Biodiversity Conservation and Sustainable Development

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Serials

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Preface

Biodiversity is the variety of plant and animal life found in an ecosystem and the variation in their genetic makeup. Biodiversity is a measure of the health of an ecosystem, with healthy ecosystems having greater variety and variation in plant and animal life than unhealthy ones. It is a large number and wide range of species of animals, plants, fungi, and microorganisms. Ecologically, wide biodiversity is conducive to the development of all species. Biodiversity, a contraction of the phrase "biological diversity," is a complex topic, covering many aspects of biological variation. In popular usage, the word biodiversity is often used to describe all the species living in a particular area. If we consider this area at its largest scale-the entire world - then biodiversity can be summarized as "life on earth." However, scientists use a broader definition of biodiversity, designed to include not only living organisms and their complex interactions, but also interactions with the abiotic aspects of their environment. Definitions emphasizing one aspect or another of this biological variation can be found throughout the scientific and lay literature. For the purposes of this module, biodiversity is defined as the variety of life on Earth at all its levels, from genes to ecosystems, and the ecological and evolutionary processes that sustain it.

There is also an important spatial component to biodiversity. The structure of communities and ecosystems for example the number of individuals and species present can vary in different parts of the world. Similarly, the function of these communities and ecosystems i.e. the interactions between the organisms present can vary from one place to another.

Different assemblages of ecosystems can characterize quite diverse landscapes, covering large areas. These spatial patterns of biodiversity are affected by climate, geology and physiography.

The structural, functional, and spatial aspects of biodiversity can vary over time; therefore there is a temporal component to the analysis of biodiversity. For example, there can be daily, seasonal, or annual changes in the species and number of organisms present in an ecosystem and how they interact. Some ecosystems change in size or structure over time (e.g. forest ecosystems may change in size and structure because of the effects of natural fires, wetlands gradually silt up and decrease in size). Biodiversity also changes over a longer-term, evolutionary, time-scale. Geological processes changes in sea-level.

The history of origin and the process of evolution have led to the diversity of life forms. The increase in environmental awareness over the last few decades has underlined the need to enhance our understanding of the ways in which human race and biodiversity interact. It is surprising that till 1992, the subject of biodiversity was never given the attention that it deserved, both at the national and the international level. It was only in June 1992, at the United Nations Conference on Environment and Development (UNCED) that the issue of biological diversity was taken up as a priority area for action for conservation and sustainable use. However, preparations for a Convention on Biological Diversity (CBD) were initiated by the Governing Council of the United Nations Environment Programme (UNEP) in 1987 through the establishment of an Ad Hoc Working Group of Experts on Biological Diversity, which met in 1988. The Ad Hoc Working Group was followed in 1991 by an Inter-Governmental Negotiating Committee for devising a Convention on Biological Diversity. The agreed text of the CBD was adopted by 101 governments in Nairobi in May 1992 and was signed by 159 governments and the European Union at the UNCED held in Rio de Janeiro in June 1992. The Convention finally entered in to force on December 29, 1993, which has since then been signed by 184 countries.

India became a signatory to the Convention by signing it on June 5, 1992.

The main objectives of the CBD, to be pursued in accordance with its relevant provisions, include conservation of biological diversity, sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilisation of genetic resources by means of appropriate access to genetic resources, appropriate transfer of relevant technologies, and appropriate funding.

This book is organized in 15 chapters. The first chapter deals with biodiversity – concept meaning and Functions. This chapter discusses functions of bio diversity, species, functional types, and composition of biodiversity, ecosystem responses to changes in biodiversity. biodiversity and ecosystem stability, predictability and reliability, affiliated ecosystems, economics and biodiversity, importance of biodiversity, soils formation and protection, contribution to climate stability, maintenance of ecosystems and social benefits. The second chapter discusses agricultural biodiversity

