

BIODIVERSITY : CURRENT STATUS AND FUTURE CONSERVATION

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PREAMBLE

The second United Nation's World Environment Conference held in Rio de Janeiro, Brazil in 1992, represented by the Heads of almost all countries of the world, discussed about the major emerging environmental problems which are considered to be a menacing threat to maintain a clean and viable environment on the surface of our planet. Out of several critical issues discussed in that Conference, one major issue was to preserve biodiversity. Twenty years earlier, the Principle 2 in the Stockholm Declaration 1972, the Magna Carta of our Environment, read as "The natural resources of the earth, including the air, water, land, flora and fauna, and especially representative samples of natural ecosystems, must be safeguarded for the benefit of the present and future generations through careful planning and management" seems as appropriate as then conceived. In view of the global importance of the relevant theme, the Govt. of India took an appropriate measure to draft a bill at the instance of the Ministry of Law and Justice (Legislative Department) which was placed for consideration in the Parliament Session where it was passed. Consequently, the following Act of Parliament received the assent of the President on 5th February 2003 and notified for general information in the Gazette of India:

THE BIOLOGICAL DIVERSITY ACT, 2002, NO. 18 OF 2003

An Act to provide for conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto;

Whereas India is rich in biodiversity and associated traditional and contemporary knowledge system relating thereto;

And whereas India is a party to the United Nations Convention on Biological Diversity signed at Rio de Janeiro on the 5th day of June, 1992;

And whereas the said Convention came into force on the 29th December, 1993;

And whereas the said Convention reaffirms the sovereign rights of the States of their biological resources;

And whereas the said Convention has the main objective of conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of utilization of genetic resources;

And whereas it is considered necessary to provide for conservation, sustainable utilization and equitable sharing of the benefits arising out of utilization of genetic resources and also to give effect to the said Convention.

Be it enacted by Parliament in the Fifty-third Year of the Republic of India.

2. CONCEPT OF BIODIVERSITY

Biodiversity, or biological diversity, refers to the range of life forms of Earth. These include millions of plants, animals and micro-organisms, the genes they contain and the intricate ecosystems of which they are a part.

Biological diversity deals with the degree of nature's variety in the biosphere. This variety can be observed at three levels; the genetic variability within a species, the variety of species within a community, and the organization of species in an area into distinctive plant and animal communities constitutes ecosystem diversity.

3. BIODIVERSITY ACT IN THE AMBIENCE OF INDIAN PERSPECTIVE

Biodiversity refers to the variety of life forms : the plants, animals and microorganisms, the genes they contain, and the ecosystem they form at any point of time - current or in the past. It is now believed by the scientists that ecosystems rich in diversity gain greater flexibility and are, therefore, able to recover more readily from stresses such as drought or human induced habitat degradation. In a diverse ecosystem there is a range of pathways for primary production and ecological processes, e.g., nutrient cycling, so that if one is damaged or destroyed, an alternative pathway may be used allowing the ecosystem to function in its normal level. If biological diversity is greatly diminished, the functioning of ecosystems is put at risk (IUCN 1998). Through several periods of mass extinction in the geological past, vast number of taxa got exterminated, when species became extinct through natural causes, e.g., volcanic eruption or climatic change through ages. But now human activities are mainly responsible for the loss of biodiversity. People for their own survival have hunted species to extinction and destroyed habitats by agricultural practices and continued deforestation. Large scale introduction of chemical pollutants and non-native species harmed native plants and animals. Lately, conservation efforts to protect the existing biodiversity by enacting laws to save endangered species by creating naturally conserved forests have slowed but not stopped its loss. It is important to maintain biodiversity because genetic diversity provided insurance against environmental changes. At any particular place or time, the genes in certain organisms make those individuals better adapted to their environment than the other members of the species. A species with a rich variety of genetic traits is better equipped to cope with change, because some of its individuals will have traits that enable them to adapt to adverse conditions. Species diversity is important to save potentially useful organisms. Otherwise sources of new drugs or food crops might be wiped out before they are even discovered. Diversity in ecosystem helps keep this planet viable, e.g., forests absorb

carbon dioxide from the atmosphere. If the green vegetation gets destroyed, carbon dioxide would build up and would contribute to a phenomenon called the greenhouse effect, resulting into creation of permanent global warming and thus destroying a vast expanse of life.

