General Article _____ Chapter- 06

ECOSYSTEM RESTORATION AND BIODIVERSITY CONSERVATION FOR SUSTAINABLE DEVELOPMENT

Rupali Singh Prem Prakash and Pooja Verma*

Abstract

Ecological restoration has a growing role in policy aimed at reverse the widespread effects of environmental degradation. It includes activities to assist the improvement of ecosystem structure and function, and the associated terms of goods and services. Rooted in ecological theory, ecological restoration requires an integrated approach of different disciplines; including soil science, hydrology and conservation biology, together with the relevant socio economical and political frameworks. Ecological restoration interventions also rely on applied fields such as agronomy, horticulture and forestry. Biodiversity refers to the variety of all forms of life on earth, including the different plants, animals, micro-organisms, the genes they enclose and the ecosystem they form. It is considered at three main levels including species diversity, genetic diversity and ecosystem diversity. Relative to the variety of habitats, biotic communities and ecological processes in the biosphere, biodiversity is vital in a number of ways including promoting the aesthetic value of the natural environment, contribution to our material well-being through utilitarian values, maintaining the integrity of the environment through; maintaining CO2/O2 balance, regulation of biochemical cycles, absorption and breakdown of pollutants and waste materials through decomposition, purpose and regulation of the natural world climate, defensive services, e.g. by acting as wind breaks and acting as indicators of environmental changes. Our understanding of conservation biology and sustainability has been independently developing for a long time. Evidence suggests that biodiversity is critical for ecosystem function and services on which humans depend, and is directly linked to the economic, social, and environmental components of sustainability. Because of this, the combination of research from each of these areas should and is becoming a priority. In this article, the development of each of these fields and, eventually, their addition are reviewed. From this, a number of research priorities that allow for the transition from conflict to mutual compatibility between conservation and sustainability objectives are explored. Solving the problem of environmental threats and a dwindling biodiversity has been on the international agenda for some decades now.

Keywords: Ecosystem, Restoration, Biodiversity conservation, Sustainable biodiversity

Dr. YSPUHF, Solan, Nauni – 173230, H.P. India.
Email-Id: srupali333@gmail.com

Introduction

Many of the world's ecosystems have undergone considerable degradation with negative impacts on biological diversity and peoples' livelihoods. There is now a growing consciousness that we will not be able to conserve the earth's biological diversity through the protection of critical areas alone. This paper explains what is meant by the term "ecological restoration" and outlines how it can supply enhanced biodiversity outcomes as well as improve human well-being in degraded landscapes. In this way ecological restoration becomes a fundamental element of ecosystem management, although until recently, its potential has not always been fully recognized. Ecological restoration involves management actions intended to accelerate recovery of degraded ecosystems by complementing or reinforcing natural processes. Ecological restoration has been viewed as ecosystem medicine where the practitioner is helping nature heal (Manfored *et al.* 2016). That is, building upon the natural recovery processes inherent in the ecosystem.

Ecological restoration is the process of supporting the recovery of an ecosystem that has been degraded, damaged or destroyed. It is an intentional activity that initiates or accelerates an ecological pathway—or trajectory through time—towards a reference state. Ecological restoration has as its goal an ecosystem that is resilient and self-sustaining with respect to structure, species composition and function, as well as being integrated into the larger landscape and supporting sustainable livelihoods. In forested ecosystems around the globe, ecological restoration can assist with climate change mitigation and adaptation while providing other tangible co-benefits to humans and natural systems. The contribution of afforestation and reforestation to reducing greenhouse gas emissions was first renowned under the Clean Development Mechanism of the Kyoto Protocol. More recently, the UN Framework Convention on Climate Change (UNFCCC) introduced reducing emissions from deforestation and forest degradation (REDD) as an international fund- or credit-based method for reducing carbon emissions and defending forest ecosystems. Now known as REDD+, it embraces "policy approaches and positive incentives on issues relating to REDD in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries" (UNFCCC 2010).

