UNIT 2 BIODIVERSITY VALUES AND ECOSYSTEM SERVICES

Structure

2.1 INTRODUCTION

Biodiversity or biological diversity is the combination of two words ‘bio’ meaning living organisms and ‘diversity’ meaning variations. The term biodiversity was coined by Walter G. Rosen in the National Forum on Biodiversity held in Washington, DC in September 1986 which refers to the genetic, species, and habitat diversity that is evaluated at different scales within

the global biosphere, including between individuals, populations, species, communities, and ecosystems (Sarkar, 2007). In other words, it is the variety of life including plants, animals, and microorganisms on Earth *i.e.,* the sum total of all genetic, organismal, and ecological variations in terms of composition and function observed within and between species and the ecosystems that coexist at a given time and place (Opoku, 2019; Wilson, 1988). The United Nations Convention on Biodiversity defined it as '*the variations and variability among living organisms including flora, fauna, and microorganisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part, that also includes the diversity within species, between species, and of ecosystems*' (CBD, 2006). The sum of a region's genes, species, and ecosystems varies widely over the world rather than being spread uniformly (Schulze et al., 2019). It also varies at both altitudinal and latitudinal gradients, always higher in tropical climates as compared to the other climatic zones and depends on mainly altitude, soil, geography, topography, temperature, precipitation, humidity, and biotic interactions (Tito et al., 2020; Martinez-Camilo et al., 2018). Climate and the amount of available space are the two major abiotic drivers of taxonomic diversity dynamics in a given area (Escarguel et al., 2011). A global increase in temperature associated with a lowering of the latitudinal gradient of temperature (IPCC, 2007) will necessarily lead to a decrease in global diversity through geographic homogenization of species assemblages (Escarguel et al., 2011). Habitat fragmentation due to the increasing anthropogenic pressure exerted at all latitudes is a major cause of a decrease in local diversity in the majority of terrestrial and marine ecosystems (Rosenzweig, 1995). Besides, the biosphere may be currently entering its sixth major extinction crisis with the ongoing global warming, local demographic, and agricultural pressures (Pimm et al., 1995). The five most notable drivers behind biodiversity loss are habitat destruction, overexploitation, climate change, invasive species, and chains of extinction (Sonwa et al., 2017). Infectious diseases like COVID-19 can originate and spread as a result of biodiversity loss (Johnson et al., 2013) that may result in health problems due to a lack of food or nutritional diversity (James et al., 1997), while enhancing biodiversity provides immediate health advantages, such as reducing air pollution through the use of green roofs (Rowe, 2011) and thereby lowering the prevalence of respiratory and cardiovascular ailments (Brunekreef and Holgate, 2002). Genetic diversity, species diversity, and community or ecosystem diversity are the three different interrelated and distinct levels of biodiversity (Sarkar, 2007). These levels of biodiversity are interrelated and distinct enough to be studied separately to understand the interactions that support life on earth (**Figure 2.1**).

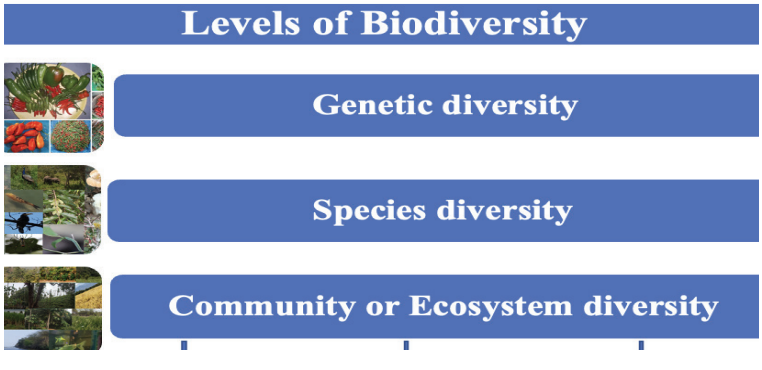

Figure 2.1: Various Levels of Biodiversity and Perspectives of Community or Ecosystem Diversity.