The importance of biological diversity for development indicates its difference from traditional nature conservation. The former entails a shift from a reactive posture protecting nature from the impacts of development - to a proactive effort seeking to meet people's needs from biological resources while ensuring the long-term ecological sustainability of our planet's biotic wealth. On a global level it thus involves not only the protection of wild species and their habitats but also safeguarding the genetic diversity of cultivated and domesticated species and their wild relatives. The conservation of biological diversity, therefore, seeks to maintain the life-support system provided by nature in all its variety, and the living resources essential for ecologically sustainable development. Humanity derives all of its food and many medicines and industrial products from the wild and domesticated components of biological diversity, the value of which is not restricted to food and medicine alone. The enormous diversity of life in itself is of crucial value, giving greater resistance to ecosystems and organisms. Generally, benefits arising out of the conservation of components of biodiversity may be considered in three groups : (a) ecosystem services, (b) biological resources and (c) social benefits. Benefits of ecosystem services are protection of water resources, nutrient storage and cycling, pollution breakdown, absorption, contribution to climate stability and recovery of plants and animals from unpredictable events. Benefits of biological resources are food, medicinal extraction, wood products, horticultural plants, breeding stocks and utilization of population potentials. Social benefits encompass research and educational monitoring, recreation, cultural values and benefits of timely action. Biodiversity is the variety that exists among organisms and their environments. Protecting biodiversity is one of the greatest challenges facing humankind, having three levels, (a) genetic diversity, (b) species diversity and (c) ecosystem diversity.

Genetic diversity is the most basic level which refers to the gamut of genetic information contained in all individual plants, animals and microorganisms. It occurs within and between populations of species, as well as between species. Species diversity is the most familiar type of biodiversity, which refers to the variety of species in a specific location or among a specific group of organisms : Most of the tropical environments have greater species diversity than temperate areas do, e.g., the small tropical country of Costa Rica has at least 830 species of birds, more than combined mainland USA and Canada. Aspects of species diversity can be classified into three groups of measurement : species richness, species abundance and taxonomic or phylogenetic diversity. Measures of species richness count the number of species in a defined area. Measure of species abundance denote the relative numbers among species, e.g., a typical sample may

contain several very common species, a few less common species and numerous rare species. Measure of species diversity simplify information on species richness and relative abundance into a single index. Species diversity actually is in extensive use. Ecosystem diversity refers to the variety of physical settings on earth, such as deserts, lakes and coral reefs, and their population of plants and animals. Every kind of ecosystem has a unique mix of species that differs from every other kind of ecosystem, e.g., mix of plants and animals may differ even in the same rain forest on opposite sides of a mountain. If an ecosystem disappears, so do the species that live only in that ecosystem. The species level is generally regarded to be the most appropriate to consider the diversity between organisms, because species are the primary focus of evolutionary mechanisms and, therefore, are relatively well defined. Ecosystem diversity encompasses the broad differences between ecosystem types, and the diversity of habitats and ecological processes occurring within each ecosystem type. It is harder to define ecosystem diversity than species or genetic diversity because the "boundaries" of communities (Association of species) and ecosystems are more flexible. In river valley projects, the study of biodiversity in the area of submergence and catchment is very important, as these areas will be permanently altered. Before formulating proper EIA and EMP, one must understand the concept of biodiversity and first must be aware of its meaning and theory.

The evolution of life on this earth, since the appearance of first organisms more than three billion years ago, relentlessly made march towards advancement and diversification. New kinds of plants and animals, some comprised of many cells instead of just one, slowly became specialized. At a very early date the first heterotrophs appeared, including consumers that fed on living plants, predators that fed on the consumers, and scavengers that decomposed the remains of the dead. Among the multicellular plants and animals there emerged a trend toward the evolution of new and larger organisms with ever more complex anatomy. At the same time a diversity of small organisms with simple body plans continued to thrive and began to colonize in uninhabited zones of the earth's surface, the deep sea, the land, and even the air. The result was a steady increase in the biomass - the amount of living matter present on the earth. The biomass at the present juncture is remarkably more complex and efficient than that might have existed on a barren planet in the initial stage of life's origin.

India has tremendous biodiversity, genetic as well as of species and ecosystems. It contains over 5 per cent of the world's biodiversity on 2 per cent of the Earth's surface. This diversity can be attributed to the vast variety of landforms and climates resulting in habitats ranging from tropical to temperate, and from alpine to desert. The number of plant species in India is estimated to be over 45,000, representing about 7 per cent of the world's flora. These include over 15,000 flowering plants of which 4,900 species are endemic to the country. India is also considered one of the world's eight centers of origin of cultivated plants. India has 51 species of

