



# Sustainable Development and Utilization of Biodiversity: A Gift for Future Generation

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## Introduction

A good environmental sense has been one of the fundamental features of India's ancient philosophy. The civilization of India has grown up in close association with the nature. The Indian human societies have always relied on biological resources for physical, mental and spiritual sustenance. Biodiversity ultimately provides us with a source of food, medicines, materials and opportunities. The earth's biological resources are vital to humanity's economic and social development. As a result, there is a growing recognition that biological diversity is a global asset of tremendous value to present and future generations. At the same time, the threat to species and ecosystems has never been as great as it is today.

Man's greed attacks nature environment and ecology and wounded nature backlashes on the human future. We are in the midst of the sixth era of extinction. This problem can be solved only by proper guidance, awareness, education, transfer of advance technology, research, conservation and sustainable use of biological diversity (Kulkarni, 2012).

## Meaning of Biodiversity

The term biological diversity was used first by wildlife scientist and conservationist Raymond F. Dasmann in the 1968 lay book *A Different Kind of Country*. In the 1980, it came into common usage in science and environmental policy. The term's contracted form *Biodiversity* may have been coined by W.G. Rosen in 1985 while planning the 1986 *National Forum on Biological Diversity* organized by the National Research Council (NRC) and first appeared in a publication in 1988 when

socio-biologist E.O. Wilson used it as the title of the Proceedings of that forum. The Convention on Biological Diversity (CBD) was negotiated and signed by nations at the UNCED Earth Summit at Rio de Janeiro in Brazil in June 1992. The Convention came into force on December 29, 1993. India became a Party to the Convention in 1994. At present, there are 175 Parties to this Convention. Biodiversity is the variety of life forms we see around us. The CBD (1992) states that "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". The United Nations designated 2011-2020 as the United Nations Decade on Biodiversity.

## Biodiversity of India

India is a second largest country in the world in population and seventh largest country in the world in area and second largest country in Asia. India ranks 7<sup>th</sup> position in the world in contribution of agricultural crops. It is 10<sup>th</sup> largest mega diverse country in the world and 4<sup>th</sup> largest Country in Asia, constitute 2.4% land area in the world containing 17.5% human population and 15% biodiversity. 18% Livestock population of the world found in India. More than 50% population of tigers and 60% population of elephants of the world found in India. 62% Amphibian species and 50% Lizards are endemic to this country. World's 50% Aquatic Flowering plants occur in India.

India is a Mega-diversity country of the world. The mega-diverse countries are a group of



countries that harbor the majority of the Earth's species and are therefore considered extremely bio-diverse. Conservation International in 1998 identified 17 Mega-diverse countries in the world. These are 1. Australia, 2. Brazil, 3. China, 4. Colombia, 5. Democratic Republic of the Congo, 6. Ecuador, 7. India, 8. Indonesia, 9. Madagascar, 10. Malaysia, 11 Mexico, 12. Papua New Guinea, 13. Peru, 14. Philippines, 15. South Africa, 16. United States 17. Venezuela.

### Like Minded Mega-diverse Countries

On 18 February 2002, the Ministers in Charge of the Environment and the Delegates assembled in the Mexican city of Cancun and formed a separate organization focusing on Like-Minded Mega-diverse Countries (LMMC), consisting of countries rich in biological diversity and associated traditional knowledge. These countries declared to set up a group of LMMC as a mechanism for consultation and cooperation so that their interests and priorities related to the preservation and sustainable use of biological diversity could be promoted

The current member countries of the Like-Minded Meg-adiverse Countries organization are: Bolivia, Brazil, Canada, China, Colombia, Costa Rica, Democratic Republic of the Congo, Ecuador, India, Indonesia, Kenya, Madagascar, Malaysia, Mexico, Peru, Philippines, South Africa and Venezuela.

### Criteria for selection of Mega-diverse countries

- First criteria is endemism- first at species level, and then at higher taxonomic levels such as genus and family.
- To qualify as Mega diversity country, a country must have at least 5000 of the world's plant as endemic.