2.1.1 Genetic diversity

A key source of biodiversity is genetic diversity which is the magnitude of genetic variability within a population (Hughes et al., 2008) or the genetic makeup of the variation of organisms and species on Earth (Elliott, 2002). Genetic diversity is the variation of genes among species and populations as well as within those populations that separate distinct breeds or races from one another (UN-FAO, n.d.). Some species have as many as 400,000 genes, *e.g.,* human beings have ~25,000 genes, while rice has >56,000 (National Geographic Society, 2022). In dynamic ecosystems, genetic variability is crucial for population survival and often rises with environmental variability since alterations in environmental variables affect genetic diversity within populations (Lovejoy and Hannah, 2005). Even species with significant capacity for gene flow are affected by environmental influences in their dynamics (Freeland et al., 2010). Failure to retain genetic variability restricts the ability of a population to adapt to a changing environmental condition, making it vulnerable to the likelihood of extinction (Szczecińska et al., 2016).

2.1.2 Species diversity

Species diversity has two primary components, *i.e.,* species richness (the number of species in a community) and species composition (the identity of the species present in a community) which has a major influence on ecosystem functioning and stability (Cleland, 2011). Typically, it is the patterns of species richness over various geographical extents (local, regional, continental, and global) or over various time periods (seasons, years, centuries, to millennia) (Chiarucci et al., 2011). Species play essential roles in ecosystems and species diversity is essential for economic, biological, social, and cultural reasons, therefore local and global species losses could threaten the stability of the ecosystem (McCann, 2000). The community and ecosystem processes became more stable as species diversity improved (Tilman, 1996). Globally, around 1.75 million species have been discovered so far, including 950,000 insect species, 270,000 plant species, 19,000 fish species, 9,000 bird species, and 4,000 mammal species (National Geographic Society, 2022). The diversity of various groups of animals and plants, the numbers of species evaluated by IUCN Red-List 2021, and the number of threatened species are given in **Table 2.1**. The number of species in a particular area (species richness) and the degree to which the relative abundances of species are similar (species evenness or equitability) are the two factors that affect species diversity (Magurran and Gill, 2011). Commonly used methods to determine species diversity include various mathematical indices known as diversity indices (the Shannon-Weiner diversity index (Magurran, 1988), Simpson's index of dominance (Simpson, 1949), Pielou's index of species evenness (Pielou, 1966), and Margalef's index of species richness (Magurran, 1988)) being the most widely used (Hamilton, 2004) (**Table 2.2**).

Table 2.2: Diversity of various groups of animals and plants, numbers of species evaluated by IUCN Red-List 2021, and number of threatened species (Source: https://www.iucnredlist.org/resources/summary-statistics)

Biodiversity	Estimated Number of described species[1]	Number of species evaluated by 2021 (IUCN Red List version 2021-3)	Number of threatened species[2] by 2021 (IUCN Red List version 2021-3)	Sources
VERTEBRATES				
Mammals (excluding domesticated one)	6,596	5,968	1,333	ASM Mammal Diversity Database, 2022
Birds	11,162	11,162	1,445	HBW and BirdLife International, 2022
Reptiles	11,733	10,148	1,839	Uetz et al., 2022
Amphibians	8,478	7,296	2,488	American Museum of Natural History, 2022
Fishes	36,272	22,581	3,332	Frick et al., 2022
Subtotal	74,241	57,155	10,437	
INVERTEBRATES				
Insects	1,053,578	12,100	2,270	Roskov et al., 2022
Molluscs	110,732	9,019	2,385	MolluscaBase, 2022
Crustaceans	80,122	3,189	743	Roskov et al., 2022
Corals	5,610	848	232	WoRMS Editorial Board, 2021
Arachnids	110,615	441	251	Roskov et al., 2022
Velvet Worms	230	11	9	Oliveira et al., 2021
Horseshoe Crabs	4	4	2	Roskov et al., 2022
Others	157,543	902	150	Roskov et al., 2022

Subtotal	1,518,434	26,514	6,042	
PLANTS				
Green Algae	12,090	16	0	Guiry and Guiry, 2021
Brown Algae	4,381	15	6	Guiry and Guiry, 2021
Red Algae	7,445	58	9	Guiry and Guiry, 2021
Bryophytes	21,925	282	165	
Pteridophytes	11,800	739	281	
Gymnosperms	1,113	1,016	403	Christenhusz et al., 2011
Angiosperms	369,000	56,232	22,477	IUCN, 2022
Subtotal	427,754	58,358	23,341	
FUNGI & LICHENS				
Lichens	28,000	76	56	Thell et al., 2012; Chapman, 2009
Mushrooms, etc.	120,000	474	208	IUCN, 2022
Subtotal	148,000	550	264	
Total	2,168,429	142,577	40,084	

Notes:

1. The number of described species in this table should be used with caution as these are not always up to date for all taxonomic groups.
2. Threatened species are those listed as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU).

