

Biodiversity, Ecosystem Services, Threats and Conservational Measures

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Introduction

Biological diversity, or biodiversity as it is commonly known, "includes all plants, animals, microorganisms, the ecosystems of which they are a part, and the diversity within species, between species, and of ecosystems (Biodiversity and Ecosystem Services, SVP, 2010). Biological variety can be observed at three levels -

- (i) **Genetic diversity:** The genetic variability within a species
- (ii) **Species diversity:** The species variability within a community
- (iii) **The ecosystem diversity:** The organization of species in an area into distinctive plant and animal communities

Mega Biodiversity Countries of the World

Countries that contain as much as 7-8% of the world's species are termed as Mega biodiversity Countries. The twelve Mega Biodiversity Countries that have been identified are: India, Brazil, Colombia, Ecuador, Peru, Mexico, Madagascar, Zaire, Australia, China, Indonesia and Malaysia. India is one of the twelve-Mega Biodiversity Countries of the world and one of the four in Asia (Fig 1).

Biodiversity of india

India is the seventh largest country in the world and Asia's second largest nation with an area of 3,287,263 square km. The Indian mainland stretches from 8 4' to 37 6' N latitude and from 68 7'



Fig 1: Map of Biodiversity Hotspots of Earth (Source: mapsofindia.com)





to 97 25' E longitude. It has a land frontier of some 15,200 km and a coastline of 7,516 km (Government of India, 1985). India is a known centre of crop diversity and harbors many wild relatives and breeds of domesticated crop. With over 46,000 species of plants and 81,000 species of animals, India accounts for 7-8% of the recorded species of the world with only 2.4 % of the world's land area. Apart from this, India represents about 17.31% of the world population (<http://ces.iisc.ernet.in>).

The hotspots are the areas with higher concentration of endemic species and which usually experience rapid rate of habitat modifications and loss. India figured with two hotspots:

- The Western Ghats and the Eastern Himalayas in an identification of 25 of the world's biologically richest and most threatened ecosystems.

A total of 23 Heritage Sites have been listed in India, including the following five Protected Areas of great conservation significance to be a part of World Culture and Heritage:

1. Kaziranga National Park, Assam, 2. Manas Wildlife Sanctuary, Assam, 3. Keoladeo National Park, Rajasthan, 4. Sunderbans National Park, West Bengal and 5. Nanda Devi National Park, Uttaranchal.

Physically, the massive country is divided into four relatively well defined regions - the Himalayan Mountains, the Gangetic river plains, the southern (Deccan) plateau, and the islands of Lakshadweep, Andaman and Nicobar.

Wetland diversity

India has a rich variety of wetland habitats. The total area of wetlands (excluding rivers) in India is 58,286,000 ha, or 18.4% of the country, 70% of which comprises areas under paddy cultivation. A total of 1,193 wetlands, covering an area of about 3,904,543 ha, were recorded in a preliminary inventory co-ordinated by the

Department of Science and Technology, of which 572 were natural (Scott, 1989). Two sites - Chilka Lake (Orissa) and Keoladeo National Park (Bharatpur) - have been designated under the Convention of Wetlands of International Importance (Ramsar Convention) as being especially significant waterfowl habitats. The country's wetlands are generally differentiated by region into eight categories (Scott, 1989):

- 1) The reservoirs of the Deccan Plateau in the south, together with the lagoons and the other wetlands of the southern west coast; the vast saline expanses of Rajasthan, Gujarat and the gulf of Kachchh.
- 2) Freshwater lakes and reservoirs from Gujarat eastwards through Rajasthan (Keoladeo National Park) and Madhya Pradesh.
- 3) The delta wetlands and lagoons of India's east coast (Chilka Lake).
- 4) The freshwater marshes of the Gangetic Plain.
- 5) The floodplain of the Brahmaputra.
- 6) The marshes and swamps in the hills of north-east India and the Himalayan foothills.
- 7) The lakes and rivers of the montane region of Kashmir and Ladakh.
- 8) The mangroves and other wetlands of the island arcs of the Andamans and Nicobars.