cereals and millets, 104 species of fruits, 27 species of spices and condiments, 55 species of vegetables and pulses, 24 species of fiber crops, 12 species of soil seeds, and various wild strains of tea, coffee, tobacco and sugarcane. Several hundred species of wild crop relatives are distributed all over the country, especially in the western and eastern Himalayas, the Western Ghats and the Malabar Coast, north-eastern India, the Gangetic Plain, and in the eastern part of the Deccan Plateau which is a major center for wild rice. *Citrus indica*, the most primitive species of citrus plants, is found in the Tura hills in Meghalaya. It is believed that the cultivated varieties of citrus in India were perhaps developed from this endangered species. India's faunal wealth is equally diverse. The total number of animal species is estimated at 81,000, representing about 6.4 per cent of the world's fauna. India's known animal diversity includes about 57,000 insects, 2,546 fish, 204 amphibians, 428 reptiles, 1,228 birds and 372 mammals; it also includes about 20,000 invertebrates. The ancient practice of domesticating animals has resulted in India's diverse livestock, poultry and other animal breeds. India has 26 breeds of cattle, 40 of sheep, 20 of goats, 8 of camels, 6 of horses, 2 of donkeys and 18 poultry. India is also containing vast microbial diversity. Although exact numbers of viruses, microscopic algae and other microscopic organisms are not known, India has at least 850 species of bacteria and 12,500 of fungi.

4. TYPES OF BIODIVERSITY

4a. Genetic Biodiversity

This is the diversity of the basic units of hereditary information (genes) within a species, which are passed down the generations. Genetic diversity results in variations. It is this type of diversity that gives rise to several "varieties" of rice and wheat. Some variations are easy to see, for example, size or colour some, such as taste or flavor, can be perceived by other senses; and some are invisible, such as susceptibility to disease.

4b. Species Biodiversity

Species is the unit used to classify the millions of life forms on Earth. Each species is distinct from every other species. Horses and donkeys are distinct species, so are lions and tigers. What unites members of a species is the fact that they are genetically so similar that they can produce fertile offspring. Species diversity is usually measured in terms of the total number of species within a defined area. Species diversity is the most commonly used level for describing the biodiversity of countries. Based on this level a few countries are Australia, Brazil, China, Colombia, Ecuador, India, Indonesia, Madagascar, Malaysia, Mexico, Peru and Zaire.

4c. Ecosystem Biodiversity

An ecosystem is a set of life forms (plants, animals and micro-organisms) interacting with one another and with the non living elements (air, soil, water, minerals, etc.) of their environment. Ecosystem diversity is therefore the diversity of habitats, place or site where an organism or a population of organisms naturally occurs, which include different life forms within.

5. LOSS OF BIODIVERSITY

Some of the factors leading to the loss of biodiversity have already been mentioned. The current losses have both direct and indirect causes. The direct mechanisms include habitat loss, invasion by introduced species, pollution, global climate change, overexploitation of species, and certain agricultural and forestry practices. But the root of the problem of biodiversity loss lies in the way we live. Biodiversity is essential for sustainable development, but finding sustainable ways of living is essential for conservation of biodiversity. Some of the major causes of biodiversity loss are precisely outlined below. Later in this section the fundamental strategies of biodiversity conservation are also discussed.

Major Causes of Biodiversity loss include :

- ∇ Habitat fragmentation,
- ∇ Introduced species,
- ∇ Overexploitation of plant and animal species,
- ∇ Pollution of soil, water and atmosphere,
- ∇ Global climate change,
- ∇ Ignorance about species and ecosystems and loss of traditional knowledge,
- ∇ Unplanned development,
- ∇ Economic systems and policies,
- ∇ Inflexible or inappropriate legal and institutional systems,
- ∇ Some agricultural and forestry practices,
- ∇ Unsustainable natural resource consumption,
- ∇ Inequities, and
- ∇ Global trading systems.

6. STRATEGIES OF CONSERVATION

It is increasingly recognized throughout the world that the conservation of biological diversity is among the most important and at the same time, least appreciated challenges of the present and immediate future. The extinction is forever, and the irreversible reduction of the biological wealth of the planet is the crime for which future generations are likely to blame us most - more than wars, pollution, social disruption or any other reversible change. In this human being dominated world, once a large fraction of the earth's biological species is extinct, it may take millions of years for nature to evolve to replace whatever functions and uses the extinct species served. Considering the relative importance of threat of species extinction, IUCN categorized six major classes of threatened species as incorporated in their "Red Data Book". This categorization involved both flora and fauna as exist in their wild habitats. The priority of conservation of various species is thus made on the basis of their relative threat potentialities. The different forms of conservation can be grouped into two main categories: *in-situ* conservation and *ex-situ* conservation. These areas vary considerably in size, design, purpose and effectiveness of management, but as a repository for much of the World's biological diversity. During the last decade not only the Government of our country but a number of research institutions, Scientific Societies and even private individuals and society at large have involved themselves in the care of the living resources.

