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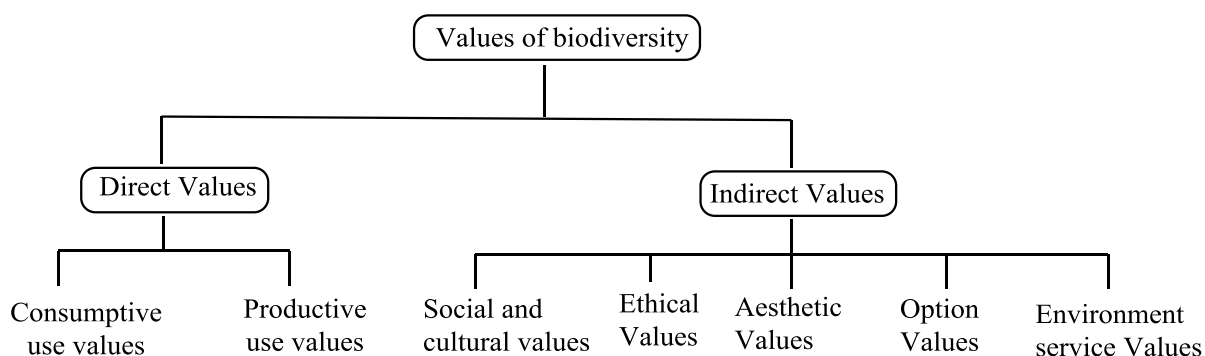
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VALUE OF BIODIVERSITY



Environmental services from species and ecosystems are essential at global, regional and local levels. Production of oxygen, reducing carbon dioxide, maintaining the water cycle, protecting soil is important services. The world now acknowledges that the loss of biodiversity contributes to global climatic changes. Forests are the main mechanism for the conversion of carbon dioxide into carbon and oxygen. The loss of forest cover, coupled with the increasing release of carbon dioxide and other gases through industrialization contributes to the 'greenhouse effect'. Global warming is melting ice caps, resulting in a rise in the sea level which will submerge the low lying areas in the world. It is causing major atmospheric changes, leading to increased temperatures, serious droughts in some areas and unexpected floods in other areas.

Biological diversity is also essential for preserving ecological processes, such as fixing and recycling

of nutrients, soil formation, circulation and cleansing of air and water, global life support (plants absorb CO₂, give out O₂), maintaining the water balance within ecosystems, watershed protection, maintaining stream and river flows throughout the year, erosion control and local flood reduction.

Food, clothing, housing, energy, medicines, are all resources that are directly or indirectly linked to the biological variety present in the biosphere. This is most obvious in the tribal communities who gather resources from the forest, or fisherfolk who catch fish in marine or freshwater ecosystems. For others, such as agricultural communities, biodiversity is used to grow their crops to suit the environment. Urban communities generally use the greatest amount of goods and services, which are all indirectly drawn from natural ecosystems.

It has become obvious that the preservation of biological resources is essential for the well-being and the long-term survival of mankind. This diversity of living organisms which is present in the wilderness, as well as in our crops and livestock, plays a major role in human 'development'. The preservation of 'biodiversity' is therefore integral to any strategy that aims at improving the quality of human life.

Direct values

Direct values, also known as use values and commodity values, are assigned to the products harvested by people. Direct values can be readily estimated by observing the activities of representative groups of people, by monitoring collection points for normal products and by examining the export/ import statistics. Some examples are:

Plants are a direct value to biodiversity because it is the fundamental value of providing food that can be harvested and consumed directly.



Figure: Plants and fish as food

Fuel is a direct value to biodiversity because for a long periods of time, forests have provided wood which is used as fuel which is used for gas, warmth, cooking, and other industrial processes.



Figure: Fuel

Drugs and Medicines are a direct value to biodiversity because traditional medical practices utilizes plants or their extracts directly, and pharmaceutical industry is more dependent on natural products.



Figure: Drugs and Medicines

These values can be further sub-divided as:

Consumptive use value:

The direct utilisation of timber, food, fuelwood, fodder by local communities.

The biodiversity held in the ecosystem provides forest dwellers with all their daily needs, food, building material, fodder, medicines and a variety of other products. They know the qualities and different uses of wood from different species of trees, and collect a large number of local fruits, roots and plant material that they use as food, construction material or medicines. Fisherfolk are highly dependent on fish and know where and how to catch fish and other edible aquatic animals and plants.