It covers topics such as food crops and biodiversity, source regions of major crops, introduced crops, agriculture and genetic diversity, genetic engineering genetic diversity and livestock breeding genetic improvement of forest species risks of high-yielding crop varieties, the value of biodiversity and soil biodiversity. The third chapter is Indian Biodiversity. It narrates about Wetlands Forests Marine Environment Species Diversity Endemic Species, Threatened Species Protected Areas of the Western Ghats Coastal and Marine Biodiversity of India and Threats to coastal and marine biodiversity. The fourth chapter is biodiversity and food security. It analyses genetic erosion in agriculture, preserving options for the future, genetic inter-dependence, farmers as innovators and conservers of diversity, biodiversity and indigenous knowledge, seeds of survival dangers of genetic uniformity and importance of crop genetic diversity. The fifth chapter discusses about biodiversity loss. It covers topics such as massive extinctions from human activity, declining ocean biodiversity, people and forests, misuse of land and resources, long term costs, species at higher trophic levels and species with chronically small populations. The sixth chapter deals with climate change and biodiversity. It explains climate change affects all biodiversity, The links between climate change and biodiversity, Biodiversity, land use and climate change, Poverty, climate change and biodiversity, climate change, conservation and development, Biodiversity and climate change and research priorities. The eighth chapter deals with people's biodiversity register with basic behavioral issues, revealed preference and biodiversity conservation, objectives of the people biodiversity register and benefit sharing. The ninth chapter discusses about biodiversity economic valuation and this chapter discusses economic valuation techniques, travel cost method, valuing changes in environmental quality at a site, basic model of ITCM, application of the individual travel cost approach, advantages of the travel cost method, evaluation of travel cost method and random utility model. The tenth chapter is biodiversity measurement. It discusses species diversity: measures and scales, species richness, functional diversity and the niche preemption model or the geometric model. The eleventh chapter narrates about biodiversity survey techniques and this chapter explains biodiversity survey, standardized data collection methods, scat collection and point count method. The twelfth chapter is bioregional planning. It points out characteristics of bioregional planning, challenges to bioregional managers, integrated strategic planning, protected areas in a bioregional framework, bioregional planning frameworks and bioregional planning in India. The thirteenth chapter is gender and biodiversity. It deals with Gender Dimensions of Biodiversity Management, *FAO, gender and biodiversity*, Ecofeminism and Biodiversity and Global Action for Women towards Sustainable and Equitable Development. The fourteenth chapter is indigenous knowledge and biodiversity. The fifteenth chapter is biodiversity education. It deals with biodiversity education methods.

I express my sincere gratitude to my revered Vice Chancellor Dr. M.Ramanathan and my beloved Director

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Dr. I. Sundar

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Bio Diversity - Concept Meaning and Functions

Biodiversity is an all encompassing term to describe the variety of all life and natural processes on Earth. The Convention on Biological Diversity defines biodiversity as "the variability among living organisms from all sources this includes diversity within species, between species and of ecosystems". Biodiversity is synonymous with all things 'natural' and worth caring for in the environment such is the generality with which the term is used. According to the United Nations Convention on Biological Diversity, the "... variability among living organisms". Hence, the term relates specifically to variability rather than to the overall extent of the biological resource.

This variability can be considered at four levels:

- Genetic in terms of genes, nucleotides, chromosomes, individuals;
- Species in terms of kingdom, phyla, families, subspecies, species, populations;
- Ecosystem in terms of bioregions, landscapes, habitats; and, Functional in terms of ecosystem robustness, resilience, goods and services.
- Hence, the term can be applied to the variability of genetic material through to landscape diversity.

It is also important to recognise that variability and overall magnitude are intrinsically linked. It is conceivable that genetic variability could be protected in intensively managed small-scale facilities such as zoos and herbariums and that mini landscape preserves could be established to provide representations at the ecosystem level. But to ensure resilience and robustness at the functional level it is difficult to imagine a protection regime that does not involve scale as well as diversity. For instance, resilience implies an ability to recover from an externally imposed shock. Almost by definition, a small-scale attempt to protect biodiversity will be at greater risk from an external shock. Even at the genetic and species levels, the protection of variability in the biological resource is afforded by larger scale protection initiatives. Put simply, scale and variability in the biological resource are likely to be strongly complementary. It is, perhaps, because of this complementarity that biodiversity has taken on such an extensive mantle in the nature conservation debate.