Table 2.2: Different most widely used diversity indices.

Diversity indices	Mathematical equation	References
Shannon-Weiner diversity index (H')	$H' = -\sum_{i=1}^{s} pi \ ln \ pi$	Magurran, 1988

Simpson's index of dominance (CD)	$CD = \sum_{i=1}^{s} (pi)^2$ where pi = ni/N ni = IVI of individual species N = IVI of all species	Simpson, 1949
Pielou's evenness index (E)	$E = \frac{H'}{Hmax}$ where H' = Shannon-Wiener diversity index $H_{max} = lnS$ (S = Total number of species)	Pielou, 1966
Margalef's index of species richness (Dmg)	$Dmg = \frac{S-1}{lnN}$ where S=Total no. of species N=Total no. of individuals	Magurran, 1988

2.1.3 Community or Ecosystem diversity

Diversity of the biological communities in which different species exist is referred to as community diversity or ecosystem diversity. Diverse ecosystems are able to withstand environmental stress, which leads to increased productivity (Chandrakar, 2012). The scale or perspectives of community or ecosystem diversity assessment may range from within a single site or habitat (refers to alpha (α) diversity) to the difference between two or more sites (beta (β) diversity) (Whittaker, 1960), which can be combined together to offer gamma (γ) diversity *i.e.,* the diversity of the entire landscape or geographic regions.

2.2 OBJECTIVES

- To get an idea about biodiversity and its levels
- To determine the consumptive and intrinsic values of biodiversity
- To determine the ecosystem services (ESs) values
- To get an idea about the monetary benefits of biodiversity

2.3 VALUES OF BIODIVERSITY

The concept 'value' is most frequently used in a financial sense and it is confusing to account for non-monetary 'values' like the aesthetic worth of a landscape or the historical or even emotional importance of a location (James, 2015). The value of biodiversity and the products and services it offers are indicators of how ready a society is to make compromises in order to protect these natural resources (Pascual and Muradian, 2010). Nature and its component biodiversity have instrumental value only and should be valued like

any other commodities as per economists' viewpoints, while as per ecologists' viewpoints, the elements of nature have 'inherent' or 'intrinsic' value, and are therefore deserving of preservation and protection for their own sake (Golliher, 1999). Biodiversity delivers tangible benefits that are of monetary value, such as crops and many other non-monetary values, such as pure air perceived by the beneficiaries (Small et al., 2017). Moreover, biodiversity has often served both non-consumptive use like recreation and consumptive use like food and also the indirect use like pollination (Pascual and Muradin, 2010). Biodiversity directly contributes to human well-being in terms of the provision of foods, fuels, and fibres, and indirectly in terms of the provision of ecosystem services (ESs) (Binder and Polasky, 2013). Different types of benefits or values gathered from the biodiversity with examples are listed in **Table 2.3**.

Table 2.3: Various types and sub-types of biodiversity values with examples.

Type of values	Sub-type of values	Major uses with examples
Instrumental or utilitarian values	Direct or consumptive use-values	• **Food: Plants**: crops, legumes, fruits, vegetables, mushrooms, etc.; **Animals**: Fish, meat, milk products, honey, etc.; **Microorganisms**: alcohol, bakery, card, cheese, etc. • **Fuel:** Fossil fuels, bioenergy crops, biomass, fuelwood, etc. • **Fibre:** Cotton, jute, bast fibre, wood fibre, grass fibre, etc. • **Drugs and medicines:** (**Plants**: *Ocimum sanctum, Azedirachta indica, Tinospora cordifolia*, etc.; **Animals**: skins of tiger, the blood of snakes, the horn of the rhino, teeth of elephants, etc.; **Microorganisms**: antibiotics, etc.)
Instrumental or utilitarian values	Indirect or non-consumptive use-values	• Ecosystem services: Erosion control, disaster risk reduction, pollution control, climate regulation, air, water, and soil quality maintenance, water supply, pollination, pest and disease control, nutrient cycling, etc. • Ecotourism: Places of natural heritage, national parks, biosphere reserves, wildlife sanctuaries, natural forests, etc. • Research and Education: Experimental plants and animals • Crop and plant breeding programs: Wild varieties of plant and animals