Man and the Web of Life

The Biodiversity of an area influences every aspect of the lives of people who inhabit it. Their living space and their livelihoods depend on the type of ecosystem. Even people living in urban areas are dependent on the ecological services provided by the wilderness in the PAs. We frequently don't see this in everyday life as it is not necessarily overt. It is linked with every service that nature provides us. The quality of water we drink and use, the air we breathe, the soil on which our food grows are all influenced by a wide variety of living organisms both plants and animals and the ecosystem of which each species is linked with in nature.

While it is well known that plant life removes carbon dioxide and releases the oxygen we breathe, it is less obvious that fungi, small soil invertebrates and even microbes are essential for plants to grow.

That a natural forest maintains the water in the river after the monsoon, or that the absence of ants could destroy life on earth, are to be appreciated to understand how we are completely dependent on the living 'web of life' on earth.

Productive use value

Marketable goods.

Value of MFP > Timber (which is part of sustainable use).

The biotechnologist uses biorich areas to 'prospect' and search for potential genetic properties in plants or animals that can be used to develop better varieties of crops that are used in farming and plantation programs or to develop better livestock. To the pharmacist, biological diversity is the raw material from which new drugs can be identified from plant or animal products. To industrialists, biodiversity is a rich store-house from which to develop new products. For the agricultural scientist the biodiversity in the wild relatives of crop plants is the basis for developing better crops.

Genetic diversity enables scientists and farmers to develop better crops and domestic animals through careful breeding. Originally this was done by selecting or pollinating crops artificially to get a more productive or disease resistant strain. Today this is increasingly being done by genetic engineering, selecting genes from one plant and introducing them into another. New crop varieties (cultivars) are being developed using the genetic material found in wild relatives of crop plants through biotechnology.

Even today, species of plants and animals are being constantly discovered in the wild. Thus these wild species are the building blocks for the betterment of human life and their loss is a great economic loss to mankind. Among the known species, only a tiny fraction have been investigated for their value in terms of food, or their medicinal or industrial potential.

Preservation of biodiversity has now become essential for industrial growth and economic development. A variety of industries such as pharmaceuticals are highly dependent on identifying compounds of great economic value from the wide variety of wild species of plants located in undisturbed natural forests. This is called biological prospecting.

Indirect Values:

Indirect values are assigned to benefits provided by biodiversity that do not involve harvesting or destroying the natural resource. Such benefits include ecological benefits such as soil formation, nutrient cycling, waste disposal, air and water purification, education, recreation, future options for human beings, etc. another some examples

Social and cultural values are an indirect value to biodiversity because in some religious countries many plants and animals are considered sacred and holy and are worshipped and respected.



Figure: Social and cultural values

Ethical values are an indirect value to biodiversity because it relates to the conservation of biodiversity where the ethical issue of 'all life forms must be preserved' is practiced. In each species there is an existence value that is attached because biodiversity is valuable for the human race, and that all species have a moral right to exist independent without our need for them.



Figure: Ethical values

Aesthetic values are an indirect value to biodiversity because natural landscapes at undisturbed places are delightful to watch that provide opportunities for recreational activities which promotes eco-tourism that further generates designing zoological gardens, national parks, wildlife conservations, etc.



Figure: Aesthetic values

Indirect value can be further sub-divided as:

4.3.3 Social values

While traditional societies which had a small population and required fewer resources had preserved their biodiversity as a life supporting resource, modern man has rapidly depleted it even to the extent of leading to the irrecoverable loss due to extinction of several species. Thus apart from the local use or sale of products of biodiversity there is the social aspect in which more and more resources are used by affluent societies. The biodiversity has to a great extent been preserved by traditional societies that valued it as a resource and appreciated that its depletion would be a great loss to their society.

The consumptive and productive value of biodiversity is closely linked to social concerns in traditional communities. 'Ecosystem people' value biodiversity as a part of their livelihood as well as through cultural and religious sentiments.

A great variety of crops have been cultivated in traditional agricultural systems and this permitted a wide range of produce to be grown and marketed throughout the year and acted as an insurance against the failure of one crop. In recent years farmers have begun to receive economic incentives to grow cash crops for national or international markets, rather than to supply local needs. This has resulted in local food shortages, unemployment (cash crops are usually mechanised), landlessness and increased vulnerability to drought and floods.