### Why rich Biodiversity in India?

- The country is rich in biodiversity due to diversified climatic conditions that vary from

the humid tropical Western Ghats ----- desert of Rajasthan to diversified north east regions of the country, from the cold desert of Ladakh and the icy mountains of Himalaya to the warm coasts of Peninsular India, and the central fertile plains providing innumerable microhabitats.

- Strategic position having connection with adjacent floristic regions.
- Vast stretch of geographic area of 329 m ha; 7500 km long coast line.
- Diverse habitats - dry deserts, cold deserts, alpine, temperate, tropical habitats, wetland areas (4.1 million ha.), mangroves.
- Diverse ecological conditions (High rainfall area, coldest place on earth etc.). Altitude varying from sea level to the highest mountain ranges of the world.
- Gondwana connection.
- Himalaya as an active speciation zone.
- 12 bio-geographic regions representing 3 basic biomes and 2 natural realms as identified (Rao, 1997).

### Phyto-diversity of India

India with 329 million hectare land and 202 million hectare of marine water under exclusive economic zone is known to have nearly 15% of the recorded life forms of the world. It is estimated that about 49,000 species of plants occur in India.

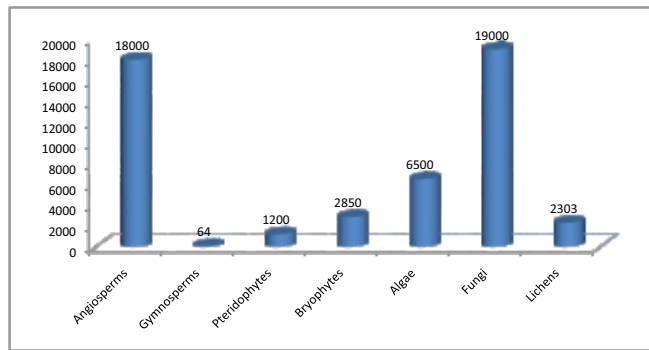
### Faunal Diversity of India

The exploration of faunal diversity has a history of 265 years in India. The field survey and systematic researches mainly by Zoological Survey of India estimate the faunal diversity as of 89000 species representing more than 7% of the world fauna.

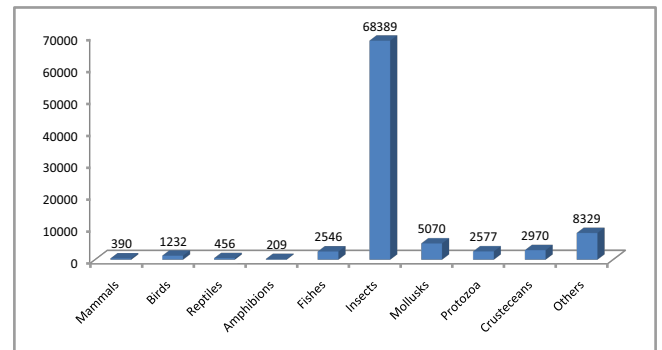
### Cultural Diversity of India

There are about 550 tribal communities of 227 ethnic groups are found in India which are





Phyto-diversity of India



Faunal Diversity of India

distributed over 5000 remote villages in and around the forests and utilize a wide variety of biodiversity resources for fulfillment of their daily needs like food, fibre, fodder, medicine etc. The tribals constitute 84.3 million population of the country.

### Endemic plant species of India

The country is rich in endemic flora. The richest regions are the Himalayas, Western Ghats, Indian Islands and North Eastern Hills of India. Each biogeographical region has several habitats, biotic communities and ecosystems. Of the total flowering plants known and described from Indian region nearly 33% are endemic to our country. The number of species, endemic species and percentage of endemic species of flowering and non flowering plants of India is given in table-1.

