

CHAPTER 07

Biodiversity and Resource Management

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Abstract

Biodiversity, with its ecosystem heterogeneity, is a repository of economic, ecological, and societal value. Recent developments in biodiversity conservation, including genetic technologies, remote sensing, and conservation-oriented practices, reveal its pivotal role in maintaining ecosystem stability, its economic importance, and its contribution to mitigating the climate crisis. Greater species variety makes ecosystems more resilient to invasion and climate change, yet habitat loss and fragmentation, driven largely by agriculture, urban expansion, and infrastructure development, remain the most significant threats. Temperature fluctuations and changing precipitation patterns disturb ecological systems and species distributions, placing many species at risk of extinction, while invasive species and pathogens further degrade habitats and introduce disease. Limited financial resources constrain long-term conservation, research, and restoration efforts. Integrated Natural Resource Management (INRM) strategies, discussed alongside the land-use and green-finance approaches of Chapters 4 and 9, have considerable potential to improve soil and water quality, increase carbon sequestration, and strengthen ecosystem resilience. Aligning national development goals with biodiversity conservation, through enhanced governance, community engagement, and the economic valuation of ecosystem services, is essential. A national conservation monitoring system, supported by artificial intelligence techniques such as machine learning and computer vision, could track progress toward conservation targets. Protecting biodiversity is therefore essential for sustaining economic development, ecological balance, and climate resilience.

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7.1 Introduction

Biodiversity is defined as “the variation among living organisms, including terrestrial, marine, and other aquatic ecosystems, and the ecological complexes to which they belong” (CBD, 1992). This variation operates across genetic, species, and ecosystem levels, forming the foundation of ecological stability and resilience. Biodiversity plays a critical role in shaping human well-being often described as “nature’s contributions to people” (IPBES, 2019) by supporting essential ecosystem services such as pollination, water purification, and nutrient cycling. Rather than merely existing as a collection of species, biodiversity functions as an interconnected system in which each organism contributes to overall ecosystem performance. This interdependence enhances ecosystem adaptability to environmental change while sustaining economic and livelihood systems. Consequently, biodiversity underpins not only ecological processes but also socio-economic outcomes, influencing food security, resource availability, and environmental sustainability. Its value therefore extends beyond intrinsic importance to include ecological, genetic, cultural, scientific, and economic dimensions (Costanza et al., 1997), making it central to effective resource management and policy planning.

Biodiversity is essential for maintaining life-support systems in the biosphere, as it sustains key ecological processes such as nutrient cycling and pollination (Linhares et al., 2023; Sobti et al., 2023). These processes directly support human needs, including food and medicine, linking biodiversity to the achievement of several Sustainable Development Goals (SDGs). However, biodiversity loss disrupts ecosystem functioning and reduces resilience, limiting the ability of natural systems to support human populations. The significant decline in ecosystems over the past 50 years reflects increasing human

pressure on natural resources, threatening essential services such as food and water supply (McElwee et al., 2020). Moreover, the degradation of approximately 60% of ecosystems indicates a failure in sustainable environmental management, while rising extinction rates highlight the accelerating pace of biodiversity loss and its long-term risks for both ecosystems and human well-being (Habibullah et al., 2022).

Figure 7.1 illustrates the hierarchical link from ecosystem functions to ecosystem services and ultimately to human well-being, highlighting how ecological processes translate into socio-economic benefits and emphasize the critical role of biodiversity in sustaining life on Earth.



Figure 7.1. Link between biodiversity, ecosystem services, and human well-being

7.1.1 The levels of biodiversity

Genetic diversity: Genetic biodiversity, which encompasses variations in genes, alleles, and heritable traits within populations or species (Biology Online, 2024; Asutosh College, 2020), serves as the most precise indicator of biodiversity. Its significance extends beyond mere description, as genetic variation underpins the ability of populations to adapt to environmental changes and evolutionary pressures (IFAD, 2023; University of Gothenburg, 2024; LibreTexts Biology, 2023). By determining an individual's capacity to survive, reproduce, and respond to stressors, genetic diversity directly influences species resilience, agricultural productivity, and the stability of ecosystem services essential for human livelihoods. Understanding genetic diversity is therefore critical for resource management and policymaking, guiding conservation strategies, crop and livestock breeding programs, and safeguarding food security. Initiatives such as the collection and preservation of DNA samples by the National Museum of Natural History protect genomes and provide references for future research in genomics, informing strategies for restoring endangered species and designing sustainable biodiversity policies (Smithsonian NMNH, 2025; National Geographic, 2013).

Species diversity: Species diversity refers to the diversity and prevalence of various species in a certain region, including both species richness and species evenness. A robust and healthy ecosystem that can sustain a range of ecological services and functions is indicated by a high species diversity. Loss of species variety can lower overall ecosystem stability and interfere with ecosystem functioning (Maestre et al., 2012). High species diversity ensures ecosystem stability by supporting complex food webs and sustaining essential ecological services, from pollination to nutrient cycling. This diversity also has direct implications for human well-being, providing medicinal plants, crop pollinators, and other resources critical for livelihoods. For example, tropical rainforests, as biodiversity hotspots, support immense species richness that underpins ecological balance and economic resources. Understanding species

diversity is vital for resource management and policy, as it informs conservation priorities, habitat protection, and sustainable use of species to maintain both ecosystem function and human benefits (Convention on Biological Diversity, 2020; FAO, 2023).