Forests diversity

The panorama of Indian forests ranges from evergreen tropical rain forests in the Andaman and Nicobar Islands, the Western Ghats, and the north-eastern states, to dry alpine scrub high in the Himalaya to the north. Between the two extremes, the country has semi-evergreen rain forests, deciduous monsoon forests, thorn forests, subtropical pine forests in the lower montane zone and temperate montane forests (Lal, 1989). The Western Ghats Monsoon forests occur both on the western (coastal) margins of the ghats and on the eastern side where there is less rainfall. The forests contain several tree species of great commercial



significance (e.g. Indian rosewood *Dalbergia latifolia*, Malabar Kino *Pterocarpus marsupium*, teak and *Terminalia crenulata*).

The tropical vegetation of north-east India embraces evergreen and semi-evergreen rain forests, moist deciduous monsoon forests, riparian forests, swamps and grasslands. Evergreen rain forests are found in the Assam Valley, the foothills of the eastern Himalayas and the lower parts of the Naga Hills, Meghalaya, Mizoram, and Manipur where the rain fall exceeds 2300 mm per annum. In the Assam Valley the giant *Dipterocarpus macrocarpus* and *Shorea assamica* occur singly, occasionally attaining a girth of up to 7 m and a height of up to 50 m. The monsoon forests are mainly moist sal *Shorea robusta* forests, which occur widely in this region (IUCN, 1991). The Andamans and Nicobar islands have tropical evergreen rain forests and tropical semi-evergreen rainforests as well as tropical monsoon moist monsoon forests (IUCN, 1986). The tropical evergreen rain forest is only slightly less grand in stature and rich in species than on the mainland. The dominant species is *Dipterocarpus grandiflorus* in hilly areas, while *Dipterocarpus kerrii* is dominant on some islands in the southern parts of the archipelago. The monsoon forests of the Andamans are dominated by *Pterocarpus dalbergioides* and *Terminalia* spp.

Marine Environment

The nearshore coastal waters of India are extremely rich fishing grounds. The total commercial marine catch for India has stabilised over the last ten years at between 1.4 and 1.6 million tonnes, with fishes from the clupeoid group (e.g. sardines *Sardinella* sp., Indian shad *Hilsa* sp. and whitebait *Stolephorus* sp.) accounting for approximately 30% of all landings. In 1981 it was estimated that there were approximately 180,000 non-mechanised boats (about 90% of India's fishing fleet) carrying out small-scale, subsistence fishing activities in these waters. At the same time there were about 20,000 mechanised boats and 75 deep-sea fishing vessels operating mainly out of

ports in the states of Maharashtra, Kerala, Gujarat, Tamil Nadu and Karnataka.

Coral reefs occur along only a few sections of the mainland, principally the Gulf of Kutch, off the southern mainland coast, and around a number of islands opposite to Sri Lanka. Indian coral reefs have a wide range of resources which are of commercial value. Other notable marine areas are seagrass beds, which although not directly exploited are valuable as habitats for commercially harvested species, particularly prawns, and mangrove stands. In the Gulf of Mannar the green tiger prawn is extensively harvested for the export market. Sea grass beds are also important feeding areas for the dugong *Dugong*, plus several species of marine turtle. Five species of marine turtle occur in Indian waters: Green turtle, Loggerhead, Olive Ridley, Hawksbill and Leatherback. Most of the marine turtle populations found in the Indian region are in decline. The Biodiversity richness is shown in absolute numbers of species and the proportion they represent of the world total (Table 1).

Table 1: Comparison between the Number of Species in India and the World

| Group | Number of Species in India (SI) | Number of World (SW) Species in | SI/SW (%) |
|------------------|---------------------------------|---------------------------------|-----------|
| Mammals | 350 | 4,629 | 7.6 |
| Birds | 1224 | 9,702 | 12.6 |
| Reptiles | 408 | 6,550 | 6.2 |
| Amphibians | 197 | 4,522 | 4.4 |
| Fishes | 2546 | 21,730 | 11.7 |
| Flowering Plants | 15,000 | 250,000 | 6.0 |

(Source: <http://ces.iisc.ernet.in>)

Endemic Species

India has many endemic plant and vertebrate species. Among plants, species endemism is estimated at 33% with 140 endemic genera but no endemic families (Botanical Survey of India, 1983). Areas rich in endemism are north-east India, the