Intrinsic or inherent values	-	• **Ethical**: Moral responsibilities to let others live • Option: Undiscovered potential of biodiversity for various products and services • Recreation and Aesthetics: Ornamental plants, fishes, uses of biodiversity goods for ornamentations (jewellery, etc.) and natural heritage sites for mental satisfaction and leisure • Religious: (Plants: Ocimum sanctum (Tulsi), Aegle mermelos (Bael), etc.; Animals: Owl, Snake, etc.) • Social and cultural: Customary uses like mango leaves in marriage, mango twig and ghee in Yagya, etc.

2.3.1 Instrumental or utilitarian values

Instrumental or utilitarian values include both direct and indirect uses of biodiversity that address the economic benefits accessed by human beings for their own sake from nature (Bullock, 2017). Sometimes, these values are related to monetary valuation and non-monetary benefits associated with many other ecosystem services (Hiron et al., 2018). It can be further divided into consumptive and non-consumptive use values as mentioned below-

2.3.1.1 Direct or Consumptive Use Values

The products of biodiversity harvested and consumed directly by locals such as food, fibres, fuels, medicines, *etc*. are considered under consumptive use value (Verma, 2016). It can be broadly categorized into foods, drugs and medicines, fibres, woods, other non-wood products, and fuels (TEEB, 2010).

2.3.1.2 Indirect or Non-consumptive Use Values

Non-consumptive values also known as non-extractive use values or functional values (Dixon and Pagiola 1998), include all the services and functions of nature through which human beings and other living beings are benefited indirectly including scientific research, recreational activities such as bird watching (Hanley and Perrings, 2019), water purification, protection of natural resources, regulation of climate, waste decomposition, nutrient cycling, ecotourism, reproductive activities, and feeding activities of commercial fishes (Alho, 2008).

2.3.2 Intrinsic or Inherent Values

The intrinsic value of biodiversity can be defined as the values of each living being within itself as it exists (Sandler, 2012) and it has a variety of philosophical,

religious, cultural, and ethical origins. It can be understood that every species being the entity of earth is valuable although it is not useful (Vucetich et al., 2015). Intrinsic values are indigenous in origin at any particular habitat and time and it is the result of a continuous evolutionary process (Alho, 2008). The global indigenous tribes have recognized the value of biodiversity and have given it an important place in their myth, culture, and traditions (Gray, 1999). The recognition of traditionally practised integral human-environment relationships and the inherent connections between biological and cultural diversity is now being reclaimed by local peoples around the world (Golliher, 1999). Acknowledging the intrinsic value of biodiversity rises from recognizing all the species of conservation concern that offer little benefit to human welfare which have been well recognized by society and have some sociological and cultural evidence (Vucetich et al., 2015). The degree to which an entity's intrinsic value is attributed to it may be judged by looking at the legal and social repercussions of breaking rules or regulations (Alcamo et al., 2005). In other words, intrinsic value refers to the sense of worth that exists irrespective of human valuations and shows the value of an ecosystem regardless of how others perceive it (O'Neill, 1993).

2.3.2.1 Ethical Values

Biodiversity has ethical values as every organism has the right to live, it teaches us the lesson to have compassion and care for other organisms. Ethical values depend on the understanding of humanity and come from ethics and the moral principles to judge right and wrong (Pojman and Fieser, 2011). Our ethical understanding of biodiversity is still in the early stages and it needs to be advanced (Bosworth et al., 2011).

