the Constitution. An Inter-State Council has been set up under article 263 of the Constitution for co-ordination on inter-state matters.

Policies on environmental management include the National Forest Policy 1988, the National Conservation Strategy and Policy Statement on Environment and Development 1992, National Policy and Macrolevel Action Strategy on Biodiversity 1999, the National Wildlife Action Plan (2002-2016), and the National Environment Policy, 2006. Some other sectoral policies (e.g. National Agriculture Policy 2000 and National Water Policy) have also contributed towards environmental management. As our development challenges evolved and understanding of the centrality of environmental concerns in development sharpened, the National Environment Policy was developed in 2006. The NEP builds on the earlier policies and strengthens them.

Environmental framework regarding biodiversity in India

Acts

- Biological Diversity Act, 2002.
- The Biological Diversity Act, 2002.
- Coming in to force of sections of the Biodiversity Act, 2002.
- Appointment of non-official members on NBA from 1st October, 2003.
- Establishment of National Biodiversity Authority from 1st October, 2003.

- Bringing into force Sections 1 and 2; Sections 8 to 17; Sections 48,54,59,62,63,64 and 65 w.e.f. 1st October, 2003.
- Central Government authorizes the officers to file complaints with regards to offences punishable under the Biological Diversity Act, 2002, Notification.
- Central Government authorizes the officers to file complaints with regards to offences punishable under the Biological Diversity Act, 2002, Amendment Notification.
- Designation of repositories under the Biological Diversity Act, 2002.

#### Rule

- Biological Diversity Rules, 2004.

The full texts can be found at <http://envfor.nic.in/legis/bio-diversity.htm>

### **Environment and Wildlife**

#### Act

- The Wild Life (Protection) Amendment Act, 2002.
- The Indian Wildlife (Protection) Act, 1972, amended 1993.

#### Rules

- The National Board for Wild Life Rules, 2003.
- The Declaration of Wild Life Stock Rules, 2003.
- The Wildlife (Specified Plant Stock Declaration) Central Rules, 1995.
- The Wildlife (Specified Plants - Conditions for Possession by Licensee) Rules, 1995
- The Wildlife (Protection) Rules, 1995.
- Recognition of Zoo Rules, 1992.
- The Wildlife (Protection) Licensing (Additional Matters for Consideration) Rules, 1983
- The Wildlife (Stock Declaration) Central Rules, 1973.
- The Wildlife (Transaction and Taxidermy) Rules, 1973.

#### Notifications

- The National Board for Wild Life Rules, 2007.
- Constitution of the National Board for Wild Life .
- Coming into force of section 6 of the Wild Life (Protection) Amendment Act, 2002 (16 of 2003).
- Delegation of Powers of section 58E of the Wild Life (Protection) Act, 1972 (53 of 1972).
- Delegation of Powers of section 54 of the Wild Life (Protection) Act, 1972 (53 of 1972).
- Coming into force of all the provisions except section 6 of the Wild Life (Protection) Amendment Act, 2002 (16 of 2003).
- Amendments to Schedule I and Part II of Schedule II of the Wild Life (Protection) Act, 1972 (53 of 1972).
- Amendments to Schedule I and Schedule IV of the Wild Life (Protection) Act, 1972 (53 of 1972).
- Amendments to Schedule I and Schedule III of the Wild Life (Protection) Act, 1972 (53 of 1972).

- Additions to Schedule I of the Wild Life (Protection) Act, 1972 (53 of 1972).

#### **Guideline**

- Guidelines for Appointment of Honorary Wildlife Wardens

The full texts can be found at <http://envfor.nic.in/legis/wildlife.htm>

Some of the important domestic legislation is given below:

#### **Biological Diversity Act, 2002**

India is one of the few countries to have enacted this legislation. This Act primarily aims at giving effect to the provisions of the Convention on Biological Diversity (CBD), including regulating access to biological resources and associated traditional knowledge so as to ensure equitable sharing of benefits arising out of their use, in accordance with the provisions of article 15 of the CBD. The Government of India has also promulgated the Biological Diversity Rules in 2004.

The Biodiversity Act primarily addresses access to genetic resources and associated knowledge by foreign individuals, institutions or companies, to ensure equitable sharing of benefits arising out of the use of these resources and knowledge to the country and the people.