Biodiversity—the diversity of life on Earth—is defined as the variability among living organisms from all sources, including diversity within species, between species, and of ecosystems. Biodiversity is essential for sustainable development and human well-being. It underpins the provision of food, fiber and water; it mitigates and provides resilience to climate change; it supports human health, and provides jobs in agriculture, fisheries, forestry and many other sectors. Without effective measures to conserve biodiversity and use its components in a sustainable manner, the 2030 Agenda for Sustainable Development will not be achievable.

The World Commission on Environment and Development defines the term sustainability as meeting the needs of the present without compromising the ability of future generations to meet their own needs. The pursuit for sustainability requires the collaboration of landscape ecology, restoration ecology, and conservation biology so that distinct levels of ecological complexity (e.g. genes, species, populations, ecosystems, and

landscapes) are understood and integrated – however imperfectly - into restoration planning and management frameworks at larger spatial scales (Aronson et al 1996). Those working in these disciplines will interact with hydrologists, microbiologists, geomorphologists, and other scientists, as well as professionals from other disciplines, in particular business, economics, human health, and social justice. Science and society must work together to navigate towards a relationship with our environment that is based on sustainability, rather than its opposite – inequitable economic growth for the few - with no regard for the rapid decline of all forms of natural capital and the growing divide between rich and poor (Aronson *et al.* 1996).

What is Ecosystem Restoration?

Restoration is defined as "any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state"; whatever is the form or intensity of degradation (IPBES, 2018). Restoration responses are varied depending on the type of ecosystem in which they are to be applied (croplands, forests, rangeland, urban land, wetlands, etc.). To enable ecosystems to provide necessary functions those responses should consider landscape-level strategies, responding to local and enabling conditions, as well as integrate indigenous and local knowledge (Hutton J, *et al.* 2005).

Ecosystem restoration is defined as "a process of reversing the degradation of ecosystems, such as landscapes, lakes and oceans to recover their ecological functionality; in other words, to improve the productivity and capability of ecosystems to meet the needs of society. This can be done by allowing the natural regeneration of overexploited ecosystems or by planting trees and other plants" (Sarkar S 1999).

The objective of ecosystem restoration is to contribute to the conservation and sustainable use of biodiversity as well as create social, economic and environmental benefits, whereby healthy and connected ecosystems should contribute to improve food and water security, peoples' livelihoods and to mitigate and adapt to climate change" (CBD, 2019). Considering ecosystems as socio-ecological areas which deliver multiple functions that benefit a diversity of stakeholders can help to identify the drivers of ecosystem degradation and loss, the existing interests to manage the landscape, economic issues and long-term goals for the ecosystem (IPBES 2018).

Principles of Ecological Restoration

Ecological restoration is a well-established practice in biodiversity conservation and ecosystem management. We have itemized fourteen principles of good ecological restoration practice based on experience gained over several decades. These principles, and the Attributes of Restoration Progress below, are consistent with both the reach and intent of the Convention on Biological Diversity's Principles for the Ecosystem Approach (IUCN 2004).

Principles of good ecological restoration practice include:

Ecosystems

- Incorporating biological and environmental spatial variation into the design.
- Allowing for linkages within the larger landscape.

- Emphasizing process repair over structural replacement.
- Allowing sufficient time for self-generating processes to resume.
- Treating the causes rather than the symptoms of degradation.
- Include monitoring protocols to allow for adaptive management.