Ecosystem diversity: Ecosystem biodiversity, encompassing terrestrial, marine, and freshwater systems such as forests, wetlands, grasslands, coral reefs, rivers, and lakes, reflects the structural and functional complexity of landscapes (Biology Online, 2013; Byrnes et al., 2015). High ecosystem diversity enhances resilience and productivity by supporting a wide range of species, ecological processes, and interactions, which in turn maintain vital services such as nutrient cycling, climate regulation, and food provision (Institute for Environmental Research & Education, 2023). The health of these ecosystems directly influences human livelihoods, as clean air, water, food, and medicinal resources depend on resilient ecological networks. For example, tropical rainforests, with their layered canopies and dense species populations, sustain high productivity and provide critical ecosystem services that underpin both conservation policies and sustainable resource management strategies (National Museum of Natural History, 2025). Understanding ecosystem diversity is therefore essential for designing effective environmental policies that protect landscapes while supporting human well-being.

Figure 7.2 visually represents these three interrelated levels, emphasizing how genetic variation supports species resilience, species diversity maintains ecosystem stability, and ecosystem diversity ensures overall ecological functionality.

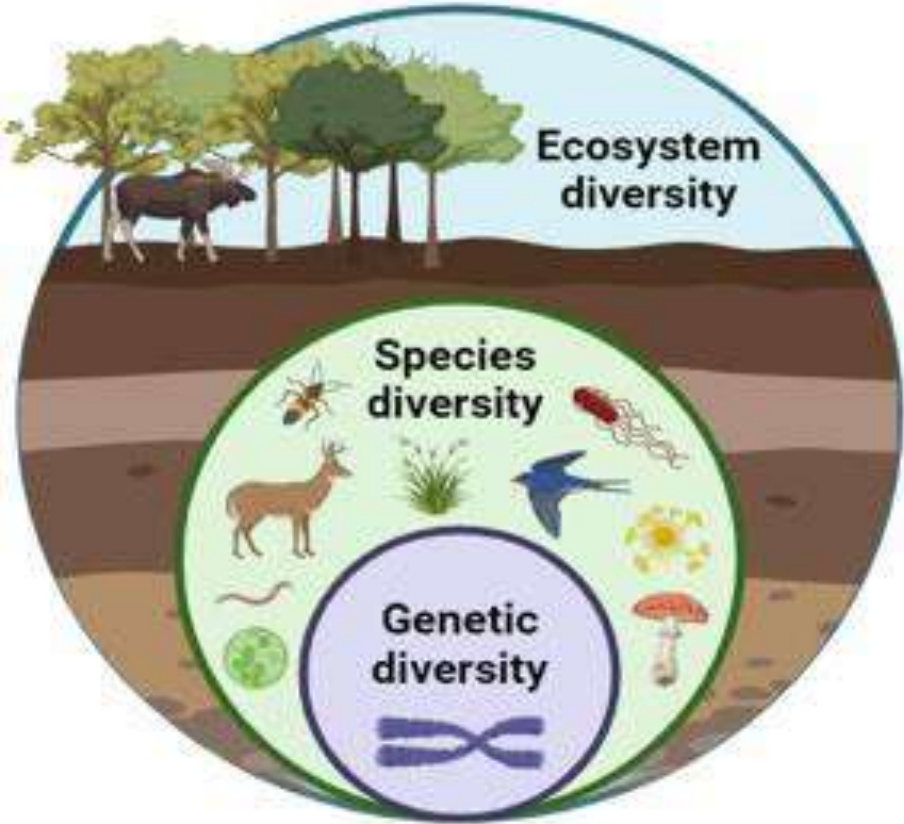


Figure 7.2. Levels of biodiversity

7.2 Biodiversity and human well being

Biodiversity underpins human well-being by supporting food security, health, and livelihoods. Diverse species maintain pollinators, soil fertility, and pest control, ensuring resilient agricultural systems and stable rural incomes (International Journal of Scholarly Research in Science and Technology, 2022; Mir et al., 2025). Medicinal plants and animal-derived resources contribute to pharmaceuticals, reinforcing both health outcomes and the economic value of biodiversity (Medicinal Plants Review Group, 2014; WHO, 2025; Crown & Smith, 2022). Cultural and recreational services from biodiversity also enhance quality of life and support local livelihoods through ecotourism (Mir et al., 2025). Despite these benefits, gaps remain in understanding how biodiversity loss affects community livelihoods and how ecosystem services can be integrated into national policies. For example, over 1.6 billion people rely directly on forest biodiversity for survival and income (FAO, 2022). Interventions such as community-managed agroforestry and payment for ecosystem services have improved well-being while conserving species.