2.3.2.2 Option Values

Biodiversity is a universal good (Government of Ireland, 2008). The future possibility to use biodiversity for the benefit of humankind is called option values. For instance, different species of plants, animals, and microorganisms might contain valuable compounds which may have the potential to cure dangerous diseases like cancer (Spellman, 2015).

2.3.2.3 Recreation and Aesthetic Values

Aesthetics are generally defined as the enjoyment and pleasure felt through the observation of environmental scenery, characteristics of the observed object, beauty, and rarity (Swaffield and McWilliam, 2013). The aesthetic value of biodiversity means the pleasure and emotion that brings a positive response through visualization and observing the beauty of nature (Tribot et al., 2018). It activates positive energy in our lives through music, literature, photography, tourism, paintings, emotions, and feeling (Saini et al., 2011). It also brings a positive social motivation for the conservation of nature and biodiversity by man through laws and policies, protected area networks, sacred grooves, and tribal efforts (Tribot et al., 2018). The increasing use of the natural area for outdoor recreation will ensure its ecological integrity in the future (Zaslowsky, 1995). Natural area preservation and restoration contribute to aesthetic appeal and passive recreational usage (City of Boulder Open Space Department, 1995).

2.3.2.4 Religious Values

Biodiversity is a part of the religious and cultural sentiments of the people around the world, especially the tribes (Saini et al., 2011). Many tribal communities worship nature, particular plants and animals as per the religious taboo and preserve it in a relict form known as sacred groves (Malhotra et al., 2001). Local communities safeguard it because of their adherence to their religious principles and long-standing customs (Khumbongmayum et al., 2004). Religion can provide emotionally compelling beliefs that can be used to implement adaptive solutions for resource management and biodiversity usage (Berkes, 2013). For instance, the use of flowers, bael Patta (leaves of *Aegle marmelos*), and tulsi (*Omimum sanctum*) in puja and Yagya in Hindu religious rituals provide the basis for their conservation. Conservation ethics and behaviour in association with religion strengthen biodiversity conservation and prevents resource depletion ensuring a symbiotic relationship with sustainable development (Negi, 2012).

2.3.2.5 Socio-cultural Values

The cultural implications make it easier to establish a connection between biodiversity and human health (MEA, 2005). Cultural pathways positively link human and natural spaces to create opportunities for cultural goods and services (Lovell et al., 2014). Numerous plants and animals have long symbolic meanings, and they are depicted on flags, in folktales, and in religious texts (Kellert and Wilson, 1993). Humans appreciate and care about biodiversity, because the loss of biodiversity may have an impact on cultural values, which will have a considerable negative impact on human well-being by raising anxiety, irritation, and stress (Clark et al., 2014).

Check Your Progress 1

Note: a) Use the space given below for your answers.

b) Check your answers with those given at the end of unit

1. What do you mean by biodiversity and what are the different levels of biodiversity?

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2. What are the major types of biodiversity values?

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2.4 MONETIZING THE VALUES OF BIODIVERSITY

The monetary value of biodiversity includes both use and non-use values, i.e., the direct value of using it for entertainment options, or as foods, woods, non-woods, drugs, medicines, and so on, as well as the indirect value of using it for various regulating services such as carbon sequestration, climate moderation, nutrient cycling, and so on (Small et al., 2017). Monetizing biodiversity helps in evaluating the effect of changes occurring in ESs for the sustenance of mankind (Wincler, 2006). It helps in knowing the consequences due to economic activities and their further reaction to the ecosystem functioning (Cordier et al., 2014). The importance of biodiversity can be understood, but not easily valued, because many ecosystem goods and services occur simultaneously, and are often very difficult to estimate (Sullivan, 1997). The monetary valuation of biodiversity influences the concept of biodiversity ownership and property (Brondizio et al., 2010). It refers to an asset's value, which is determined by its function in meeting human requirements through spiritual enlightenment, aesthetic enjoyment, or the provision of certain marketable items (Barbier et al., 2009). Through payments, valuation plays a vital role in developing markets for the protection of biodiversity and ESs (Engel et al., 2008). Such a market development process necessitates the demonstration and appropriation of values, as well as the sharing of conservation benefits (Kontoleon and Pascual, 2007). Besides, the value of biodiversity is calculated by considering the components of the ecosystem *i.e.,* ecosystem products, services, and other benefits, place of marketing with restoration and preservation facilities, and different direct and indirect monitoring techniques (Cordier et al., 2014). The complexity of ecosystem services, the provision of multiple services at once, the effects of high uncertainty, ignorance, and scaling up estimated values of ESs, the presence of ecological thresholds and non-linearities, the lack of methods to incorporate the idea of the resilience of socio-ecological systems, and the dynamic behaviour of ecosystems are among the most significant challenges for valuation of the goods and services provided by biodiversity (IPCC, n.d.). Small-scale measures for biodiversity conservation with sensitive planning are an important pathway for achieving conservation with sustainable development (Kowarik et al., 2020) (**Figure 2.2**).