Fig. 1: Ecosystem Restoration

Ten Principles that Underpin Ecosystem Restoration

- Ecosystem restoration contributes to the unsustainable development goals and the goals of the rio conventions.
- Ecosystem restoration promotes inclusive and participatory governance, social fairness and equity from the start and throughout the process and outcomes.
- Ecosystem restoration includes a continuum of restorative activities.
- Ecosystem restoration aims to achieve the highest level of recovery for biodiversity, ecosystem health and integrity, and human well-being.
- Ecosystem restoration addresses the direct and indirect causes of ecosystem degradation.
- Ecosystem restoration incorporates all types of knowledge and promotes their exchange and integration throughout the process.
- Ecosystem restoration is based on well-defined short-, medium- and long-term ecological, cultural and socio-economic objectives and goals.
- Ecosystem restoration is tailored to the local ecological, cultural and socioeconomic contexts, while considering the larger landscape or seascape.
- Ecosystem restoration includes monitoring, evaluation and adaptive management throughout and beyond the lifetime of the project or programme.
- Ecosystem restoration is enabled by policies and measures that promote its long-term progress, fostering replication and scaling-up.

Fig. 2: Ten Principles that Underpin Ecosystem Restoration

Ecosystem Restoration and Human Habitat Needs

Philosophically, ecosystem restoration is founded on symbiosis with land, economic, public, and private; as that can accelerate recovery of the ecosystem. Close "a protest beside destructive land use;" as and effort "to attention must be given to restoration of both structure preserve both utility and beauty;" as "a state of har- and processes, including natural disturbance regimes, money between men and land;" and finally, as "if restoration is to be successful. This management positive exercise of both skill and insight, not merely actions can be viewed as working hypotheses to be negative exercise of abstinence and caution."

The Need for Restoration

As the global economy has prospered, our planet's ecological health has suffered. Diverse ecosystems are depleted, from the 20 per cent of croplands showing stressed or declining productivity, to the 66 per cent of ocean ecosystems that are now damaged, degraded, degraded or modified.

50 percent of city inhabitants, for example, are without access to safe drinking water and 80 per cent live in areas of unsafe air quality. What's more, the brunt of the burden of speedy ecosystem degradation is being unequally borne by marginalized groups

such as women, indigenous peoples and people living in poverty, says the report, and the Covid-19 pandemic has exacerbated existing inequalities.

Scope and Scale of Ecosystem Restoration

Ecosystem restoration refers to the process of managing or assisting the improvement of an ecosystem that has been degraded, damaged or damaged as a means of sustaining ecosystem flexibility and conserving biodiversity. Degradation is characterized by a decline or loss of biodiversity or ecosystem functions. Degradation and restoration are context-specific and refer to both the state of ecosystems and to ecosystem processes.

The action plan aims to facilitate ecosystem restoration across all types of habitat, biomes and ecosystems, including forests, grasslands, croplands, wetlands, savannas and other terrestrial and inland water ecosystems, marine and coastal ecosystems, and, as appropriate, urban environments. The activities can be applied at the national, regional, sub national and site levels within a land-and seascape perspective. Actions intended to reduce, mitigate or reverse direct drivers of degradation; restore ecosystem conditions and processes may be undertaken on a range of scales within a mosaic of land uses, for a range of purposes and with different actors.

Key Activities of the Action Plan

The plan comprises four main groups of activities that could be undertaken, as a menu of options, on a voluntary basis, by Parties and other Governments, in collaboration with relevant organizations, in accordance with national legislation, circumstances and priorities. The four main groups of activities are:

(a) Assessment of opportunities for ecosystem restoration;
(b) Improving the institutional enabling environment for ecosystem restoration;
(c) Planning and implementation of ecosystem restoration activities;
(d) Monitoring, evaluation, feedback and disseminating results.