Western Ghats and the north-western and eastern Himalayas. A small pocket of local endemism also occurs in the Eastern Ghats (MacKinnon & MacKinnon, 1986). The Gangetic plains are generally poor in endemics, while the Andaman and Nicobar Islands contribute at least 220 species to the endemic flora of India (Botanical Survey of India, 1983). The 396 known endemic higher vertebrate, 44 species of Indian mammal have a range that is confined entirely to within Indian territorial limits. Only 55 bird species are endemic to India, with distributions concentrated in areas of high rainfall. There are around 187 endemic reptiles, and 110 endemic amphibian species.

Ecosystem services

Ecosystem services are the benefits that people obtain from ecosystems. They support, directly or indirectly, our survival and quality of life. Some ecosystem services are well known, such as those which are essential for life (e.g. food and clean air and water) or those which improve our quality of life (e.g. recreation and beautiful landscapes). Other services are often taken for granted, such as natural processes (e.g. pollination and flood regulation) (Fig 2). According to the Millennium Ecosystem Assessment (MA) that 60% of ecosystem services are being degraded or used unsustainably, often resulting in significant harm to human well-being. The MA categorised ecosystem services into four classes:

1. **Provisioning services**, which are the products obtained from ecosystems, such as food, water, fuel and materials for building. Agro-ecosystems provide food for human consumption and, together with the associated ecosystems supporting marine and freshwater fisheries, underpin global food security. Ecosystems play important roles in the global hydrological cycle, contributing to water provision, regulation and purification (Dudley and Stolton 2003; Bruijnzeel 2004; Brauman *et al.* 2007). The provision of fuels and fibres, medicinal and other biochemical resources such as metabolites, pharma-ceuticals,

nutrients, crop protection chemicals, cosmetics and other natural products for industrial use and as a basis for biomimetics that may become increasingly important in nanotechnology applications (Ninan 2009). Biodiversity has also played an iconic, ornamental role throughout the development of human society. Uses of plant and animal parts, especially plumage of birds, have been important in conferring individual status, position and influence. Ornamental plants are typically grown for the display of their flowers but other common ornamental features include leaves, scent, fruit, stem and bark.

2. **Regulating services**, Ecosystems contribute to several of natural processes, like air quality regulation, climate regulation, water/flood regulation, disease and pest control, pollination and water purification, environmental regulation services of importance for human wellbeing, particularly in urban areas where vegetation reduce air and noise pollution, mitigate the "urban heat island effect" (Santamouris, 2001), and reduce impacts related to climate change (Bolund and Hunhammar, 1999). Numerous factors interact in the regulation of climate, including the reflection of solar radiation by clouds, dust and aerosols in the atmosphere. Vegetation cover also play a key factor in preventing soil erosion and vegetation cover combined with drought resulted in unprecedented wind erosion, destroying farmland and livelihoods.
3. **Cultural services**, which are the non-material benefits people, obtain from ecosystems and landscapes through spiritual enrichment, recreation and aesthetic enjoyment.
4. **Supporting services**, such as soil formation, photosynthesis and nutrient and water cycling which are necessary for the production of all other ecosystem services. In some estimates, over 75% of the world's crop plants, as well as many plants that are source species for pharmaceuticals, rely on