Commonly used modern drugs derived from plant sources:

DRUG	PLANT SOURCE	USE
Atropine	Belladonna	Anticholinergic: reduces intestinal pain in diarrhoea.
Bromelain	Pineapple.	Controls tissue inflammation due to infection
Caffeine Tea,	Coffee	Stimulant of the central nervous system.
Camphor	Camphor tree	Rebefacient: increases local blood supply.
Cocaine	Cocoa	Analgesic and local anesthetic: reduces pain and prevents pain during surgery.
Codeine	Opium poppy	Analgesic: reduces pain.
Morphine	Opium poppy	Analgesic: controls pain.
Colchicine	Autumn crocus	Anticancer agent.
Digitoxin	Common foxglove	Cardiac stimulant used in heart

		diseases.
Diosgenin	Wild yams	Source of female contraceptive: prevents pregnancy.
L-Dopa	Velvet bean	Controls Parkinson's Disease which leads to jerky movements of the hands
Ergotamine	Smut-of-rye or ergot	Control of haemorrhage and migraine headaches.
Glaziovine	ocotea glaziovii.	Antidepressant: Elevates mood of depressed patients
Gossypol	Cotton	Male contraceptive.
Indicine N-oxide	heliotropium indicum.	Anticancer agent
Menthol	Mint	Rubefacient: increases local blood supply and reduces pain on local application.
Monocrotaline	Cotolaria sessiliflora	Anticancer agent.
Papain	Papaya	Dissolves excess protein and mucus, during digestion.
Penicillin	Penicillium fungi	General antibiotic, kills bacteria and controls infection by various micro-organisms.
Quinine	Yellow cinchona	Antimalarial.
Reserpine	Indian snakeroot.	Reduces high blood pressure
Scopolamine	Thorn apple	Sedative.
Taxol	Pacific yew	Anticancer (ovarian).
Vinblastine,	Rosy periwinkle	Anticancer agent: Controls cancer in children.

From: '*The Diversity of Life*'; Edward O. Wilson

Ethical values

Ethical values related to biodiversity conservation are based on the importance of protecting all forms of life. All forms of life have the right to exist on earth. Man is only a small part of the Earth's great family of species. Don't plants and animals have an equal right to live and exist on our planet which is like an inhabited spaceship? We do not know if life as we know it exists elsewhere in the universe. Do we have the right to destroy life forms or do we have a duty to protect them?

Apart from the economic importance of conserving biodiversity, there are several cultural, moral and ethical values which are associated with the sanctity of all forms of life. Indian civilization has over several generations preserved nature through local traditions. This has been an important part of the ancient philosophy of many of our cultures. We have in our country a large number of sacred groves or 'deorais' preserved by tribal people in several States. These sacred groves around ancient sacred sites and temples act as gene banks of wild plants.

Aesthetic value

Knowledge and an appreciation of the presence of biodiversity for its own sake is another reason to preserve it. Quite apart from killing wildlife for food, it is important as a tourist attraction. Biodiversity is a beautiful and wonderful aspect of nature. Sit in a forest and listen to the birds. Watch a spider weave its complex web. Observe a fish feeding. It is magnificent and fascinating.

Symbols from wild species such as the lion of Hinduism, the elephant of Buddhism and deities such as Lord Ganesh, and the vehicles of several deities that are animals, have been venerated for thousands of years. Valmiki begins his epic story with a couplet on the unfortunate killing of a crane by a hunter. The 'Tulsi' has been placed at our doorsteps for centuries.

Option value

Keeping future possibilities open for their use is called option value. It is impossible to predict which of our species or traditional varieties of crops and domestic animals will be of great use in the future. To continue to improve cultivars and domestic livestock, we need to return to wild relatives of crop plants and animals. Thus the preservation of biodiversity must also include traditionally used strains already in existence in crops and domestic animals.

Environment Service Values

Environmental services are also known as ecosystem services,* both terms reflecting environmental functions and ecological processes. They can be defined as any functional attribute of natural ecosystems that are demonstrably beneficial to humankind. They comprise the main indirect values of biodiversity, as opposed to direct values in the form of material

goods such as timber, fish, plant-based pharmaceuticals, and germ-plasm infusions for major crops. They include generating and maintaining soils, converting solar energy into plant tissue, sustaining hydrological cycles, storing and cycling essential nutrients (notably in the form of nitrogen fixation), supplying clean air and water, absorbing and detoxifying pollutants, decomposing wastes, pollinating crops and other plants, controlling pests, running biogeochemical cycles (of such vital elements as carbon, nitrogen, phosphorus, and sulfur), controlling the gaseous mixture of the atmosphere (which helps to determine climate), and regulating weather and climate at both macro and micro levels. Thus they basically include three forms of processing, namely of minerals, energy, and water. In addition, biodiversity provides sites for research, recreation, tourism, and inspiration.