7. THE PROTECTED AREAS NETWORK

Thirteen Biosphere Reserves have been set up in the country to protect representative ecosystems and serve as laboratories for evolving alternative models of development. Three Biosphere Reserves from India are now included in the World Network of Biosphere Reserves namely; Sundarbans (West Bengal), Gulf of Mannar (Tamil Nadu) and Nilgiri (Kerala, Karnataka and Tamil Nadu). There are 92 National Parks and 500 Wild sanctuaries in the country covering an area of 15.67 million hectare. Financial assistance for development of National Parks and Sanctuaries was provided to 269 National Parks and Sanctuaries in 28 States (including North-Eastern States) and Union Territories in the country during the year. Twenty eight Tiger Reserves have so far been set up in 17 States covering an area of about 37,761 Sq.km. in the country. Project Tiger has been rated as a role model and one of the 56 events that changed India since independence. Eight potential areas in the country have also been identified for inclusion under Project Tiger.

This network of protected areas covers most of the representative habitat types in the country and affords protection both to the wild fauna and flora. National Parks and Sanctuaries have been set up within the legal framework of Wildlife (Protection) Act 1972, thus, these areas were accorded with the much needed legal support. Under National Action Plan for Wildlife, it is now proposed to undertake critical review of the existing protected areas to identify whether any particular biogeographic region has been left out.

Legal Protection : It may be pointed out that Biosphere Reserve Programme is very urgent and that it is complementary to that of national parks and sanctuaries established under the specific law - the Wildlife (Protection) Act of 1972.

Ex-Situ Conservation : As a rule, however, *in situ* conservation is not practicable for domesticates. *Ex situ* conservation, is "conservation outside their habitats by perpetuating sample populations in genetic resource centers, zoos, botanical gardens, culture collections, etc., or in the form of gene pools and gamete storage for fish; germplasm banks for seeds, pollen, semen, ova, cells, etc." It is safest and cheapest if life processes are reduced to the minimum level.

Seed Banks : Such conservation is practiced through cold storage in Seed Bank where seed is stored for long durations. Even after germplasm of primitive cultivars or land races and other cultivars is introduced in seed banks, the possibility of diversity being lost is still there on account of the fact that the seed samples are often not large enough to cover the whole spectrum of variation.

Botanical Gardens : They play an important role in the conservation of plant species so much so that there are several instances when plants believed to be extinct were found living only in a botanical garden. *Sophora toronirois* the famous example.

Pollen Storage : Pollen storage is of considerable interest in the conservation of genetic diversity. However, the life of pollen is much shorter than seed and a maximum of 3 years in some species has been reported.

Tissue Culture : This technique can be used to considerable advantage for stalling genetic erosion by organizing 'Tissue Banks'. Firstly, this could be done by freeze preservation of disease-free meristems. Secondly, through *in vitro* long-term culture of excised roots and proliferating shoots without loss of regeneration potential as also change in genetic constitution by eliminating callusing phase.

Genetic Engineering : These new scientific developments provide us with many new opportunities and also make it necessary to reassess strategies toward biological diversity. It helps in the genetic manipulation of an organism by increasing its usefulness to people. The term genetic engineering is usually used with reference to new technologies such as Recombinant DNA, Gene splicing, etc.

8. PROTECTION OF EXISTING BIODIVERSITY VIS-A-VIS HUMAN ACTIVITIES

Minor human activities pertaining to cultivation, building of structures, industrialization or recreation, have negative impact on the natural environment. Major interference like commercial logging, construction of roads and railways, mining, oil and natural gas exploration, occasional war, damming water bodies and rivers for construction of hydroelectric power plants, all with multiple repercussions, cause irreversible changes for worse. Environment in the intermediate regions of forests and human habitations is a complex mixture of physical, social, economic, ecological, geological and ethnic conditions, equally applicable to man and other life-forms in the region. A clear perspective of the subject, therefore, is essential while formulating an Environmental Impact Assessment (EIA). Wildlife resources should get a balanced approach with life-supporting systems like agriculture, ground water, safe living space, education, health care and social security. It is an essential prerequisite to review the likely effects of mega - as well as micro-level projects while conducting a detailed environmental impact assessment study, covering the area under direct influence, i.e., the submergence zone and the sites identified for rehabilitation, along with the areas associated with the submergence, namely, canal and rehabilitation sites. Human settlement requirements, namely, fodder, fuel and medication for livelihood should be identified to clearly indicate the ultimate effect of the project on their survival requirements and cultural attributes. For the regions of wildlife, contiguity, quality of forest in terms of density and taxa proliferation, species diversity of wild plants and animals, i.e., biodiversity, and movement patterns, should be monitored.

Finally, it may be highlighted that uncontrolled population growth is now a worldwide disturbing phenomenon. This trend needs to be checked, if we seriously wish to bring a semblance between destruction and conservation to get a healthy future for forthcoming generations of this planet to live in a healthy and non-confrontational biotic society.

NOTE : *This article is dedicated to my esteemed friend Prof. K. B. Mishra, formerly of the Magadh University, for his academic friendship with me for last several decades, which still retains its human warmth.*