A three tiered structure at the national, state and local level has been established. All matters relating to requests for access by foreign individuals, institutions or companies, and all matters relating to transfer of results of research to any foreigner will be dealt with by the National Biodiversity Authority (NBA). All matters relating to access by Indians for commercial purposes will be under the purview of the State Biodiversity Boards (SBB). The Indian industry will be required to provide prior intimation to the concerned SBB about the use of biological resource. The State Board will have the power to restrict any such activity, which violates the objectives of conservation, sustainable use and equitable sharing of benefits. Institutions of local self government will be required to set up Biodiversity Management Committees (BMC) in their respective areas for conservation, sustainable use, documentation of biodiversity and chronicling of knowledge relating to biodiversity by preparing People's Biodiversity Registers (PBRs). NBA and SBBs are required to consult the concerned BMCs on matters related to use of biological resources and associated knowledge within their jurisdiction.

The Act provides for the following exemptions

- Exemption to local people and community of the area for free access to use biological resources within India
- Exemptions to growers and cultivators of biodiversity and to Vaidis and Hakims to use biological resources.
- Exemption through notification of normally traded commodities from the purview of the Act
- Exemption for collaborative research through government sponsored or government approved institutions subject to overall policy guidelines and approval of the Central Government.

### Wildlife (Protection) Act, 1972

The Act provides for the protection of wild animals, birds and plants; and for matters connected therewith or ancillary or incidental thereto. It extends to the whole of India, except the State of Jammu and Kashmir which has its own wildlife act. It has six schedules which give varying degrees of protection. Schedule I and part II of Schedule II provide absolute protection - offences under these are prescribed the highest penalties. Species listed in Schedule IV are also protected, but the penalties are much lower. Enforcement authorities have the power to compound offences under this Schedule (i.e. they impose fines on the offenders). The Act establishes a network of ecologically important protected areas. The Wildlife Protection Act, 1972 empowers the central and state governments to declare any area a wildlife sanctuary, national park or closed area. There is a blanket ban on carrying out any industrial activity inside these protected areas. It provides for authorities to administer and implement the Act; regulate the hunting of wild animals; protect specified plants, sanctuaries, national parks and closed areas; restrict trade or commerce in wild animals or animal articles; and miscellaneous matters. The Act prohibits hunting of animals except with permission of authorized officer when an animal has become dangerous to human life or property or as disabled or diseased as to be beyond recovery.

The Act underwent many amendments. An amendment to the Act in 1982, introduced provisions permitting the capture and transportation of wild animals for the scientific management of animal population. An amendment in the year 1991 resulted in the insertion of the special chapters dealing with the protection of specified plants and the regulation of zoos. This also recognized the needs of tribal and forest dwellers and changes were introduced to advance their welfare. The near-total prohibition on hunting was made more effective by the Amendment Act of 1991

Widespread changes have been made by the Wildlife (Protection) Amendment Act, 2002 and a new chapter has been incorporated as Chapter VI-A to deal with the forfeiture of property derived from illegal hunting and trade. Further, this amendment Act also introduced the concept of co-operative management through conservation reserve management committee and community reserve committees.

The Act thus leaves out from its scope the following:

1. Wild flora outside the notified sanctuaries and National parks (many of which located outside forest areas including deserts, coastal and marine systems, grasslands, riverine systems, wetlands)
2. Although the Act provides for protection of a number wild animals which are included in Schedules, it leaves out a large number of invertebrates (out of the 81,000 animal species so far described from the country about 68,000 are invertebrates) and micro organisms
3. The Act also does not deal with the following:
  - Issue of access to biological resources and benefit sharing
  - Protection of traditional knowledge and equitable sharing of benefits arising out of the use of such knowledge.

### Forest (Conservation) Act, 1980

The Act came into force on 25th October, 1980 and extends to the whole of India except the State of Jammu and Kashmir. It restricts dereservation of forests or use of forest land for non-forest purpose. No State Government or other authority can, except with the prior approval of the Central Government, make any order directing (i) that any reserved forest shall cease to be reserved; (ii) that any forest land may be used for any non-forest purpose; (iii) that any forest land may be assigned by way of lease or otherwise to any private person or to any authority, corporation, agency or any other organisation not owned, managed or controlled by Government; (iv) that any forest land may be cleared of trees which have grown naturally in that land or portion, for the purpose of using it for reforestation.

#### Environment (Protection) Act, 1986

In the wake of the Bhopal Gas tragedy the Government of India enacted the Environment (Protection) Act, 1986 under Article 253 of the Constitution. The purpose of the Act is to act as an “umbrella” legislation designed to provide a framework for Central government co-ordination of the activities of various central and state authorities established under previous laws, such as water Act and Air Act. The potential scope of the Act is broad, with “environment” defined to include, air, water and land and the inter-relationships which exist among these components and human beings and other living creatures. Environment protection rules were enacted as a corollary to this Act.