Table 1: Indicative Timeline for Short-Term Actions on Ecosystem Restoration

Key activities	One to three years	Three to six years
Step A. Assessment of opportunities for ecosystem restoration	Identify the drivers related to the loss of biodiversity. Identify current restoration activities and initiatives and how they integrate biodiversity considerations.	Ongoing assessments, including of the potential costs and the multiple benefits. Identify and secure resources for restoration. Identify options to reduce or eliminate drivers of biodiversity loss.
Step B. Improving the institutional enabling environment for ecosystem restoration	Assess targets, policies and strategies, incentive measures, spatial planning tools and processes, and consider the need for safeguard measures. Review legal, policy and financial frameworks to inform actions in step C.	Implement relevant tools, processes and measures. Evaluate adequacy of resources; seek and secure further resources as needed.
Step C. Planning and implementation of ecosystem restoration activities	Prioritize restoration opportunities based on step A and develop restoration plans with clear and measurable objectives.	Implement restoration plans facilitated by actions in step B.
Step D. Monitoring, evaluation, feedback, and disseminating results	Share experiences from current activities and initiatives to support adaptive management and promote continuity	Monitor results and report on lessons learned from activities in steps B and C to support adaptive management and improve outcomes of future restoration efforts.

How to Support Ecosystem Restoration?

Ecosystem restoration should not be considered a substitute for sustainably protecting and managing native ecosystems. Most natural and semi-natural ecosystems are not readily transformable or easily restored once degraded. Moreover, restoration science and technologies for many ecosystems are still far from achieving 100% recovery of biodiversity, ecosystem functionality, or delivery of ecosystem services. This means that the promise of restoration should never be invoked as a justification for destroying or damaging existing ecosystem (Miller *et al.* 2005).

Optimal restoration outcomes (environmental, social and economic) are more likely to be achieved when indigenous knowledge, legal frameworks, regulations, financial and market mechanisms are applied in a coordinated approach throughout the restoration process. Multiple issues can be addressed and diverse needs of local actors can be met if there is adequate development of innovative financing mechanisms combined with a supportive enabling environment (FAO 2021).

Biodiversity Conservation for Sustainable Development

Biodiversity—the diversity of life on Earth—is defined as the variability among living organisms from all sources, including diversity within species, between species, and of ecosystems. Biodiversity thus includes not only the millions of different species on Earth, it also consists of the specific genetic variations and traits within species (such as different crop varieties), as well as the various types of different ecosystems, marine and terrestrial, in which human societies live and on which they depend, such as coastal areas, forests, wetlands, grasslands, mountains and deserts.

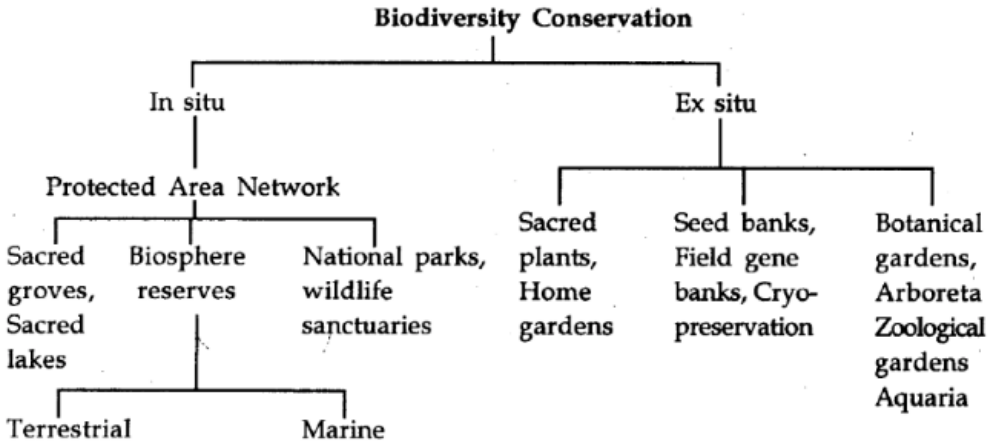

Fig. 3: The in-situ and ex-situ approaches of conserving biodiversity in India

Biodiversity is essential for sustainable development and human well-being. It underpins the provision of food, fibre and water; it mitigates and provides resilience to climate change; it supports human health, and provides jobs in agriculture, fisheries, forestry and many other sectors. Without effective measures to conserve biodiversity and use its components in a sustainable manner, the 2030 Agenda for Sustainable Development will not be achievable (Lamb D *et al.* 2005).