development.

Figure 2.2: Contributions of biodiversity conservation towards economic growth and sustainable

2.5 BIODIVERSITY AND ECOSYSTEM SERVICES (ESS)

Ecosystems are important not only for maintaining the global carbon cycle and climate change adaptation but also for a wide range of ESs that are necessary for human well-being and the accomplishment of the Millennium Development Goals (MEA, 2005; Malhi et al., 2020). ESs are the conditions and processes through which natural ecosystems and their component biodiversity contribute to the survival of life on Earth and the fulfilment of human needs (Daily, 1997). Humankind derives substantial benefits not only from the products of biodiversity but also from services of ecosystems, such as water purification, erosion control, and pollination (National Research Council (US) Committee on Noneconomic and Economic Value of Biodiversity, 1999). The basic ESs provided by natural ecosystems are primary productivity, biogeochemical cycling, waste decomposition, soil formation and erosion control, climate extremes moderation, flood control, pollution mitigation, biological control of insect pests, water, air, and soil quality protection and maintenance, and crop pollination (Sullivan, 1997; Daily, 1997). Global climate change and change in atmospheric composition are likely to have an impact on most of these goods and services, with considerable impacts on socioeconomic systems (Winnett, 1998). Biodiversity is extremely complex and dynamic, and supports many ESs that are often not easily visible and plays an important role in regulating the atmospheric conditions, hydrological cycle, and recycling nutrients (Kunhikannan, 2017). It also contributes to climate change mitigation and adaptation through the provisioning of ESs (Seddon et al., 2020). Ecosystems and biodiversity may be generally regarded as elements of our natural capital, and the flow of ESs is the interest that society receives from that capital (Costanza and Daly, 1992). The goods and services provided by biodiversity are of great value to human health, livelihoods, and well-being (Wei et al., 2021). Some of the ESs, like food, are necessary for human existence, while others are highly desirable services for human enjoyment, like recreation (Small et al., 2017). A healthy ecosystem provides us various ESs including fertile soil for better crop productivity to fulfil food security, clean water, food, timber, regulate O_2 and CO_2 concentration in the atmosphere, moderate the climate, reduce the spread of diseases, protect against erosion, flood, and draught, and any other natural disasters (TEEB, 2010). The Millennium Ecosystem Assessment by the United Nations (2005) divided ESs into four main categories: provisioning, regulating, supporting, and cultural services (Alcamo et al., 2005) (**Figure 2.3**). Provisioning services included food, pharmaceutical products, building material, etc., while regulating services included climate regulation, disaster risk reduction, and population maintenance of different species. On the other hand, supporting services included nutrient cycling, primary production, erosion control, etc. and cultural services included spiritual experience, recreation, aesthetics, etc. (MEA, 2005). Depending on the timeframe and direct influence on people, some ESs, like erosion control, can be categorised as both supporting and regulating (TEEB, 2010).