7.2.1 Economic, ethical and cultural dimensions of biodiversity

Many economic activities, such as forestry, fishing, tourism, and agriculture, depend on biodiversity (World Bank, 2025; CBD Secretariat, 2019). Ecosystems in good health offer vital resources and services that sustain livelihoods and promote economic growth (GNA, 2025). Economies and businesses may be negatively impacted by the loss of biodiversity (BCG, 2021). The preservation of biodiversity is linked to ethical considerations and has intrinsic value. The spiritual, artistic, and cultural value of biodiversity is acknowledged by numerous cultures and indigenous groups (PolSci Institute, 2023). Ethical concerns regarding humanity's need to protect the planet's biological diversity are brought up by the extinction of species (UNESCO, 2025). Integrating economic and ethical considerations into policy design supports interventions such as payments for ecosystem services, community-led conservation, and biodiversity-inclusive agricultural practices, ensuring ecological, socio-cultural, and economic values inform sustainable resource management.

7.2.2 Purpose and structure of chapter

The overall goal of this chapter is to examine how resource management and biodiversity are related within the larger context of sustainable development. It studies the factors behind biodiversity's decrease, emphasizes the ecological, economic, and social significance of biodiversity, and explores strategies to incorporate conservation principles into resource governance. The conversation is organized so that the conceptual and theoretical underpinnings of biodiversity–resource links are first established, and then global trends and management concerns are examined. The following sections discuss frameworks for sustainable management, with a focus on Integrated Natural Resource Management (INRM), and end with recommendations for practice and policy that will improve sustainability and resilience in ecosystems.

7.3 Global Context: The Biodiversity and Resource Management Crisis

One of the biggest threats to biodiversity is human activity, which includes pollution, overfishing, deforestation, and climate change (IPBES, 2019; Zero Carbon Analytics, 2024). Globally, these activities are leading to previously unheard-of rates of biodiversity loss. Over a million species face extinction, many of them within the next few decades, according to a report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019). The world economy is seriously threatened by this loss of biodiversity, which is expected to cost trillions of dollars each year (Zero Carbon Analytics, 2024). Numerous economic sectors, such as forestry, fishing, tourism, and agriculture, may be impacted by biodiversity loss (IPBES, 2019). Furthermore, decreased water quality, soil erosion, and the introduction of invasive species can all influence agriculture and other businesses as a result of biodiversity loss (Liang et al., 2016). Significant losses in forest biodiversity are being caused by deforestation, which is being fueled by logging, agricultural expansion, and other human activities (The

Royal Society, 2024). Among other effects, this loss of biodiversity may result in lower water quality, higher carbon emissions, and decreased forest production (Liang et al., 2016).

The global LPI 2024 fell by 73% (range: -67% to -78%) between 1970 and 2020, with an average yearly decline of 2.6% (World Wildlife Fund [WWF], 2024). These results demonstrate that nature is generally declining across all systems: clean water (85% decline, ranging from -77% to -90%, presenting an overall annual drop of 3.8%), aquatic (56% decline, range: -43% to -66%, indicating an average annually decrease of 1.6%), and groundwater (69% reduction, between -55% to -79%, suggesting an overall yearly loss of 2.3%).

Significantly 1.5°C of worldwide warming is expected to wipe out 70–90% of coral reefs, according to the Intergovernmental Panel on Climate Change (IPCC, 2018). However, new research indicates that the situation is significantly worse. If any of the planet’s finest ecosystems vanished, there would be severe social and economic consequences. Around 330 million people directly rely upon reefs for storm surge protection, food and livelihood, and other benefits. Further, over one billion people may be directly or indirectly benefited by the coral reefs’ tens of billions of dollars yearly net economic value, which supports industries including tourism, fishing for commercial purposes, and coastal development (Coral Reef Alliance, 2020; United Nations Environment Programme [UNEP], 2016; International Coral Reef Initiative [ICRI], 2011). Figure 7.3 highlights a 73% decrease in the Living Planet Index since 1970, illustrating the alarming rate of species population decline and underscoring the urgency for effective conservation and sustainable resource management.

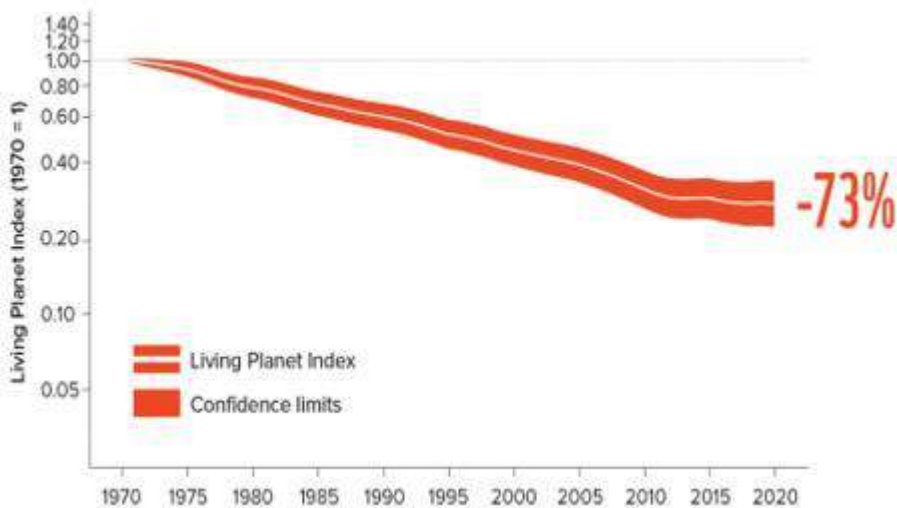


Figure 7.3. Global trend in living planet index (1970-2020)