Sustainable Development

Sustainable development, according to the Brundtland Report of 1987, is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Put in the new globalised order, sustainable development is the integration of economic, social and environmental development considered as the inter-dependent and mutually reinforcing pillars which operate at the local, national, regional and global levels. This sets out two fundamental principles of intergenerational and intergenerational equity (Wetangula G *et al.* 2002).

There are many ways to define sustainable development. Use the following definitions to inspire your own:

- "Sustainable development involves the simultaneous pursuit of economic prosperity, environmental quality and social equity. Companies aiming for sustainability need to perform not against a single, financial bottom line but against the triple bottom line."
- "Improving the quality of human life while living within the carrying capacity of supporting ecosystems."
- "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
- "Taking from the Earth only what it can provide indefinitely, thus leaving future generations no less than we have access to ourselves."

Biodiversity is Essential for Sustainable Development

The 2030 Agenda for Sustainable Development, agreed by the 193 States Members of the United Nations, sets out an ambitious framework of universal and indivisible goals and targets to address a range of global societal challenges. Biodiversity and ecosystems feature prominently across many of the Sustainable Development Goals (SDGs) and associated targets. They contribute directly to human well-being and development priorities. Biodiversity is at the centre of many economic activities, particularly those related to crop and livestock agriculture, forestry, and fisheries. Globally, nearly half of the human population is directly dependent on natural resources for its livelihood, and many of the most vulnerable people depend directly on biodiversity to fulfill their daily subsistence needs (kailash *et al.* 2014).

Connecting Biodiversity Conservation to Sustainable Development

Biodiversity provides people with basic ecosystem goods and services. It provides goods such as food, fiber and medicine, and services such as air and water purification, climate regulation, erosion control and nutrient cycling. Biodiversity also plays an important role in economic sectors that drive development, including agriculture, forestry, fisheries and tourism. More than three billion people rely on marine and coastal biodiversity, and 1.6 billion people rely on forests and non-timber forest products (e.g. the fruits from trees) for their livelihoods. Many people depend directly on the availability of usable land, water, plants and animals to support their families. In fact, ecosystems are the base of all economies.

Interrelation of Biodiversity and sustainable Development

In the sustainability framework discussed earlier, biodiversity is a key feature or element of the natural resource base which, when it interacts with the technology and socioeconomic dimensions, determines the pathway of development. If the existing technological, socioeconomic and institutional processes erode biodiversity and its functional elements as a component of the natural resource base, the resulting development process will not be sustainable in the long run. However, if biodiversity is well-managed such that its structure and functional relations are kept intact, then a more sustainable pathway for economic development could likely be attained.

Conservation and Sustainable Use

While there is considerable debate over the scale at which biodiversity extinction is occurring, there is little doubt we are presently in an age where species loss is well above the established biological norm. Extinction has certainly occurred in the past, and in fact, it is the fate of all species, but today the rate appears to be at least 100 times the background rate of one species per million per year and may be headed towards a magnitude thousands of times greater.

Mainstreaming Biodiversity for Sustainable Development

Biodiversity underpins all life and provides vital benefits to our societies and economies. Yet despite this, pressures from land use change, over-exploitation of natural resources, pollution and climate change are contributing to an alarming loss of living diversity. We have to reverse these trends. Biodiversity and ecosystem services provide invaluable – but often invisible – benefits at global, regional and local scales. These include services such nutrient cycling, habitat provisioning, pollination, erosion control and climate regulation. The need to mainstream biodiversity and ecosystem services more effectively into national and sectoral policies has recently gained renewed impetus on the global policy agenda. In line with the Convention on Biological Diversity and the 2011-2020 Aichi Biodiversity Targets, the 2030 Agenda for Sustainable Development places strong emphasis on biodiversity for achieving these global goals.