**Table-1.** Number and percentage of endemic species of flowering and non flowering plants of India.

Plant groups	No of species	Endemic species	% of endemic species
Angiosperms	17500	5725	32.71
Gymnosperms	64	10	15.62
Pteridophytes	1200	193	16.38
Bryophytes	2850	938	33.91
Lichens	2021	466	23.35
Algae	6500	1924	29.6
Fungi	23000	3500	13.21

The total endemic taxa of flowering plants in India consist of about 148 endemic genera, 5725 species which are distributed over 47 families. Out of 5725 species, 3471 taxa occur in Himalayas, 2015 taxa occur in Peninsular India and 239 taxa occur in the Andaman & Nicobar Islands. The family Lauraceae has the largest number of endemic taxa (80.90%), followed by Apiaceae (78.80%), Ranunculaceae (75%), Rosaceae (72.80%) etc (table-2).

**Table-2.** Families of flowering plants having highest percentage of endemic species

Families	Total Taxa	Endemic Taxa	% of Endemism
Lauraceae	163	133	80.90%
Apiaceae	209	165	78.80%
Ranunculaceae	180	135	75.00%
Rosaceae	250	182	72.80%
Balsaminaceae	180	123	68.30%
Acanthaceae	380	224	58.90%
Liliaceae	203	114	55.60%
Primulaceae	165	80	48.40%

The mega centers of endemic plants in India are (i). Eastern Himalaya (1808 endemic species). (ii). Western Ghats (1500 endemic species). (iii) Western Himalaya (1195 endemic species). Some important endemic plants are *Aconitum ferox* Wall. (Sikkim Himalaya), *Adhatoda beddomei* C.B.





**Fig.1.** *Alectra chitrakutensis* (Rau) R. Prasad & R.D. Dixit



**Fig.2** *Lilium macklineae* Sealy



**Fig.3.** *Meconopsis latifolia* (Prain) Prain



**Fig. 4.** *Paphiopedilum druryi* (Bedd.) Stein



**Fig.5.** *Paphiopedilum fairrieanum* (Lindl.) Stein

Clarke (Agasthyamalai Hills), *Alectra chitrakutensis* (Rau) R. Prasad & R.D. Dixit (Bundelkhand) (Fig.1); *Coptis teeta* Wall. (Eastern Himalaya), *Myristica malabarica* Lam. (Southern Western Ghats), *Picrorhiza kurroa* Royle ex Benth. (Himalaya), *Curcuma cannorensis* R. Ansari et al. (Kerala), *Cypripedium himalaicum* Rolfe (Himalaya), *Lilium macklineae* Sealy (Manipur) (Fig.2); *Meconopsis latifolia* (Prain) Prain (Kashmir Himalaya) (Fig.3); *Paphiopedilum druryi* (Bedd.) Stein (Southern Western Ghats) (Fig.4); *Paphiopedilum fairrieanum* (Lindl.) Stein (E. Himalaya) (Fig.5); *Paphiopedilum wardii* Summerth





(Arunachal Pradesh), *Mangifera andamanica* King (Andaman Islands), *Bentinckia nicobarica* (Kurz) Becc. (Nicobar Islands) etc.

## Hindustan Centre of Origin of Crop Plants

N. I. Vavilov (1951) named 8 centres of origin of crop plants and India was known as *Hindustan Centre of Origin of Cultivated plants*. Zeven & Zhukovsky (1975) identified 12 mega regions of cultivated plants and Indian region is designated as *Hindustani Region*.

Indian region has been the primary centre of domestication for rice, sugarcane, banana, tea, mango, cucumber, citrus, jute, minor millets, vignas, brassicas, alocasia, colocasia, cardamom, zinger, black pepper, turmeric, bamboos etc.

It has also been a secondary centre of domestication for sesame, tomato, maize, soybean, etc. It is also estimated that about 167 important cultivated species of plants and about 335 species of wild relatives of crop plants have been originated in India. Out of 335 species about 60 are endemic.