7.3.1 Economic costs of biodiversity loss

The detrimental effects that biodiversity loss has on the economy, society, and human well-being are known as the economic costs of biodiversity loss (ECB Economic Bulletin, 2024; GNA, 2023). For instance, the loss of pollinators like bees can have a significant financial impact on agriculture since it reduces crop yields and drives up the cost of pollination services (ScienceDaily, 2008; IUCN, 2008). Loss of biodiversity can worsen cultural customs and practices that depend on biodiversity, promote the spread of infectious diseases, and make natural regions less appealing to tourists (Civitello et al., 2015).

7.3.2 Ecosystem services and their economic value

The advantages that natural ecosystems provide to people are known as ecosystem services. The economic value of ecosystem services is significant because it guides our usage decisions and helps us realize the need to protect natural ecosystems. Examples of ecosystem services lost because of biodiversity loss and their estimated financial implications are as follows:

Pollination: Bees, butterflies, and birds are examples of pollinators that are essential to plant reproduction and the production of many of the crops that we depend on. Pollinators are thought to produce between \$235 and \$577 billion worth of crops worldwide each year (IPBES, 2016). However, some pollinator species' numbers are dropping because of biodiversity loss, which may result in decreased crop yields and higher food costs (Potts et al., 2010).

Water purification: Water is suitable for human consumption after being filtered and purified by wetlands, forests, and other natural ecosystems (TEEB, 2010). The estimated yearly cost of replacing this service with water treatment is \$2.2 trillion (Costanza et al., 2014).

Climate regulation: Because they produce oxygen and store carbon, natural ecosystems like wetlands, forests, and oceans help control Earth's climate (IPCC, 2019; Costanza et al., 2014). However, these ecosystems' capacity to store carbon declines when biodiversity is destroyed (TEEB, 2010). By 2030, the annual cost of climate change resulting from deforestation and other changes in land use is predicted to exceed \$3.3 trillion (Griscom et al., 2017).

Soil fertility: Loss of biodiversity can cause soil degradation, which lowers agricultural output and fertility (FAO, 2017). An estimated \$300 billion is spent each year on soil erosion and degradation (Pimentel et al., 1995).

Disease regulation: The risk of zoonotic diseases, diseases that transfer from animals to people, can rise as biodiversity declines (Keesing et al., 2010). Deforestation and habitat degradation, for instance, can increase the risk of disease transmission by bringing people and wild animals closer together (Allen et al., 2017). Epidemics of zoonotic diseases can have serious negative effects on people's health and finances. The COVID-19 pandemic, for example, is estimated to have cost trillions of dollars (McKibbin & Fernando, 2020).

7.3.3 Case study

The critical role that honeybees play in pollination, which is necessary for food production and the general health of ecosystems, has made the honeybee extinction catastrophe a major worry in recent years. There are fewer places for bees to feed and breed because of the alarming rate at which honeybee habitats are being destroyed due to increased urbanization and agricultural growth. Since many of the chemicals used to control weeds and pests are hazardous to bees, pesticide use is another significant factor contributing to the loss of honeybees. Global economy, ecological health, and food production may all be significantly impacted by the disappearance of these vital pollinators. The anticipated annual economic cost of honeybee extinction on a global scale is between \$235 billion and \$577 billion. Depending on the nation's reliance on pollination services for agriculture, the economic repercussions of honeybee extinction can differ at the national level. Crops like almonds, apples, and blueberries greatly rely on bee pollination, and the economic worth of honeybee pollination services in the US is estimated to be over \$15 billion yearly (Kumar et al., 2024).

7.3.4 Goals and progress

A stable climate and human well-being are dependent on nature, as acknowledged by the worldwide objectives for biodiversity, climate change, and development that is sustainable. Under the CBD, the Kunming-Montreal Global Biodiversity Framework (GBF) has goals to safeguard 30% of land and seas, finish or start restoring 30% of degraded regions, and eradicate all species extinctions caused by humans by 2030 (CBD Secretariat, 2022; CBD Secretariat, 2024). In 2023, the Paris Agreement's global stock take and the SDG Progress Report both issued warnings that, in the absence of substantial effort, none of

the targets outlined in the agreements will be accomplished by 2030 (SDSN, 2023; UN Secretary-General, 2024). By 2050, the current course of events would result in a world that is clearly unsustainable and unfair. Thirty percent of the SDG targets would either stagnate or worsen from the 2015 baseline, and more than half of them will be missed by 2030 (UN General Assembly, 2024; SDSN, 2023). Complex social and ecological systems cannot be managed by fragmented local, national, and international governing structures. In order to accomplish the global goals, national laws must be strengthened and aligned and coordinated policies and activities must be developed to improve results for people, the environment, and the climate. Conflicts between various aims are more likely when climate, biodiversity, and development goals are approached separately. Examples include:

Land-use conflicts: By intruding on natural ecosystems and displacing food crops, afforestation and the production of biofuel to slow down climate change may jeopardize efforts to conserve biodiversity (Searchinger et al., 2008; Fargione et al., 2008; Balmford et al., 2019).