Functions of Bio Diversity

Ecosystem functioning reflects the collective life activities of plants, animals, and microbes and the effects of these activities. Feeding, growing, moving, excreting waste, etc. have on the physical and chemical conditions of their environment. Note that functioning means showing activity and does not imply that organisms perform purposeful roles in ecosystem-level processes. A functioning ecosystem is one that exhibits biological and chemical activities characteristic for its type. A functioning forest ecosystem, for example, exhibits rates of plant production, carbon storage, and nutrient cycling that are characteristic of most forests. If the forest is converted to an agroecosystem, its functioning changes. Ecologists abstract the essential features of an ecosystem into two compartments, the biotic and the abiotic. The biotic compartment consists of the community of species, which can be divided functionally into plant producers, the consumers that feed on producers and on each other, and the decomposers. The abiotic compartment consists of organic and inorganic nutrient pools. Energy and materials move between these two compartments, as well as into and out of the system. Ecosystem processes are quantified by measuring rates of these movements e.g., plant production, decomposition, nutrient leaching or other measures of material production and transport or loss. Ecosystem functioning, in turn, is quantified by measuring the magnitudes and dynamics of ecosystem processes.

Ecologists describe Ecosystem functioning results from interactions among and within different levels of the biota as a nested hierarchy. For example, green plant production on land is the end product of interactions of individual plants nested within populations; interactions among populations nested within a single species; interactions among a variety of species nested within a group of functionally similar species; and so on up to the level of interactions between different types of ecosystems nested within landscapes.

Biodiversity: Species, Functional Types, and Composition

Every organism contributes to ecosystem processes, the nature and magnitude of individual contributions vary considerably. Research in biodiversity places much emphasis on the uniqueness of individual species and their singular contributions to ecosystem services. Yet most ecosystem processes are driven by the combined biological activities of many species, and it is often not possible to determine the relative contributions of individual species to ecosystem processes. Species within groups such as grazing mammals, large predators, perennial grasses, or nitrogen-fixing microbes may therefore be functionally similar despite their uniqueness in genes, life history, and other traits. Groups of species that perform similar roles in an ecosystem process are known as functional types or functional groups. Species may also be divided into functional types based on what they consume or by trophic status e.g., their place in the food web as producers, decomposers and predators. Within trophic groups, species may be further divided according to life history, climatic or nutrient needs, physiology or other biological traits. Researchers may place a species into several different functional categories depending on the ecosystem process they are studying.

Figure 1- Magnified portion of the biosphere showing its position within the three major biogeochemical spheres. Driven primarily by solar energy, producers, decomposers, and consumers annually move large quantities of materials containing many elements and compounds among the different spheres. The role of the tremendous diversity found within the biosphere is only recently beginning to be understood.

Figure 2- The Role of Earth's Biota in Biogeochemical Processes

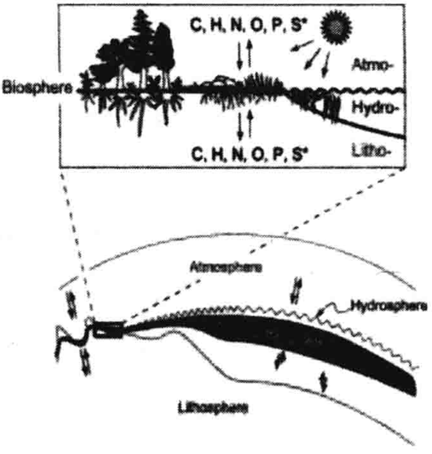

Figure 3- The major biogeochemical spheres consist of the lithosphere, hydrosphere, and atmosphere, where the biosphere is found.

Because species can vary dramatically in their contributions to ecosystem functioning, the specific composition or identity of species in a community is important. The fact that some species matter more than others becomes especially clear in the case of .keystone species. or .ecosystem engineers or organisms with high .community importance values.. These terms differ in usage, but all refer to species whose loss has a disproportionate impact on the community when compared to the loss of other species. For example, a species of nitrogen-fixing tree, Myrica faya, introduced to the Hawaiian Islands has had large-scale effects on nitrogen cycling, greatly increasing the amount of this essential plant nutrient in soils where the tree invades. The nitrogenfixing lupine Lupinus arboreus also enriches soils and, as a consequence, encourages invasions of weedy grasses. Among animals, moose i.e. Alces alces through their dietary preferences greatly reduce soil nitrogen levels and also influence the succession of trees in the forest. Beavers, too, through their feeding and dam-building not only alter soil fertility and forest succession but increase the diversity of ecosystems in a landscape. Even termites play critical roles in soil fertility and other ecological processes in many arid grasslands. On the other hand, there are some examples where additions or losses of particular species have had little effect on ecosystem processes.