#### National Forest Policy, 1988

The principal aim of the National Forest Policy, 1988 is to ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium, which are vital for sustenance of all life forms, human, animal and plant. The derivation of direct economic benefit must be subordinated to this principal aim. The national goal should be to have a minimum of one-third of the total land area of the country under forest or tree cover. In the hills and in mountainous regions, the aim should be to maintain two-third of the area under such cover in order to prevent erosion and land degradation and to ensure the stability of the fragile ecosystem. The MoEF has mooted a Multi-Stakeholder Partnership (MSP) framework involving the three partners, namely, the land owning agency/ forest department, the local village community and the sponsor, for afforestation on degraded forest lands and other lands, as one of the measures to achieve the National Forest Policy goal of one-third forest and tree cover in the country.

#### National Environment Policy, 2006

The National Environment Policy (NEP), 2006 seeks to achieve balance and harmony between conservation and development. The policy is intended to mainstream environmental concerns in all development activities. The dominant theme of this policy is that while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from the fact of conservation, than from degradation of the resources. The NEP prescribes that human beings are at the center of concerns for sustainable development and they are entitled to a healthy and productive life in harmony with nature.

## Conservation efforts in India

A total of 605 Protected Areas (PA) covering approximately 4.74% of the total geographical area of the country are under in situ conservation through a PA network of National Parks (96), Wildlife Sanctuaries (509), and Conservation Reserves (3), established under the Wildlife (Protection) Act. A state-wise list of National Parks and Wildlife Sanctuaries in the country is given in Appendix II. The PA network covers about 24.2% of the forest area of the country, mainly with relatively larger populations of target species and associated ecological components. Many important habitats exist in the rest of the forests, which require special attention for conservation for ensuring sustainability of the populations. Habitats of sandalwood, red sanders, shola forests of southern tropical montane forests, alpine meadows in the Himalayan region, elephant habitats including corridors connecting PAs, southern tropical rain habitats, tropical swamps, mangroves outside forests in Sunderbans, etc., are some of such habitats existing in the forests outside the PAs. Hence, in the Eleventh Five year plan, it is envisaged to take up a new component for protection of wildlife outside PAs under the centrally sponsored scheme on 'Integrated development of wildlife habitats'.

A substantial chunk of India's biodiversity exists outside the precincts of 'formally declared conservation zones', which are owned and managed by the local communities. The livelihood security of these communities is delicately and intricately interwoven with the prudent resource management and conservation status of these areas. Further, any future plans to expand the Protected Area network in India, would depend significantly in recognizing such Community Conserved Areas. Recent amendments to the Wildlife (Protection) Act provide for setting up of Community and Conservation Reserves.

To conserve the representative ecosystems, a Biosphere Reserve (BR) programme is being implemented. Fifteen BRs have been notified, of which four have been recognized by the UNESCO under the World Network of BRs (Appendix III). Fourteen more potential sites have also been identified for this purpose. Specific programmes for scientific management and wise use of fragile ecosystems such as wetlands, mangroves and coral reef are under implementation (Appendix IV). Internationally significant wetlands are declared as Ramsar sites under the Ramsar Convention (Appendix V). Under the World Heritage Convention, natural sites are declared as world heritage sites. A National Lake Conservation Plan (NLCP) is being implemented for conservation of polluted and degraded urban/semi-urban lakes, leading to lake rejuvenation in terms of improvement in water quality and biodiversity. As on March 2007, 31 projects for conservation of 46 lakes have been taken up (Appendix VI). A National River Conservation Plan (NRCP) is also under implementation in 160 towns along polluted stretches of 34 rivers spread over 20 states, the major rivers being Ganga, Yamuna, Gomti, Damodar, Satluj, Krishna, Cauveri and Godavari. The objective of NRCP is to check pollution in rivers through implementation of various pollution abatement schemes.

Large mammal species specific projects (e.g. Project Tiger, Project Elephant) based on the perception of threat to them have been under implementation. Large tracts of the habitat of

the Great Indian Bustard in different states have been declared as protected areas. Various measures are being taken to address the declining population of vultures in India. Intensive conservation measures for other flagship species such as snow leopard, musk deer and Kashmir stag have been taken up during the Eleventh Five Year plan. Gene sanctuaries for preserving the rich native diversity of citrus, banana, rhododendron and orchids have also been established. Subsequent to amendments to the Wildlife (Protection) Act in the year 2006, National Tiger Conservation Authority and Wildlife Crime Control Bureau have been constituted.