Energy and conservation: Increasing the use of renewable energy to achieve climate targets may have negative effects on ecosystems and biodiversity, such as the fragmentation of freshwater habitats by hydropower dams, the mining of vital minerals, and the installation of latest power cables in environmentally vulnerable places (Turney & Fthenakis, 2011; Sovacool, 2021).

Inclusivity and diversity: Although carbon pricing have the potential to lower emissions, poorly crafted policies may disproportionately penalize low-income households (Goulder & Schein, 2013). Protected zones constructed to protect biodiversity may stimulate evictions where property rights are violated, in addition to denying neighboring communities access to high-quality agricultural, fishing spots, sources of water, and other natural resources (Oldekop et al., 2016; Büscher & Fletcher, 2015).

7.3.5 Major forces driving change

Biodiversity is increasingly threatened by multiple, interacting drivers that vary in intensity across regions and ecosystems.

Loss of habitat: Habitat loss remains the leading cause, arising from land-use changes such as logging, mining, urban development, and unsustainable agriculture, which fragment or degrade ecosystems and reduce species survival (Foley et al., 2005; Sala et al., 2000; Millennium Ecosystem Assessment, 2005). Freshwater and marine systems face additional pressures from water abstraction, river modification, dredging, and bottom trawling, highlighting the need for region-specific management strategies (Dudgeon et al., 2006; Halpern et al., 2008).

Overexploitation: Excessive exploitation acquires two forms: direct and indirect. Unregulated hunting, smuggling, and extraction, either for trade or sustenance, are known as "direct overexploitation" (Ripple et al., 2015; Schipper et al., 2008). Unintentional killing of non-target species, such as bycatch in fisheries, is known as indirect overexploitation (Lewison et al., 2004).

Climate change: When combined with climate change, which shifts species' ranges and disrupts seasonal behaviors like migration and reproduction, these pressures can create cascading effects that exacerbate population declines (Parmesan & Yohe, 2003; Root et al., 2003; Visser & Both, 2005).

Pollution: By altering the environment to one that is unfavorable for its survival, pollution can have a direct impact on a species. For instance, in the event of an oil leak, this is what occurs (Peterson et al., 2003). A species may also experience indirect effects, such as decreased population numbers over time due to changes in food availability or reproductive efficiency.

Exotic species and genes: Invasive species can be predators of indigenous species as well as competitors for resources like food and space (Mack et al., 2000; Simberloff et al., 2013).

Disease: Diseases that were previously absent from the environment can be spread by species that spread their extent to a new location (Daszak, Cunningham, & Hyatt, 2000). Additionally, humans spread new

diseases around the world (Jones et al., 2008). A species may become more susceptible to illness because of additional risks like habitat loss and climate change (Harvell et al., 2002).

This synthesis demonstrates that biodiversity threats rarely act in isolation. Understanding how these drivers interact across regions is essential for designing effective policy interventions. For instance, protecting riparian zones and regulating coastal development can reduce habitat fragmentation, while sustainable fisheries management combined with invasive species control addresses multiple pressures simultaneously. Figure 7.4 illustrates the key drivers of biodiversity loss, showing how human activities and environmental changes interact to reduce species populations, disrupt ecosystems, and compromise ecosystem services.