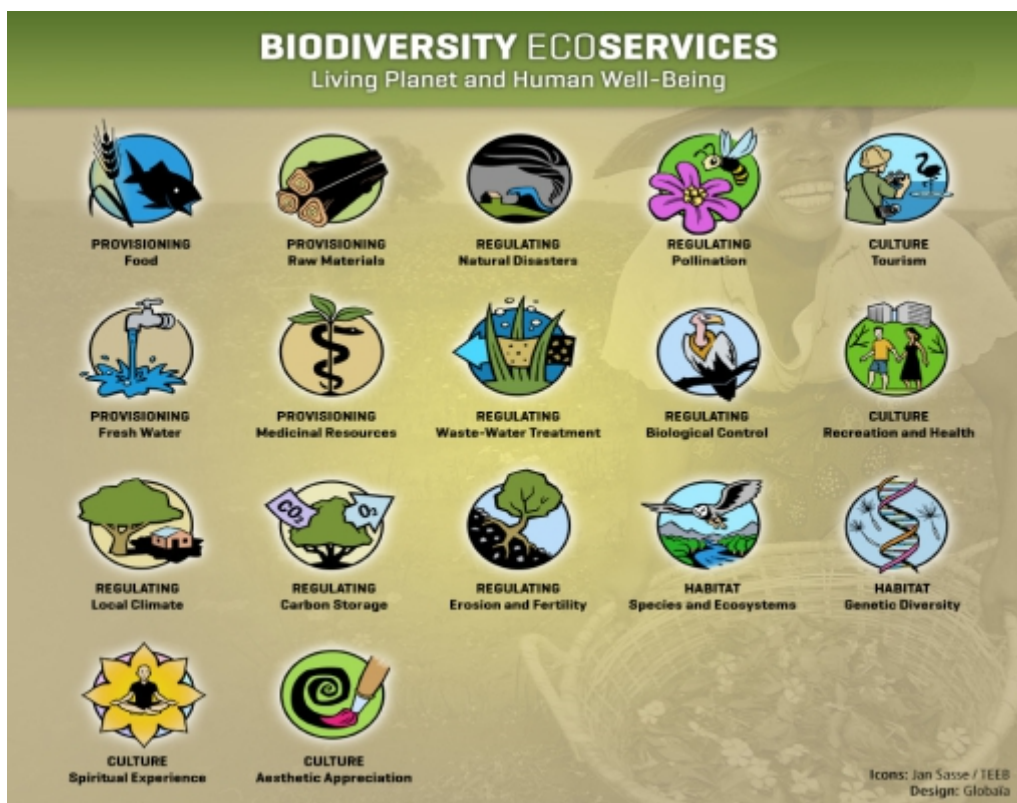


Fig 2: Services provided by Ecosystem (Source: Jan Sasse/ TEEB)

Table 3: Biological and physical processes and interactions that comprise ecosystems functions important for ecosystem services

| Ecosystem | Function Processes |
|---------------------|--|
| Primary production: | Photosynthesis ,Plant nutrient uptake |
| Decomposition: | Microbial respiration ,Soil and sediment food web dynamics |
| Nitrogen cycling: | Nitrification ,Denitrification ,Nitrogen fixation |
| Hydrologic cycle: | Plant transpiration ,Root activity |
| Soil formation: | Mineral weathering ,Soil bioturbation ,Vegetation succession |
| Biological control: | Predator-prey interactions |

pollination by animal vectors (Nabhan and Buchman, 1997). Klein *et al.* (2007) found that, for 87 out of 115 leading global crops (representing up to 35% of the global food supply), fruit or seed numbers or quality were increased through animal pollination. In many agricultural systems, pollination is actively

managed through the establishment of populations of domesticated pollinators, particularly the honeybee.

Threats to Biodiversity

The biological wealth of our planet has been declining rapidly and the accusing finger is clearly



pointing to anthropological activities. The colonisation of tropical Pacific Islands by humans is said to have led to the extinction of more than 2,000 species of native birds. The IUCN Red List (2004) documents the extinction of 784 species (including 338 vertebrates, 359 invertebrates and 87 plants) in the last 500 years. Adding to the grim scenario of extinctions is the fact that more than 15,500 species world-wide are facing the threat of extinction. Presently, 12 per cent of all bird species, 23 per cent of all mammal species, 32 per cent of all amphibian species and 31 per cent of all gymnosperm species in the world face the threat of extinction. It is now generally accepted that global biodiversity will be significantly affected by climate change, although its precise impacts are still nebulous (Fig 3):

- **Water pollution:** Water pollution can be caused by excessive amounts of nutrients and phosphorus in surface water, leading to eutrophication. Other pollutants, such as hazardous substances, can lead to biodiversity decline.
- **Air pollution:** Air pollution affects biodiversity in different ways. Examples include "acid rain" caused by sulphur dioxide (SO₂) emissions, eutrophication of vegetation caused by excessive nitrogen emissions (NO_x, NH_x, etc.), and climate change caused by greenhouse gas emissions (CO₂, CH₄, etc.)
- **Land use change:** Land use pattern is a major source of biodiversity decline. Semi-natural agricultural areas and grasslands are declining and becoming increasingly fragmented. This makes them vulnerable to external pressures.
- **Soil pollution:** Soil pollution can affect the microbial population in the soil and alter a whole range of ecosystem services - from nutrient cycling to the regulation of air, water quantity and quality.
- **Over exploitation:** Over-exploitation of water resources, in particular groundwater can cause desiccation effects in habitats which are groundwater-dependent. This is a typical local effect.