Existing Policy Responses

There are so many International as well as national legislations relating to conservation and sustainable use of the natural resources. Some of them are discussed below:

- The Convention on Biological Diversity.
- Biological Diversity Act, 2002
- Wild Life Protection Act
- Constitutional provisions

Conclusion

Ecological restoration has as its goal the restoration of degraded ecosystems to resemble, or emulate more closely conditions that prevailed before disruption of natural structures and processes. A key concept in restoration ecology is that of the reference conditions defined as the range of ecosystem conditions (including structure and function) which have prevailed over recent evolutionary time. Underlying the idea of reference conditions is the concept of the evolutionary environment -the environment in which species have evolved. Ecological restoration consists of management actions designed to accelerate recovery by complementing or reinforcing natural processes. The idea of biodiversity conservation rests on several fundamental arguments including nostalgia and human benefits and needs. The innate desire we all have is our children to experience the great pleasure and curious excitation that biodiversity has given us. Moreover we were not bequeathed this earth and its biodiversity. We must return it to our future generation in the manner in which we have received. Biodiversity conservation and sustainable development are two inter-related branches focusing on social progress, economic growth and environmental protection on one side, and ecosystem conservation on the other. Conservation includes the efforts carried out in protected areas such as national parks and community reserves, and in other areas with rich and important biodiversity where conservation is not the main focus. It is in these latter productive landscapes where sustainability is needed most. Sustainable agriculture, sustainable fisheries and sustainable management of natural resources are the main approaches for preserving these landscapes for long-term social, economic and ecological benefits. This is a critical moment in earth's history, a time when humanity must choose its future. Our planet earth is perhaps the only human habitat in the vast universe and we owe it to posterity to preserve the divine heritage of our biosphere without pollution, degradation and destruction.

References

Aronson J, and E. Le Floc'h. 1996. Hierarchies and landscape history: dialoguing with Hobbs and Norton. *Restoration Ecology* 4: 327-333.

Convention on Biological Diversity (CBD). COP 13Decision XIII/5. Ecosystem restoration: short-term action plan. Decision adopted by the conference of the parties to the Convention on Biological Diversity at its thirteenth meeting, 4-17 December 2016. https://www.cbd.int/doc/decisions/cop-13/cop-13-dec-05-en.pdf.

Flader, S.L. 1974. Thinking like a mountain: Aldo Leopold and the evolution of an ecological attitude toward deer, wolves, and forests. University of Missouri Press, Columbia, MO.

Hubbell S.P. 2001. The Unified Neutral Theory of Biodiversity and Biogeography (MPB-32); Princeton University Press: Princeton, NJ, USA.

Hutton J, Adam, W.M, Murombedzi J.C. 2005. Back to the Barriers? Changing Narratives in Biodiversity Conservation. Forum Dev. Stud. 32, 341–370.

IPBES. 2018. The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.).

Lamb D, P. D. Erskine, and J. A. 2005. Parrotta. Restoration of degraded tropical forest landscapes. *Science*. 310(5754):1628.

Manforedo MJ, Teel TL, Dietsch AM. 2016. Implication of human value shift and persistence for biodiversity conservation*, Conser. Biol*. 30(2), 287-296.

Miller J R. Biodiversity Conservation and the extinction of experience. 2005. *Trends Ecol. Evol*. 20, 430-434.

Negi S. S. Biodiversity and its Conservation in India, Indus Publishing, 1-341.

Rapport, D. J. 1995. Ecosystem health: an emerging integrative science. In: D.J. Rapport, C.L. Gaudet, and I'. Calow (eds.), Evaluating and Monitoring the Health of Large-Scale Ecosystems. *NATO AS1 Series. Series I: Global environmental change*. Vol. 28. Springer-Verlag, Berlin.

Sarkar S. 1999. Wilderness preservation and biodiversity conservation—Keeping divergent goals distinct. *Bio Science*. 49, 405–412.

Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. 744 pages.

Wetangula G, and Ajayi J. 2002. Power development and nature conservation – two scenarios. University of Iceland, Iceland and Olkaria Geothermal Power Project, Naivasha, Kenya.