Biodiversity patterns and global biodiversity hot spots

Biology Biodiversity patterns:

Biodiversity is the variety in organisms found at every level of biological organization. The ecologists studied biodiversity in the environment and observed a regular pattern in which diversity was distributed over the entire area of the planet.

Darwin* noticed three distinctive patterns of biological diversity: (1) Species vary globally, (2) species vary locally, and (3) species vary over time. Darwin noticed that different, yet ecologically similar, animal species inhabited separated, but ecologically similar, habitats around the globe.

Species Vary Globally: Species living in similar habitats but in different parts of the world, making them distantly related, looked and acted in a similar way. Emus found in Australia; Rheas found in S. America; Ostriches found in Africa. They are flightless birds.

Some areas such as islands had endemic species. **Endemic species** are species of plants and animals that exist only in one geographic region. Species may be endemic to a particular continent, some to part of a continent, and others to a single island.



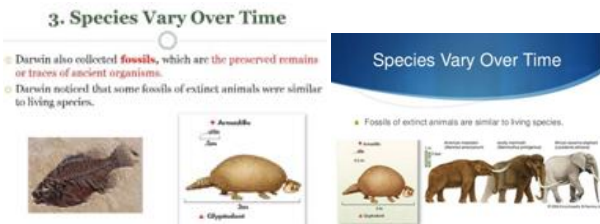
Species Vary Locally:

The **Galapagos Islands** are a group of islands relatively close to each other but have different climates. Isabela mountains are more mountainous with higher rainfall. Espanola island has lower elevations with dry climate. Each island has its own finch species and tortoise species. Each is adapted to conditions on that particular island.



Species Vary over Time:

Through the studies of fossils, it was found that— some were enormous versions of modern-day species. For Example, modern-day armadillo (50 cm long) and the fossil remains of glyptodont (3 m long) resemble each other.



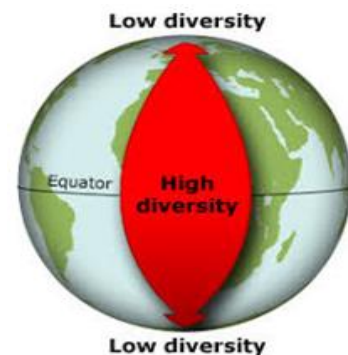
PATTERNS OF SPECIES BIODIVERSITY

Ecologists have studied various patterns of species biodiversity. The various patterns of biodiversity can also be explained in terms of space and time. They are discussed below.

PATTERNS ACCORDING TO SPACE

Latitudinal Gradients:

Till date, it is the most well defined and well-known pattern of biodiversity that has been studied. According to this pattern, the species diversity shows a systematic pattern as one moves from the equator to the polar regions. Scientists have observed that species diversity tapers at the poles, either north or south. The tropics are very rich in species diversity. This pattern is an ancient pattern that has existed for thousands of years, across many taxa, from trees to fossil foraminifera.



Habitat Variety

Like the variety of the habitat increases, greater is the species diversity within it. This pattern explains, why there are more species in a bigger area. The big area covers a greater variety of habitat.

PATTERNS ACCORDING TO TIME:

Seasonal patterns

The diversity of species can be seen during different seasons of the year. According to different seasons, the population of one particular species fluctuates. For example, some terrestrial beetles have larval stages that are underground and they only emerge to the surface as adults. The birds also show seasonal patterns, because many are migratory and the bird diversity of an area may be affected by the absence of seasonal breeders and the presence of migrants passing through. These seasonal patterns are mostly seen in temperate areas but are also reported in tropical areas. In both terrestrial and aquatic habitats, the diversity of species can be seen during different seasons.

Successional patterns

After a disturbance (such as fire or harvesting in agriculture), the plants and animals' species begin to reoccupy the habitat, grow, and get replaced or out-competed by other species. This pattern of a gradual time-based shift in the species composition of a community is called **succession**. It may result from a variety of processes including migration, dispersal, growth, competition and environmental change. For plants, diversity increases with succession until woody species (trees and brushes) begin to flourish, whereby diversity then

decreases. For animals, diversity generally increases with succession, for example, this has been observed for birds and insects.

INDIA AS A MEGA DIVERSITY NATION

Geological events in the landmass of India have provided conditions for high levels of biological diversity. A split in the single giant continent around 70 million years ago, led to the formation of northern and southern continents, with India a part of Gondwanaland - the southern landmass, together with Africa, Australia and the Antarctic. Later tectonic movements shifted India northward across the equator to join the Northern Eurasian continent. As the intervening shallow Tethys Sea closed down, plants and animals that had evolved both in Europe and in the Far East migrated into India before the Himalayas had formed. A final influx came from Africa with Ethiopian species, which, were adapted to the Savannas and semi-arid regions. Thus India's special geographical position between three distinctive centres of biological evolution and radiation of species is responsible for our rich and varied biodiversity.