Remedial actions for restoration of degraded areas have been undertaken through eco-restoration programmes by involving local people. Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act enacted in 2006, is a tool to provide occupational and habitational rights to the people. Empowering people, particularly assigning the ownership of minor forest produce for the purpose of access, processing and trade would enhance their livelihood. The Ministry of Tribal Affairs have allocated financial resources to the development of forest villages which have hitherto been totally cut off from the mainstream development in the country. The National Forest Policy (1988) and National Forestry Action Programme (1999) also endeavour to address some of the concerns towards Sustainable Forest Management (SFM). The Joint Forest Management (JFM) programme in the country has emerged as a powerful tool to achieve sustainable management of forestry in India. A decentralized two-tier institutional structure (Forest Development Agency [FDA] and JFM Committee) facilitates greater participation of the local communities, both in planning and implementation, to conserve forests as well as secure livelihoods. At present, more than 22.02 million ha of forests are managed by around 1.06 lakhs JFM Committees (JFMCs) involving 21.99 million people living in and around forest areas. NAEB in the MoEF gives special attention to regeneration of degraded forests. To complement the initiatives of JFMCs, a new programme called 'National Afforestation Programme' (NAP) was launched during 2002-03. Under this programme, an extent of 14.1 lakh ha is being covered by 28,181 JFMCs under 782 FDAs in 29 states. Integrated Forest Protection Assistance is also being given to States and UTs for Assistance for fire protection (196819 km).

Out of the various parameters of water quality that is monitored, Biochemical Oxygen Demand (BOD) and Coliforms are critical. Maintenance of certain level of flow that could ensure a minimum assimilative capacity in water bodies is a matter of concern, especially in the light of increasing consumptive demands of various sectors such as household, industry, and agriculture. Based on monitoring done during the last 10 years, 14% of riverine length is highly polluted (BOD more than 6 mg/litre) and 19% moderately polluted (BOD—3 to 6 mg/litre). Under the National River Conservation Plan (NRCP) a total of 86 polluted stretches have been identified and action plans for improving the water quality in them are being prepared.

With regard to conservation of mountain ecosystems the MoEF has established an autonomous institute, the G.B. Pant Institute of Himalayan Environment and Development (GBPIHED), with the overall mandate of dealing with issues relating to the environment of the Indian Himalayan Region. The results of project studies of the Institute also have implications on issues such as climate change and land degradation.

There is pressure on forests as 95% of the medicinal plants at present are collected from the wild. In situ conservation of medicinal plants is being undertaken by various government and non-government organizations. A National Medicinal Plants Board was set up in November 2000 under the Ministry of Health and Family Welfare to promote coordination and implementation of policies relating to medicinal plants both at the Central and State levels.

To compliment in situ conservation, attention has been paid to ex situ conservation measures through setting up of botanical gardens, zoos, deer parks, safari parks, aquaria, etc. Central Zoo Authority has been set up to ensure better management of zoos. Under a plan scheme 'Assistance to Botanic Gardens', financial assistance is provided to strengthen measures for ex situ conservation of threatened and endangered species. Guidelines for botanical gardens have been finalized and the vision is to have at least one botanical garden per district. The Indian Council of Agricultural Research has set up a number of gene banks for ex situ conservation under the National Bureau of Plant Genetic Resources (NBPGR), New Delhi, National Bureau of Animal Genetic Resources (NBAGR), Karnal, National Bureau of Fish Genetic Resources (NBFGR), Lucknow, and National Bureau of Agriculturally Important Microorganisms (NBAIM), Mau. A large number of microorganisms of agricultural importance also form a vital part of the diversified Indian agricultural ecosystem

Projects have been initiated for reintroduction of threatened species into their natural habitats under appropriate conditions. Examples include mass propagation of pitcher plant, rehabilitation of mangroves in degraded open mud flats, and the effort towards relocation of rhinoceros from Kaziranga to Manas and tigers from Ranthambore to Sariska in Rajasthan.

Special attention has been given to coastal zones through Coastal Zone Regulation Rules, 1991 under the Environment (Protection) Act. This notification is under reformulation based on scientific principles as recommended by Swaminathan Committee (2005), and a draft notification on Coastal Management Zone 2008 has been issued.