## Biodiversity Hotspots

Biodiversity hotspot is a bio-geographic region that is both a significant reservoir of biodiversity and is threatened with destruction. The biodiversity hotspots were originally identified by Dr. Norman Myers in two articles in the *Environmentalist* (1988 & 1990) and revised in an article in the journal *Nature* (2000). The term biodiversity hotspot specifically refers to 34 biologically rich areas around the world that have lost at least 70% of their original habitat. The remaining natural habitat in these biodiversity hotspots amounts to just 2.3 percent of the land surface of the planet, yet supports nearly 75 percent of the world's plant, bird, mammal, reptile, and amphibian species. In India Eastern Himalayas, Western Ghats and Eastern Himalayas are rich in endemic plants. Eastern Himalayas has 1808 endemic species, Western Himalayas 1195 endemic species and Western Ghats has 1500

endemic species of flowering plants. Of which Eastern Himalayas (1808) and Western Ghats (1500) are the hotspots of the world. Nayar (1996) has identified 25 micro endemic centers in India.

## Sustainable Development

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Put in the new globalised order, sustainable development is the integration of economic, social and environmental development considered as the inter-dependent and mutually reinforcing pillars which operate at the local, national, regional and global levels. This sets out two fundamental principles of inter-generational and intragenerational equity. The principle of Intergenerational equity means needs to preserve natural resource for the benefit of future generations. The principle of Intra-generational equity means equitable use of natural resources which implies that use by one state must take into account of the needs of other states (Kulkarni, 2012).

India is a fast developing country in world. As per the forest policy 33% of land of country should be covered under the forests but currently the country has about 20% forest cover. Several developmental activities which are being taken by central and state governments like construction of dams, hydroelectric and power thermal stations, roads, railway lines, industries establishment s etc should be avoided in biodiversity rich areas.

## Sustainable Utilization of Biodiversity

Biodiversity of India is depleting fast from the natural habitats due to over exploitation and unsustainable utilization. Over 90% raw material of forest resources collected unsustainable manner by traders of Ayurvedic and pharmaceutical companies. Out of this 75% collected from destructive manner. Traders give temptation to the innocent tribal people to collect invaluable medicinal plants. Trainings to the tribal and local



people on good collection practices should be provided. 40% mature fruits and roots should be left on plants for regeneration. The Ayurvedic and pharmaceutical companies cultivate high value medicinal plants in farmers' fields and purchase the ready crop by contract or buy back policy. Local and tribal people should be made aware about the value and importance of biodiversity through meetings, pamphlets and handouts distribution, rallies and fairs organization, print and electronic media etc.

Over 8% population of the country are tribals. They have vast knowledge of plant diversity. They utilize a wide variety of biodiversity resources for food, fodder, fibre, dye, gum, medicine, thatching, house hold and agriculture implements etc. They are acquiring this knowledge from their ancestors from mouth to mouth and from generation to generation. But at present, their knowledge is declining day by day. Therefore, this traditional knowledge should be documented.

## Value of Biodiversity

Biodiversity, literally, is the foundation upon which human civilization has been built. In addition to its intrinsic value, biodiversity provides goods and services that underpin sustainable development in many important ways, thus contributing to poverty alleviation. First it supports the ecosystem functions essential for life on Earth, such as the provision of fresh water, soil conservation, and climate stability. Second, it provides products such as food, medicines and materials for industry. Finally, biodiversity is at the heart of many cultural values. In total, biodiversity is life insurance for sustainable development.

## Loss of Biodiversity

It is estimated that about 30,000 plant species will extinct in near future. According to Peter Raven (1988) 60,000 species will lost from globe till middle of 21st century. Myers (1988) estimated that the destruction of tropical forests causes mass extinction of biodiversity. Today we are losing at

least one higher plant species per day from tropical forests alone.