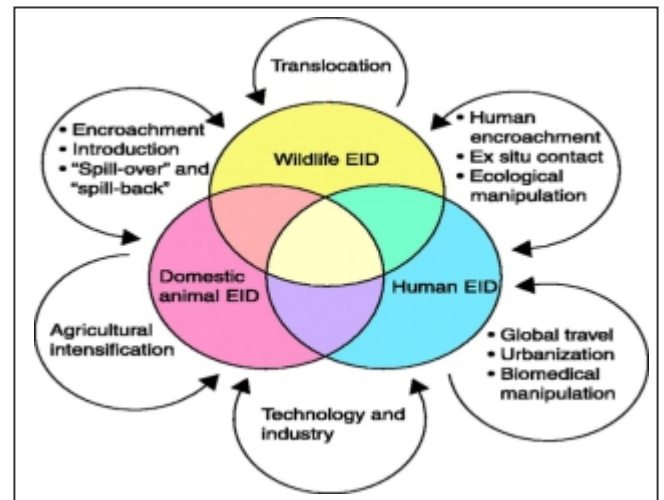


Fig 3: Factors responsible for Biodiversity loss (Source: Google)

- **Invasive alien species:** Invasive alien species are non-native species posing a threat to biodiversity as they out compete and displace native species.
- **Climate change:** Climate change is expected to exacerbate the pressures on biodiversity caused by the drivers above.
- **Habitat loss and fragmentation:** This is the most important cause driving animals and plants to extinction. The most dramatic examples of habitat loss come from tropical rain forests.

In general, loss of biodiversity in a region may lead to (a) decline in plant production, (b) lowered resistance to environmental perturbations such as drought and (c) increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycles.

Conservational Measures

It has taken millions of years of evolution, to accumulate this rich diversity in nature, but we could lose all that wealth in less than two centuries if the present rates of species losses continue. Biodiversity and its conservation are now vital environmental issues of international concern as more and more people around the world begin to realise the critical importance of biodiversity for



our survival and well-being on this planet. Biodiversity is a wealth to which no value can be put. In the final analysis, the very survival of the human race is dependent on conservation of biodiversity. It is evident that this invaluable heritage is being destroyed at an alarming rate due to several reasons.

There are several strategies which are adapted for conservation of biodiversity. Some of these are:

1. Legislation

Formal policies and programmes for conservation and sustainable utilisation of biodiversity resources date back to several decades. The concept of environmental protection is enshrined in the Indian constitution in Articles 48a and 51a (g). Major central acts relevant to biodiversity include: Environment Protection Act, 1986; Fisheries Act, 1897; Forest Act, 1927; Forest (Conservation) Act, 1980; Wildlife (Protection) Act 1972 and Wildlife (Protection) Amendment Act 1991. Biological Diversity Act, 2002.

2. In-situ Conservation

Conserving the animals and plants in their natural habitats is known as in situ conservation. The established natural habitats are: National parks and sanctuaries; Biosphere reserves; Nature reserves; Reserved and protected forests; Preservation plots; Reserved forests.

Biosphere Reserves are another category of protected areas. Under this, a large area is declared as a Biosphere Reserve where wildlife is protected, but local communities are allowed to continue to live and pursue traditional activities within the Reserve. A programme "Eco-development" for *in-situ* conservation of biological diversity involving local communities was initiated. It integrates the ecological and economic parameters for sustained conservation of ecosystems by involving local communities with maintenance of earmarked regions surrounding protected areas.

3. Ex-situ Conservation

Ex-situ conservation of plants and animals preserve/ or protect them away from their natural

habitat. This could be in zoological parks and botanical gardens or through the forestry institutions and agricultural research centres. A lot of effort is under way to collect and preserve the genetic material of crops, animal, bird and fish species.