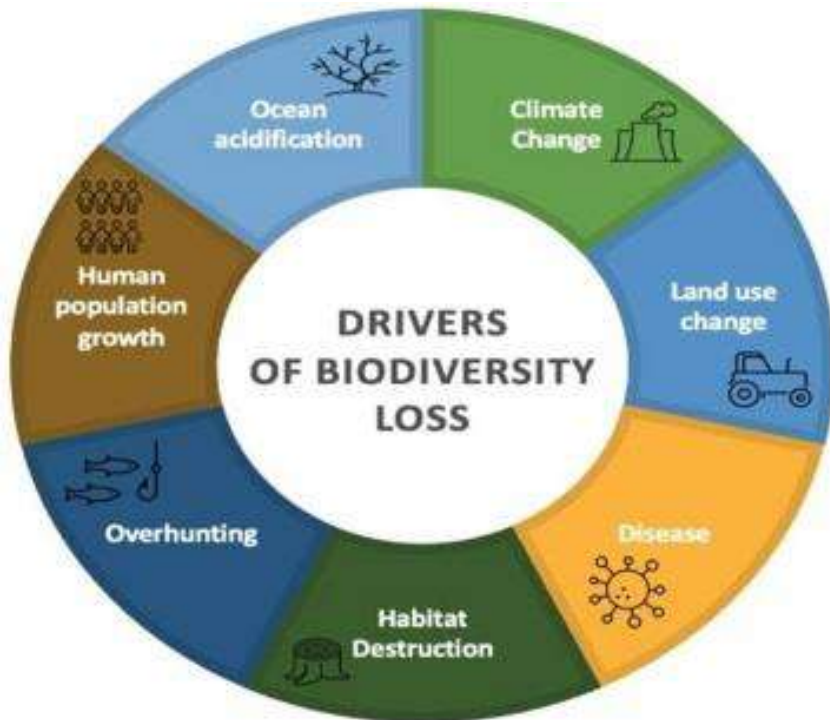


Figure 7.4. Drivers of biodiversity loss

7.4 Resource management:

Integrated Natural Resource Management (INRM) extends traditional natural resource management by explicitly linking the sustainable use of water, land, forests, fisheries, and wildlife to ecological, social, and economic outcomes (Garritty et al., 2010; FAO, 2007). Unlike conventional NRM, which often addresses resources in isolation, INRM considers the interactions among resources, biodiversity, and human communities, ensuring that ecosystem services such as soil fertility, nutrient cycling, water purification, and climate regulation are maintained while supporting livelihoods (Millennium Ecosystem Assessment, 2005). By incorporating biodiversity at genetic, species, and ecosystem levels, INRM provides a framework to align conservation with human well-being and economic objectives. For example, agroforestry systems in Southeast Asia combine timber production, soil restoration, and crop diversity, enhancing food security while preserving local species richness. Similarly, community-managed fisheries in coastal regions integrate habitat conservation with sustainable harvest practices,

balancing ecosystem health with economic benefits. Mangrove conservation provides a related example of how biodiversity management can support both ecological resilience and economic activities in coastal areas, including fisheries, aquaculture, and ecotourism (Azeem & Ishaq, 2026).

7.4.1 Moving toward the sustainable world:

To accomplish SD and sustainability, NRM is one such topic that considers a number of factors. First, one should concentrate on the resource utilization pattern, specifically superior utilization and conservation harvesting. This strategy would eventually result in conservation and management of biodiversity on many different fronts. (Raj et al., 2018). The variety of organisms found in an ecosystem at a given location and time determines how homeostatic and homeorhetic the ecosystem is. It has an indirect negative impact on the world's population's access to food. It is significant that the future of human civilization will be determined by global biodiversity; therefore, preserving biodiversity at the species, genetic, and ecological levels will become crucial for human survivalists (Raj et al., 2018). These methods have contributed to the preservation of agroecosystems' ecological integrity. The preservation of biological diversity is the foundation of sustainable resource usage. Protection of both the species and the habitat is the main goal of these kinds of strategies (FAO, 2020). Sustainability is a major concern that calls for eco-friendly methods to sustain both the health of the environment and the proper operation of ecosystems. According to this viewpoint, nations that embrace environmentally friendly technologies typically exhibit strong environmental performance, healthy environments, and vibrant ecosystems.

7.4.2 Role of Integrated Frameworks (INRM)

A comprehensive strategy for controlling water, land, biodiversity, and alternative environmental resources to achieve production and livelihood objectives while guaranteeing long-term ecosystem sustainability is known as integrated natural resource management, or INRM. INRM highlights the interdependence of ecological and socioeconomic systems, in contrast to traditional sector-based management, which frequently concentrates on specific resources or outputs (Campbell & Sayer, 2003; van Noordwijk et al., 2019). Through participatory, adaptive, and multi-scalar processes, it aims to balance trade-offs between agricultural productivity, ecological health, and community welfare. The shortcomings of conventional natural resource management and the understanding that sustainable results necessitate the integration of ecological processes with human decision-making systems gave rise to the INRM framework (Sayer & Campbell, 2004). According to Reed et al. (2016), its fundamental tenets—integration, engagement, adaptation, and learning—align strongly with modern sustainability paradigms like Ecosystem-Based Management (EBM) and Landscape Approaches. INRM bridges the gap between environmental preservation and development needs by connecting biodiversity conservation with resource usage efficiency.

INRM has been used in forest landscape restoration, watershed planning, and agroecosystem management in practice, frequently showing increased stakeholder equity and resilience (Douthwaite et al., 2007). The Sustainable Development Goals (SDGs), especially those pertaining to land use management (SDG 15), uncontaminated water (SDG 6), and zero hunger (SDG 2), are also supported by its adaptable framework. Therefore, INRM plays a fundamental role in promoting development that is favorable to biodiversity, encouraging cooperative governance, and putting sustainability ideas into practice across ecological and human systems. Figure 7.5 presents a conceptual framework for integrated biodiversity–resource management, illustrating how drivers of biodiversity loss, economic incentives, and institutional governance interact to guide policy and management decisions.