In India, it is estimated that more than 10% of flowering plants are threatened due to the various anthropogenic factors. The major threatened plants of India are *Aconitum heterophyllum* Royle, *Acorus calamus* L., *Alectra chitrakutensis* (Rau) R. Prasad & R.D. Dixit, *Alpinia galanga* (L.) Willd., *Aristolochia indica* L., *Berberis aristata* DC., *Cheilocostus speciosus* (J. Koenig) C. Specht. (Fig.6); *Ceropegia vincaefolia* Hook., *C. huberi* Ansari, *C. noorjahaniae* Ansari, *Commiphora wightii* (Arn.) Bhandari, *Coscinium fenestratum* (Gaertn.) Colebr., *Dactylorhiza hatagirea* (D. Don) Soo, *Dioscorea deltoidea* Kunth, *Frerea indica* Dalz. (Fig.7); *Gentiana kurroo* Royle, *Gloriosa superba* L. (Fig.8); *Inula racemosa* Hook.f., *Livistona jenkinsiana* Griff. (Fig.9); *Nardostachys jatamansi* DC., *Nepenthes khasiana* Hook.f. (Fig. 10); *Paeonia emodi* Wall. ex Royle, *Podophyllum hexandrum* Royle (Fig. 11); *Polygonatum verticillatum* Allioni, *Rauvolfia serpentina* (L.) Benth. ex Kurz (Fig.12); *Rheum australe* Don, *Rubia cordifolia* L., *Sapria himalayana* Griff. (Fig. 13); *Saraca asoca* (Roxb.) De Wilde (Fig.14); *Saussurea costus* (Falc.) Lip., *S. obvallata* Edgew. (Fig.15); *Swertia chirayita* (Roxb. ex Flem.) Karsten, *Tecomela undulata* (Sm.) Seem, *Uraria picta* (Jacq.) Desv. ex DC., *Valeriana jatamansi* Jones and *Vanda coerulea* Lindl. etc. (Fig. 16)

## Causes of Biodiversity Loss

Habitat destruction, overexploitation, pollution and invasive species introduction are the major causes of biodiversity loss in India. Other factors included fires, which adversely affect regeneration in some cases, and such natural calamities as droughts, diseases, cyclones, landslides and floods. Major threats to Biodiversity while non recognition of the importance of biodiversity remains the principal and overriding threat to conservation initiatives, the following are agreed to be the major threats to biodiversity:

- High rate of human population growth





**Fig. 6.** *Cheilocostus specius* (J. Koenig) C. Specht



**Fig. 7.** *Frerea indica* Dalz.



**Fig. 8.** *Gloriosa superba* L.



**Fig. 9.** *Livistona jenkinsiana* Griff.



**Fig. 10.** *Nepenthes khasiana* Hook. f.



**Fig. 11.** *Podophyllum hexandrum* Royle





**Fig. 12.** *Rauvolfia serpentina* (L.) Benth. ex Kurz,



**Fig. 14.** *Saraca asoca* (Roxb.) De Wilde



**Fig. 13.** *Sapria himalayana* Griff.



**Fig. 15.** *Saussurea obvallata* Edgew.



**Fig. 16.** *Vanda coerulea* Lindl.





and unsustainable natural resources consumption.

- Uncontrolled commercial exploitation of natural resources, Habitat destruction, including destruction of forests, reclamation of wetlands etc.
- Global climate change.
- Economic system and policies that fails to value the environment and its resources.
- Lack of knowledge about biodiversity conservation and its application in human well being.
- Lack of legal and institutional systems that promote unsustainable exploitations.
- Deforestation and degradation of forest area.
- Degree of specialization of a species and its morphological features.
- Position of organism in the food chain.
- Unrestricted use of pesticides, insecticides and chemicals.
- Adhoc extension of high input agriculture,
- Conversion of rich biodiversity sites for human settlement and industrial development,

The former Secretary General of United Nations Organization, Kofi Annan very rightly said that "Failure to conserve and use biological diversity in a sustainable manner would result in degrading environments, new and more rampant illnesses, deepening poverty and a continued pattern of inequitable and untenable growth."

## Conservation of Biodiversity

Conservation means the management of men's use of the biodiversity in such a way that maximum benefit accrues from it to the present generation while maintaining its potential to meet the requirements of the future generations.