4. Community Participation in Biodiversity Conservation

It is being recognized that no legal provisions can be effective unless local communities are involved in planning, management and monitoring conservation programmes. Successful conservation strategies will have to have the confidence and participation of the local communities.

5. Recording Indigenous Knowledge

The lives of local communities are closely interwoven with their environment, and are dependent upon their immediate resources for meeting their needs. These communities have a vast knowledge about local flora and fauna which is very important for biodiversity conservation. Much of this knowledge is orally passed on from generation to generation.

6. International Conservation Strategies

Conserving biodiversity is not an issue confined to any one country or community. It is a crucial global concern. Several international treaties and agreements are in place in the attempt to strengthen international participation and commitment towards conserving biodiversity. Some of these are:

- **The Convention on Biological Diversity:** This was signed during the Earth Summit in 1992. It focuses not only on conserving biodiversity but also on sustainable use of biological resources and equitable sharing of benefits arising from its use.
- **The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES):** This is an international treaty which is designed to protect wild plants and animals affected by international trade. The treaty, in





force since 1975, controls the export, import and re-export of endangered and threatened wildlife.

- **The Convention on Wetlands of International Importance:** This Convention, also known as the Ramsar Convention, was signed in Ramsar (Iran) in 1971 and came into force in December 1975. It provides a framework for international cooperation for the conservation of wetland habitats which have been designated to the 'List of Wetlands of International Importance' (Dilip Sarkar, Conserving Biodiversity in India).

Role of Communities in Biodiversity Conservation

There is an increased awareness among the people towards the conservation of ecologically sensitive areas. There are many conservation movements and initiative in India, which have saved the precious natural resources. Despite all threats, diversity of the species and diversity within the species still continue to survive. Their continued existence is due to farmers and other communities living within the forest. Their cultural practices and knowledge systems have helped nurture biodiversity.

Green India Mission

The National Mission for a Green India, recently announced by the Prime Minister, is one of the eight National Missions under India's National Action Plan on Climate Change. Its major focus is to increase cover and density of India's medium density forests and degraded forests. This mission will have repercussions for livelihoods of people and biodiversity.

Saving Biodiversity - Saving Life

Following conservation actions that we can take up:

- **Plant trees.** Grow native species of plants (trees, shrubs and climber) where ever

possible, this would attract local wildlife such as birds, butterflies and insects.

- Grow local vegetables in school garden that are not usually available in the markets. This would allow help conserve them for generations to come. Initiate, organize and participate in responsible citizen action against existing or proposed activities that harm or are likely to harm local biodiversity.
- Make a list of different kinds of trees in your campus or locality. For each one find out the names, uses, flowering season, animals and birds that depends on it. Present this information in an interesting way, and put it up by the tree. Many people will stop by to read this information and know more about the tree.
- Curb our greed for products made out of animal parts like skin, fur, ivory, bones, nails, etc., to discourage wildlife traders and poachers, and spare the lives of the remaining animals.
- Adopt vegetarianism which would require fewer animals to be fattened for slaughtering and more plants to be grown for food.
- Avoid using insecticides, pesticides and inorganic fertilizers and try to use natural plant-based substitutes wherever possible. Paper and cloth should replace non-biodegradable plastic and polyester which damage the ecosystem.
- Make children aware of their surroundings and the need for biodiversity.
- Promote bio-farming which is less intensive and environmental-friendly.
- Make use of sustainable technologies like smokeless chulhas, ground water recharging unit, wind energy, solar power, etc.
- Set up 'Community Sanctuaries' for free ranging animals, migratory birds and endemic species. Establish voluntary 'Village Reserves' for plants and animals.



- Assist National level Bodies in recording and preserving rare and endemic species
- Create 'Biodiversity Registers' in communities, schools, villages.

Biodiversity Register

Students can made inventory and maintain records of all living beings in their locality. A

biodiversity register is a compilation of day-to-day observations of the immediate environment. It is a documentation of knowledge of diversity of life known to local people. It is a means of recording the wealth of biodiversity of a region. The register may include minute details about plants and animals, both wild and domesticated. The record may include traditional knowledge regarding use of the various species

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