The Scheme on Conservation and Management of Mangroves, Coral Reefs, and Wetlands has been too small to make an impact on the conservation of these ecosystems. As mangroves and coral reefs are mainly found on government lands, development of appropriate institutions to motivate people to cooperate in the conservation efforts of these systems will be a priority area under the Eleventh Five Year Plan. More protected areas are needed for the

conservation of coral reefs. Restoration and plantation programmes for mangroves are necessary to make these eco-systems function as effective barriers against invasion of land by sea. The existing programmes on wetlands, mangroves, and coral reefs will be extended to mountains, grasslands, and alpine ecosystems.

The Department of Biotechnology (DBT) has been implementing focused programmes on biodiversity conservation through biotechnological interventions since 1991, inter alia by developing techniques, tools and technologies for ex situ conservation. Many tissue culture protocols have been developed for regeneration of endangered and threatened species. The DBT has established a national facility “Laboratory for conservation of species” – LaCONES, at Hyderabad jointly with the help of Central Zoo Authority (MoEF), CSIR and Andhra Pradesh Government for the conservation of endangered animal species like tiger, lion, black buck, vulture, etc. Some other programmes supported by the DBT have focus on animal biotechnology, medicinal plants and aromatic grasses including societal programmes specifically for the cultivation of medicinal plants/aromatic grasses and extraction of valuable chemicals/products for economic upliftment of SC/ST and weaker sections.

The Indian Council of Forestry Research and Education (ICFRE) is the premier organization which imparts education, creates awareness and undertakes research and extension activities on forestry and environmental issues, through its institutes located in various regions of the country. The Indian Institute of Forest Management imparts education and training in forest management. The Wildlife Institute of India imparts training on wildlife management and undertakes research on various related issues. The Centre for Environment Education (CEE), CPR Environment Education Centre, and other Centres of Excellence supported by the MoEF, organize activities aimed at creating environmental awareness among all sections of the society. National Institute on Mangroves and Coastal Bioresources is being set up by the MoEF in the Sunderbans. The Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) through its research councils is undertaking validation of traditional systems of medicines.

The documentation of traditional knowledge available in our ancient texts is being undertaken by Council of Scientific and Industrial Research (CSIR), in the form of a computerized database, called Traditional Knowledge Digital Library (TKDL). People’s Biodiversity Registers (PBRs). under the Biological Diversity Act, 2002 is expected to document the un-coded, oral traditional knowledge of local people. There is also a felt need for an All India Coordinated Project on Traditional Knowledge for documenting the un-coded, oral traditional knowledge of local people, especially of little-known bioresources of potential economic value. The Patents Act, 1970 provides for mandatory disclosure, in patent application, of the source and geographical origin of the biological material and associated traditional knowledge used in the invention. This Act also provides for pre and post grant opposition of applications and revocation of granted patents on grounds of non-

disclosure or wrongful disclosure of source or geographical origin of biological resources and traditional knowledge.

In order to generate awareness regarding the need to conserve and sustainably utilize biological resources, the various means of communication such as TV, radio and press are being utilized. The education system, both formal and non-formal, is also being mobilized to this end. The MoEF interacts with the Ministry of Human Resource Development, University Grants Commission (UGC), National Council of Educational Research and Training and other educational bodies for introducing and expanding environmental concepts, themes and issues in the curricula of schools, colleges and universities. The Environment Education in School System project initiated in 1999 strengthens environment education in the formal school curriculum through infusion of appropriate education material. Introduction of environmental concepts in Business/Management Education is another focus area. A committee comprising representatives from management institutions, All India Council for Technical Education (AICTE), UGC,, industry and MoEF is working on this. During the Eleventh Plan, the programme of Environmental Education, Training, and Extension is being continued with further linkages with the publicity and awareness mechanisms of State forest departments.

The implementation of the Biological Diversity Act, 2002 and Rules, 2004 and National Environmental Policy, 2006 calls for an adequate number of trained taxonomists. Existing programmes on botanical gardens and taxonomic capacity building assume immense significance in this respect. MoEF provided assistance to 72 botanical gardens during the Tenth Plan and under The All India Coordinated Project on Taxonomy (AICOPTAX) 11 coordinating centres and two centers for training have been supported at various institutions. The Zoological Society of India and the Botanical Survey of India will be the key institutions to organize taxonomic capacity building programmes and train young Indian taxonomists for forest, wildlife and management.

### **Institutional mapping of laws in India**