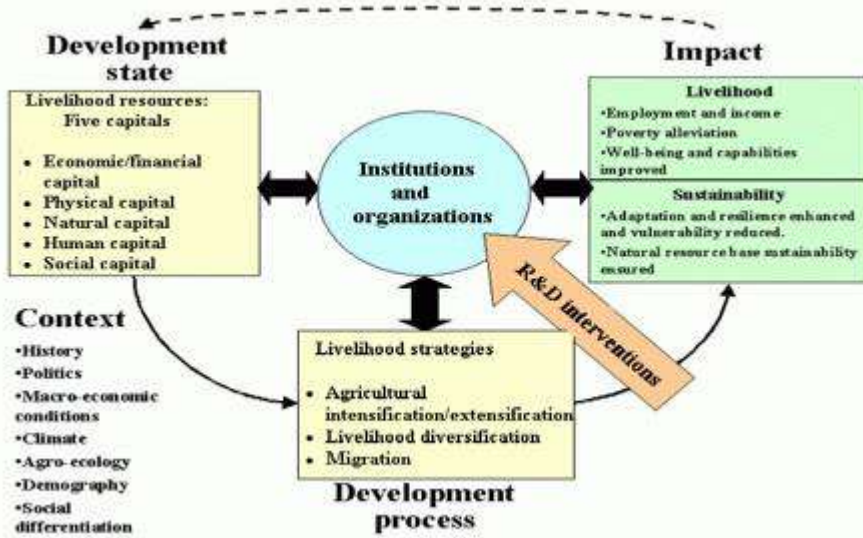


Figure 7.5. Flowchart showing integrated biodiversity-resource management framework

7.5 Conceptual framework

Effective natural resource management requires a conceptual framework that links biodiversity, ecological drivers, socio-economic incentives, and policy interventions. This framework situates natural resources within both ecological and human systems, illustrating how integrated management can sustain ecosystem services while supporting human well-being.

7.5.1 Natural resource system:

Natural resources, whether renewable or non-renewable, are essential for maintaining species, populations, and ecosystems, as well as meeting human physiological, socio-economic, and cultural needs (Chopra & Sodhi, 2011; FAO, 2007). Renewable resources, such as crops, forests, soil, water, and solar energy, can regenerate naturally or be managed to restore ecological function, making them central to sustainable agricultural and INRM strategies. Non-renewable resources, including minerals, metals, and fossil fuels, are finite and require careful management to avoid permanent depletion. By integrating renewable and non-renewable resources into a single framework, managers can prioritize interventions that maintain ecosystem integrity while addressing human development needs.

7.5.2 Economic Services Framework and Policy Integration

The framework incorporates economic valuation of ecosystem services, linking ecological health directly to human and societal benefits. Tools such as Payments for Ecosystem Services (PES) and Ecosystem Service Opportunities (ESO) translate biodiversity into quantifiable economic incentives, encouraging actors to conserve ecosystems while sustaining livelihoods (Schomers & Matzdorf, 2013; Wunder, Engel, & Pagiola, 2008). Initiatives like TEEB (2010) and the 2019 IPBES Global Assessment demonstrate that declines in species and ecosystems driven by overexploitation, habitat loss, climate change, invasive species, and pollution carry significant societal costs that traditional economic indicators, such as GDP, fail to capture (Costanza et al., 2014; IPBES, 2019).

By integrating drivers of biodiversity loss, INRM principles, and economic-ethical considerations, this conceptual framework provides analytical justification for intervention strategies. For example:

- Linking PES schemes to areas facing habitat fragmentation addresses both economic incentives and ecological drivers.

- Combining renewable resource management with restoration programs ensures sustainable supply while increasing ecosystem resilience.
- Incorporating ethical and cultural values into resource use guidelines strengthens community participation and policy compliance.

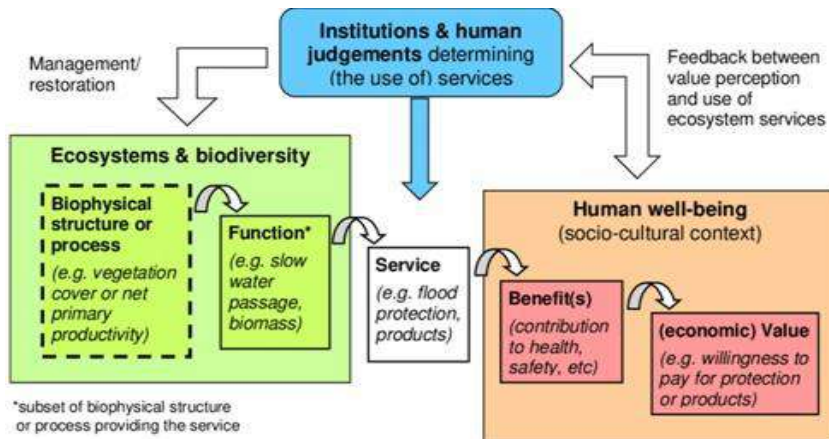


Figure 7.6. Ecosystem services framework

The framework therefore guides actionable policy: it identifies intervention points, aligns ecological and socio-economic goals, and provides a structured method for prioritizing conservation actions. Figure 3 (adapted from TEEB, 2010) illustrates the integration of biodiversity levels, drivers, ecosystem services, and economic incentives, demonstrating how management strategies can maximize ecological, social, and economic outcomes. Figure 7.6 illustrates the ecosystem services framework, showing how biodiversity underpins ecological processes, which in turn deliver benefits to people, and how these services can be valued and managed to inform policy and resource allocation.