The post Rio scenario has projected a new dimension to value of conservation of biodiversity. Efforts to conserve biodiversity must focus on sustainable development. The goal of biodiversity conservation is not simply to protect and maintain

the existing biological resources but to utilize them for human welfare in such a way that the use does not diminish the world's variety of genes and species or important habitats and ecosystem. Thus three basic elements are involved in conservation-saving biodiversity, study and understand its structure and function and use it sustainably. The methods of conservation of biodiversity can be broadly classified as *in situ* conservation and *ex situ* conservation (Goel and Mitra, 2000).

1. ***In situ* conservation:** *In situ* conservation is the most appropriate method to maintain species of wild plants and animals in their natural habitats. This approach includes protection of total ecosystem through a network of protected areas. The common protected areas that have been set for *in situ* conservation of wild plants and animals include- National Parks, Wildlife Sanctuaries, Biosphere Reserves and Wetlands. The India has 92 National Parks, 510 Wildlife Sanctuaries, 14 Biosphere Reserves, 6 Ramsar Wetlands, thousands of Sacred Groves and 29 Tiger Reserves.
2. ***Ex situ* conservation:** In the face of increasing human interference, *in situ* conservation is not a viable option for most of the rare species. In the natural habitats, species may decline and/or become extinct due to several factors such as genetic drift and inbreeding deterioration of habitat quality and /or habitat loss, demographic and environmental variations, competition from exotic species, diseases as well as over exploitation. Under such circumstances, ulcerative method of conservation of species is *ex situ* conservation. Here individuals of species are maintained in artificial conditions under human supervision. In other words, *Ex situ* conservation involves cultivation of rare plants and rearing of threatened animal species in Botanical and Zoological gardens respectively and preserve the former in the form of seeds in seed banks etc by means of tissue culture techniques.



These methods also include maintaining gene banks and pollen of species. In-vitro conservation especially cryo-preservation is useful technique for preserving vegetatively propagated crops e.g. seeds of plants and preserving sperms, eggs, cells and embryonic tissues of animals at 196 °C temperature.

## Principles for conserving Biodiversity

*Dubey et al* (2007) described the following principles which are very useful for conservation of biodiversity:

1. Every form of life is unique and warrants respect from humanity. Every life form have right to live in their habitat.
2. Biodiversity conservation is an investment that yields substantial local, national and global benefits in terms of medicines, genetic resources etc.
3. As part of larger effort to achieve sustainable development, biodiversity conservation requires fundamental changes in patterns and practices of economic, social and cultural development.
4. Increased funding for biodiversity conservation will not by itself slow biodiversity loss. Policy and institutional reforms, peoples participation networking of efforts are needed to create the conditions under which increased funding can percolate to the desired locations.
5. Biodiversity conservation can be sustained only if people's involvement, awareness and concern are substantially heightened and addressed.
6. Priorities for biodiversity conservation differ when viewed from local, national and global perspectives; all are legitimate and should be taken in to account. All communities have vested interest and old traditions in conserving their biodiversity. The focus should not be exclusively on a few species rich ecosystems or areas. It should be logical and realistic with broader vision.
7. Action to conserve biodiversity must be planned and implemented at a scale determined ecological and social criteria. The focus of activity must be in the vicinity where people live and work as well as in wild land areas.
8. Cultural diversity is closely linked to biodiversity. Humanity's collective knowledge of biodiversity and its use and management rests in cultural diversity; conversely conserving biodiversity often helps strengthen cultural integrity and value.
9. Respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional life styles relevant for conservation and sustainable use of biodiversity and promote their wider application.
10. Caring biodiversity before introducing any technological development. Protocol to care for this should be a part of new initiatives.
11. Identification of keystone species, edge species, flagship species and looking into causes of their threat and measures to check it.

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*Sustainability is about  
ecology, economy and equity.*

*- Ralph Bicknese*