Among the biologically rich nations, India stands among the top 10 or 15 countries for its great variety of plants and animals, many of which are not found elsewhere. India has 350 different mammals (rated eight highest in the world), 1,200 species of birds (eighth in the world), 453 species of reptiles (fifth in the world) and 45,000 plant species, of which most are angiosperms, (fifteenth in the world). These include especially high species diversity of ferns (1022 species) and orchids (1082 species). India has 50,000 known species of insects, including 13,000 butterflies and moths. It is estimated that the number of unknown species could be several times higher.

It is estimated that 18% of Indian plants are endemic to the country and found nowhere else in the world. Among the plant species the flowering plants have a much higher degree of endemism, a third of these are not found elsewhere in the world. Among amphibians found in India, 62% are unique to this country. Among lizards, of the 153 species recorded, 50% are endemic. High endemism has also been recorded for various groups of insects, marine worms, centipedes, mayflies and fresh water sponges.

	India's World Ranking	Number of species in India
Mammals	8 th	350
Birds	8 th	1200
Reptiles	5 th	453
Amphibia	15 th	182
Angiosperms	15 th -20 th	14,500

Apart from the high biodiversity of Indian wild plants and animals there is also a great diversity of cultivated crops and breeds of domestic livestock. This is a result of several thousand years during which civilizations have grown and flourished in the Indian subcontinent. The traditional cultivars included 30,000 to 50,000 varieties of rice and a number of cereals, vegetables and fruit. The highest diversity of cultivars is concentrated in the high rainfall areas of the Western Ghats, Eastern Ghats, Northern Himalayas and the North-Eastern hills. Gene-banks have collected over 34,000 cereals and 22,000 pulses grown

in India. India has 27 indigenous breeds of cattle, 40 breeds of sheep, 22 breeds of goats and 8 breeds of buffaloes.

HOTSPOTS OF BIODIVERSITY

The earth's biodiversity is distributed in specific ecological regions. There are over a thousand major ecoregions in the world. Of these, 200 are said to be the richest, rarest and most distinctive natural areas. These areas are referred to as the Global 200.

Global species diversity

Group	No. of Described Species
Bacteria and blue-green algae	4,760
Fungi	46,983
Algae	26,900
Bryophytes (Mosses and Liverworts)	17,000 (WCMC, 1988)
Gymnosperms (Conifers)	750 (Reven et al., 1986)
Angiosperms (Flowering plants)	250,000 (Reven et al., 1986)
Protozoans	30,800
Sponges	5,000
Corals and Jellyfish	9,000
Roundworms and earthworms	24,000
Crustaceans	38,000
Insects	751,000
other arthropods and minor Invertebrates	132,461
Molluscs	50,000
Starfish	6,100
Fishes (Teleosts)	19,056
Amphibians	4,184
Reptiles	6,300
Birds	9,198 (Clements, 1981)
Mammals	4,170 (Honacki et al., 1982)
Total:	1,435,662 SPECIES

From: 'Conserving the World's Biological Diversity WRI, IUCN, CI, WWF-US, The World Bank.'

It has been estimated that 50,000 endemic plants which comprise 20% of global plant life, probably occur in only 18 'hot spots' in the world. Countries which have a relatively large proportion of these hot spots of diversity are referred to as 'megadiversity nations'. The rate at which the extinction of species is occurring throughout our country remains ob-scure. It is likely to be extremely high as our wilderness areas are shrinking rapidly. Our globally accepted national 'hot spots' are in the forests of the North-East and the Western Ghats, which are included in the world's most biorich areas. The Andaman and Nicobar Islands are

extremely rich in species and many subspecies of different animals and birds have evolved. Among the endemic species i.e. those species found only in India, a large proportion are concentrated in these three areas. The Andaman and Nicobar Islands alone have as many as 2200 species of flowering plants and 120 species of ferns. Out of 135 genera of land mammals in India, 85 (63%) are found in the Northeast. The Northeast States have 1,500 endemic plant species. A major proportion of amphibian and reptile species, especially snakes, are concentrated in the Western Ghats, which is also a habitat for 1,500 endemic plant species.

Coral reefs in Indian waters surround the Andaman and Nicobar Islands, Lakshadweep Islands, the Gulf areas of Gujarat and Tamil Nadu. They are nearly as rich in species as tropical evergreen forests!

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