7.6 Sustainable Development Approaches for Biodiversity Conservation

A variety of tactics are needed to conserve biodiversity, such as creating protected areas, repairing damaged ecosystems, using sustainable land use, and cutting greenhouse gas emissions. Protected areas such as national parks, wildlife refuges, and wilderness zones offer high levels of species protection and ecosystem preservation by limiting human interference (Watson et al., 2014; Dudley, 2008). Their strength lies in safeguarding critical habitats, but they can be limited by inadequate management resources and potential conflicts with local communities (Jenkins & Joppa, 2009). Ecosystem restoration, including reforestation and wetland rehabilitation, improves degraded landscapes and restores ecological functions (Aronson et al., 2010; Suding, 2011). While restoration enhances ecosystem resilience, it can be costly and slow to deliver measurable biodiversity benefits.

Sustainable agriculture practices like crop rotation, agroforestry, and integrated pest management integrates biodiversity into production landscapes, supporting both food security and ecosystem services (Garrity et al., 2010). Its effectiveness depends on local adoption and training, but it directly links conservation to community livelihoods. International agreements, such as the Convention on Biological Diversity and the Paris Climate Agreement, provide global frameworks for coordinated action, yet implementation varies across regions depending on governance capacity (CBD Secretariat, 2024; UNFCCC, 2015).

Payments for ecosystem services (PES) incentivize communities and landowners to maintain ecological functions such as carbon sequestration, water filtration, and wildlife habitat (Engel, Pagiola, & Wunder,

2008). PES is particularly effective in linking conservation to tangible economic benefits, though it requires robust monitoring and equitable benefit-sharing. Finally, global development objectives, especially the United Nations SDGs, provide integrated targets for biodiversity, including protecting terrestrial and aquatic ecosystems, expanding protected areas, and promoting sustainable land use (United Nations, 2015; Sachs et al., 2019; Saleh et al., 2024).

By comparing these approaches, no single method is sufficient on its own. Effective biodiversity management requires context-specific combinations, such as pairing protected areas with PES schemes or integrating sustainable agriculture with restoration efforts, to achieve ecological, socio-economic, and policy goals simultaneously. Linking each approach to relevant SDGs ensures that biodiversity conservation contributes directly to human well-being, sustainable resource management, and climate resilience.

7.7 Common tools for policy based on economic concepts

7.7.1 Fees and surcharges for users: Enforce costs and taxes for the expenditure of products, facilities, or environmental-related tasks. The goal is to make money; all or part of the fees are kept and put back into conservation (Emerton, 2001).

7.7.2 Payments for Ecosystem Services (PES): PES is most used to regulate services like biodiversity protection, landscape improvement, water quality and supply, and disaster risk reduction (Wunder, 2005). In Pakistan, PES remains relatively underutilized and insufficiently embedded in environmental and agricultural policy, although evidence suggests that appropriately designed PES incentives can encourage sustainable natural-resource management and improve household economic outcomes (Tanveer et al., 2026).

7.7.3 Insurance schemes: Insurance programs reimburse locals for expenses or losses associated with conservation such as crops or animals consumed by wildlife (Naidoo et al., 2011).

7.7.4 Taxes: "Ecological" taxes or comparatively higher tax rates apply to activities that utilize ecosystem services or pose a threat to biodiversity and ecosystem services (Tietenberg, 2006).

7.7.5 Performance bonds and depositors: People or businesses that engage in activities that endanger the environment or call for mitigation, remediation, or management plan must deposit money against the associated expenses, which is typically refundable (Kettunen et al., 2009)

7.7.6 Biodiversity offsets, habitat/mitigation banking: Businesses that engage in activities that harm biodiversity or destroy natural habitats such as mining, transportation, forest conservation, petroleum products, agriculture, or infrastructure make up for the damage by investing in biodiversity conservation elsewhere. When mitigation banking is created, a landholder who takes action to protect the organic environment is considered to have made a investment in the bank and is granted credits (Madsen, Carroll, & Moore Brands, 2010).

7.8 Conclusion

Resource management and biodiversity are closely related aspects of sustainable development, where long-term productivity and human well-being depend on ecological integrity. This chapter highlights that unsustainable resource exploitation, land-use change, and weak governance are key drivers of biodiversity loss, emphasizing the need for more integrated and policy-driven responses. A shift from extraction-based practices to adaptive, ecosystem-based, and participatory management is therefore essential to address these challenges. Frameworks such as Integrated Natural Resource Management (INRM) offer practical approaches by linking ecological, social, and economic dimensions; however, their success depends on effective implementation, institutional capacity, and inclusive governance. Policy measures should focus on biodiversity-inclusive land-use planning, strengthened regulations, and incentive-based mechanisms such as payments for ecosystem services, aligned with the Sustainable Development Goals (SDGs). Future research should further examine the socio-economic impacts of biodiversity loss and evaluate the effectiveness of integrated management approaches in different contexts. Ultimately, biodiversity

conservation and sustainable resource use are mutually reinforcing, requiring coordinated policies, local engagement, and the integration of biodiversity values into decision-making for long-term sustainability.

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