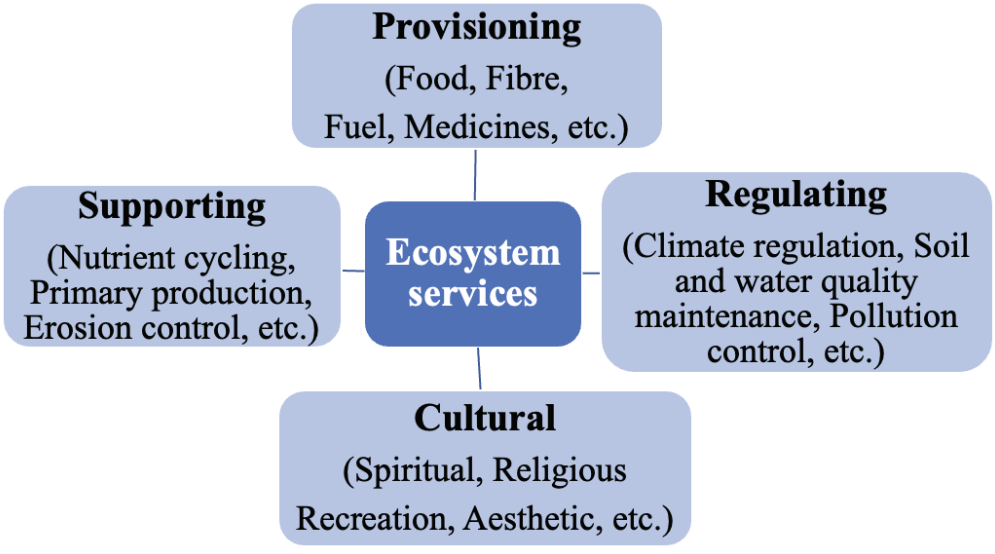

Figure 2.3: Various types of ecosystem services provided by biodiversity (MEA, 2005).

2.5.1 Provisioning ESs

Biodiversity provides various provisioning services including food, fibre, fuel, water, drugs and medicines, woods, and other goods (TEEB, 2010; MEA, 2005). Many provisioning services are traded in markets known as productive use of biodiversity in the form of raw materials of industries (e.g., Bamboos in the paper industry and woods in the plywood industry) and many rural households in developing countries, directly depend on provisioning services for their livelihoods (e.g., fuelwood, wild edible plants, fruits, vegetables, herbal medicines, etc.) (UN-FAO, n.d.).

2.5.2 Regulating Services

Regulating services are often invisible but when they are damaged, the resulting losses can be substantial and difficult to restore (UN-FAO, n.d.). These are the advantages derived from ecological processes and biodiversity that control climate, diseases, waste, various other disasters, and the quality of the soil, water, and air (MEA, 2005). Additionally, ecosystems provide regulating functions such as carbon sequestration and storage, limiting the occurrence of severe events, wastewater treatment, controlling river flow, biological control, or pollinating crops (TEEB, 2010).

2.5.3 Supporting Services

Services that are necessary for all other ESs to be produced including soil formation, erosion control, photosynthesis, nutrient cycling, etc. are referred to as supporting services (MEA, 2005). Supporting services have an indirect or sluggish impact on people, whereas changes to the other ESs have a more direct and instant impact on people. Humans, for instance, do not directly rely on the services of soil formation, but alterations to these would have an indirect effect on humans due to their impact on the provisioning services of food supply (Alcamo et al., 2005). Similarly, ecosystems offer habitat for plants

and animals, and also help in maintaining the diversity that underpins the other ecosystem services (TEEB, 2010). Another important supporting service of natural ecosystems is the preservation of genetic variation, which serves as a basis for locally well-adapted cultivars and a gene pool for the development of commercial crops and livestock (UN-FAO, n.d.).

2.5.4 Cultural services

Cultural services refer to non-material advantages provided by ecosystems including ecotourism, and spiritual, and ethical values (MEA, 2005). These are the intangible advantages that humans gain from ecosystems, such as mental improvement, introspection, leisure, and aesthetic pleasures (Alcamo et al., 2005). Numerous cultural manifestations result from interactions between people and the environment (Church et al., 2014). Cultural services are common across and within other ESs like regulating and provisioning ESs (Scholte et al., 2015). For example, *Ocimum sanctum* (Tulsi) provides both a cultural service through religious uses and a provisioning service in terms of medicine (from traditional to the modern allopathic system of medicines).

Check Your Progress 2

Note: a) Use the space given below for your answers.

b) Check your answers with those given at the end of unit

1. What do you mean by ecosystem services and what are the different types of ecosystem services provided by biodiversity?

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2. Write a short note on monetizing biodiversity values.