Ecosystem Responses to Changes in Biodiversity

Since Darwin, prominent biologists have hypothesized about the relationship between biodiversity and ecosystem functioning. More recently, concerns about increasing loss of biodiversity and questions about resulting degradation of ecosystem services have stimulated unprecedented observational, theoretical, and experimental studies.

Observational Studies

It might seem that observational studies comparing one ecosystem type with another, or comparing similar ecosystems at different locations, could provide ready answers to questions about the impacts of species richness on ecosystem processes. But these studies have invariably proven problematic. For example, an ecosystem such as a tropical forest or a coastal wetland may vary from one site to another not only in species number and composition, but also in physical and chemical conditions such as soil type, slope, rainfall, or nutrient levels. Comparing different ecosystems is likely to yield an unclear result because the response to variations in biodiversity cannot easily be distinguished from responses caused by variations in environmental and other factors. It is possible, though difficult, to control statistically for such potentially confounding factors.

Experimental Studies

Experimental studies, if well-designed, can minimize the confounding factors that plague observational studies. Experiments can provide insights not only into the relationships between biodiversity and ecosystem functioning but also into the possible mechanisms behind the relationships. Studies to date have ranged from large outdoor experiments and trials in large controlled environment facilities to modest-sized pot experiments and tests in small laboratory microcosms (Figure). This research has attempted to address two different questions about the link between biodiversity and ecosystem functioning. First, how are levels of ecosystem functioning affected by changes in biodiversity, particularly species richness? Second, how are the dynamics of ecosystem functioning, particularly the resilience and stability of processes, affected by changes in biodiversity?

The following two sections review the experimental and theoretical results that shed light on these questions.

Biodiversity and Levels of Ecosystem Functioning

Results from many recent experimental studies conducted in North America and Europe demonstrate that ecosystem productivity increases with species richness. These studies range from large outdoor experiments to controlled laboratory experiments conducted in growth chambers, greenhouses, or small containers. Outdoor experiments such as those conducted in grasslands on nutrient-poor serpentine soils at Stanford, California and on prairie grasslands at Cedar Creek Natural History Area, Minnesota

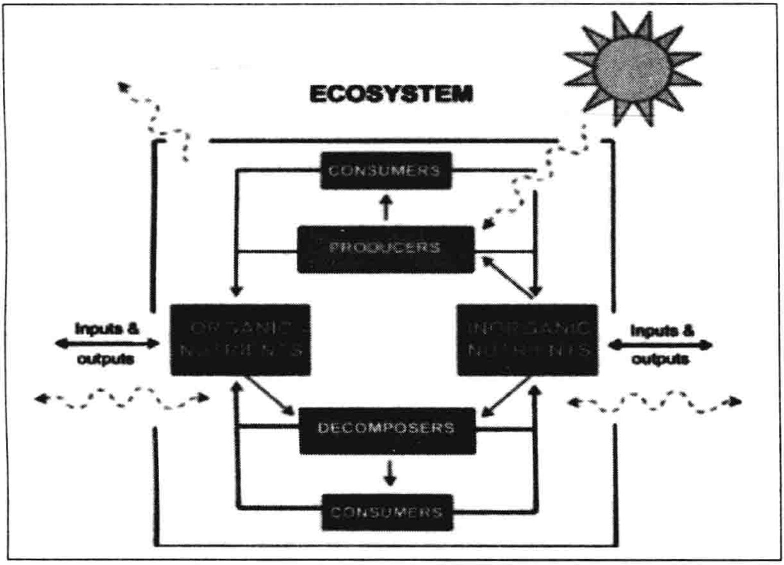

Figure 4- Basic Ecosystem Functioning

Producers acquire energy through photosynthesis and take up inorganic nutrients to produce living biomass, forming the food base for consumer species such as herbivores and their predators. Mortality leads to accumulation of organic nutrients which are transformed by decomposers into living biomass, forming the food base for consumers. Decomposers and consumers contribute to formation of inorganic nutrients by mineralization, completing the cycling of nutrients between organic and inorganic forms. Energy flows shown in the form of wavy, dashed lines begin with acquisition by producers and end in loss due to the respiration activities of all organisms. More recent laboratory experiments in Europe and North America have begun to examine the impact of other components of biodiversity, such as the diversity of soil microorganisms, on plant production and the role of bacteria, predators, and herbivores in freshwater microbial communities.