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2.6 CONSERVATION INITIATIVES

Conserving natural terrestrial, freshwater, and marine ecosystems and their constituent species and restoration of damaged and degraded ecosystems including their genetic and biological diversity are important for the sustainable development of the society and nation's economy (Sandifer et al., 2015). There are an increasing number of regional, national, and international awareness-raising and policy activities aimed at protecting biodiversity as a result of the threat of species extinction due to habitat loss and degradation, global climate change, and human population pressure (Kullberg and Moilanen,

2014). Regarding this, various initiatives had been taken by IUCN in 1994 which proved to be essential for the development of different tools and equipment for the conservation of biodiversity and other natural resources on both national and international grounds (Lamoreux et al., 2003). In an effort to stop the further loss of biodiversity, the United Nations (2002) designated 2010 as the International Year of Biodiversity. Despite significant attempts to stop biodiversity loss, there is little evidence that this trend is being reversed as it continues to diminish (Butchart et al., 2010). On December 29, 1993, the Convention on Biological Diversity (CBD) came into effect, with the primary goals of conserving biodiversity, its sustainable uses, and fair and equitable sharing of the benefits (CBD, 2012). About 87% of CBD signatories have produced National Biodiversity Strategies and Action Plans, providing frameworks for addressing biodiversity loss on a national level (Rands et al., 2010). Despite the repeated implementation of international conservation conventions, such as the UN Decade of Biodiversity (2011-2020), the CBD (1992), and several other biodiversity conservation initiatives with negligible success, biodiversity continues to decline (Pe'er et al., 2017; Kleijn et al., 2011). The United Nations Convention on Biological Diversity, developed the Aichi Biodiversity Targets, a 10-year strategic plan for 2011–2020 that recognises the importance of the link between biodiversity and bio-economy (Mehta et al., 2020). The development of a post-2020 global biodiversity framework to replace the 2011-2020 Strategic Plan for Biodiversity (including the Aichi Biodiversity Targets) was the main goal of the 15th Conference of Parties (COP 15) for the Convention on Biological Diversity, which was held in Kunming, China in October 2021.

2.7 LET US SUM UP

In this chapter, we have discussed biodiversity in general and its values in particular. The maintenance of life on Earth depends critically on the conservation and sustainable use of biodiversity. Different ecological, socioeconomic, and cultural viewpoints may be used to analyse the goods and benefits that people directly or indirectly obtain from biodiversity. Sustainable utilisation of different biological resources either for research, commercial, or personal use with strict policy regulations and strategies helps to resolve the issues related to biodiversity loss. A broadened understanding of various dimensions of biodiversity and its components is necessary for its sustainable management. Contemporary patterns of economic growth, globalization, and modernization are the major reasons behind biodiversity loss and its over-exploitation. The protection of biodiversity often turns common places into distinct places. Sustainable and effective conservation of biodiversity is possible through community participation in natural resource management and enabling policy frameworks. Understanding the importance of biodiversity can enhance a manager's capacity to resolve disputes and comprehend the viewpoints of those engaged in decision-making.

2.8 KEYWORDS

- **Biodiversity**: The variety and variability among the life forms including plants, animals, and microorganisms.

- **Biodiversity Values**: It is about the consumptive (provisioning services), non-consumptive (regulatory services), and non-monetary (intrinsic values like ethical, spiritual, aesthetic, recreational, social, and religious) values of biodiversity.
- **Ecosystem Services**: It is all about the goods and services provided by one healthy ecosystem including provisioning, regulatory, supporting, and cultural services.

2.9 REFERENCES AND FURTHER READING

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2.10 KEYS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. Your answer must include the following points
   - Well known definition of biodiversity
   - Different levels of biodiversity
   - Different perspective of community and ecosystem diversity
2. Your answer must include the following points
   - Utilitarian values including both consumptive and non-consumptive values
   - Inherent values including ethical, option, recreation and aesthetic, religious, and socio-cultural values

Check Your Progress 2

1. Your answer must include the following points
   - Concepts of ESs
   - Different types of ESs including provisioning, regulatory, cultural, and supporting services
2. Your answer must include the following points
   - General perception of monetizing the values of biodiversity
   - Criteria of valuation
   - Challenges of valuation