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# Biodiversity and Land Restoration in India:

## A narrative of India's sustainability efforts vis-à-vis the world

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Biodiversity and Land Restoration in India:
*A narrative of India's sustainability efforts vis-à-vis the world*

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## List of Acronyms

| | |
|---|---|
| APCNF | Andhra Pradesh Community-Managed Natural Farming |
| BHS | Biodiversity Heritage Sites |
| CAMPA | Compensatory Afforestation Fund Management and Planning Authority |
| CBD | Convention on Biological Diversity |
| EDCs | Eco-Development Committees |
| GEF | Global Environment Facility |
| G20 | Group of Twenty |
| ISFR | Indian State of Forest Report |
| ISRO | Indian Space Research Organization |
| IWMP | Integrated Watershed Management Programme |
| JFMCs | Joint Forest Management Committees |
| LDN | Land Degradation Neutrality |
| MoEFCC | Ministry of Environment, Forest, and Climate Change |
| MPAs | Marine Protected Areas |
| NABP | National Biodiversity Action Plan |
| NAP | National Afforestation Programme |
| NAPCC | National Action Plan on Climate Change |
| NBSAPs | National Biodiversity Strategies and Action Plans |
| PDMC | Public Debt Management Cell |
| PMKSY | Pradhan Mantri Krishi Sinchayee Yojana |
| REDD+ | Reducing Emissions from Deforestation and Forest Degradation |
| SBBs | State Biodiversity Boards |
| SDGs | Sustainable Development Goals |
| UNCCD | United Nations Convention to Combat Desertification |
| UNEP | United Nations Environment Programme |
| UNFF | United Nations Forum on Forests |
| UNFCCC | United Nations Framework Convention on Climate Change |

## Executive Summary

This paper examines India's biodiversity conservation and land restoration efforts within the framework of global sustainability goals, comparing them with initiatives in developed countries. Recognizing the critical role of biodiversity in ecological stability, it explores international frameworks such as the UN Convention to Combat Desertification (UNCCD), the Convention on Biological Diversity (CBD), and the UN Framework Convention on Climate Change (UNFCCC). These frameworks emphasize the importance of land restoration in addressing global environmental challenges, including commitments like the Bonn Challenge to restore 350 million hectares (Mha) of degraded land by 2030.

The paper traces the evolution of India's biodiversity and land restoration policies, showcasing the progressive nature of its legislative and programmatic framework. Key policies and laws such as the Biological Diversity Act (2002) and the National Action Plan on Climate Change (NAPCC) provide the foundation for India's efforts in protecting and rehabilitating its natural ecosystems. Additionally, the analysis covers major conservation initiatives such as Project Tiger, which focuses on the protection of India's flagship species and their habitats, and the Green India Mission, which aims to restore forest and tree cover while enhancing ecosystem services.

The study also investigates targeted efforts to combat desertification, a significant challenge in India due to its extensive arid and semi-arid regions. It emphasizes the crucial role of indigenous communities and the incorporation of traditional knowledge as key factors in the successful implementation of these initiatives. Examples of community-led conservation and restoration practices are provided, showcasing the effectiveness of local involvement. Initiatives such as Joint Forest Management Committees and Eco-Development Committees, along with projects in the Sundarbans and natural farming in Andhra Pradesh, demonstrate the importance of local participation in ecological restoration. These approaches merge traditional practices with modern conservation techniques, creating sustainable models that contribute to both national and global goals.

For a comparative perspective, the study analyses biodiversity conservation and land restoration initiatives in developed countries, exploring their policy frameworks, implementation strategies, and outcomes. Noteworthy examples include the European Union's Biodiversity Strategy, which is part of its Green Deal, and the United States' Endangered Species Act (ESA), both of which have robust legal backing and clear implementation mechanisms. The analysis delves into significant restoration programmes across Europe and North America, such as the EU's LIFE Program and the US Conservation Reserve Program (CRP). These programmes are characterized by the use of advanced technologies like remote sensing, artificial intelligence, and environmental DNA (eDNA) for monitoring and assessing biodiversity and land health. Furthermore, the study emphasizes the substantial financial investments made in these regions, which have enabled large-scale restoration projects and contributed to more effective conservation outcomes.

The comparative analysis reveals critical differences in policy execution between India and developed nations. While developed countries benefit from longer-standing legal frameworks, advanced technologies, and greater financial resources, India's approach is distinguished by its integration of community-based initiatives and traditional knowledge, providing unique social and cultural dimensions to conservation efforts. Challenges such as regulatory enforcement, varying socio-economic conditions, and the scale of land degradation present distinct obstacles

for India. However, the study identifies opportunities for South-North collaboration, where India can learn from technological advancements and financial models in developed countries while offering insights into community-driven approaches and traditional ecological practices.

The paper concludes by offering recommendations for enhancing India's biodiversity and land restoration efforts, underscoring the necessity for innovative financing models to support these initiatives, increased funding mechanisms, and more robust stakeholder engagement. Key suggestions include exploring new funding mechanisms, such as green bonds and payments for ecosystem services, strengthening policy enforcement through public-private partnerships, and integrating traditional knowledge with modern conservation strategies. A balanced approach that combines local wisdom with global best practices is essential for India to effectively safeguard its diverse ecosystems amid ongoing environmental challenges.

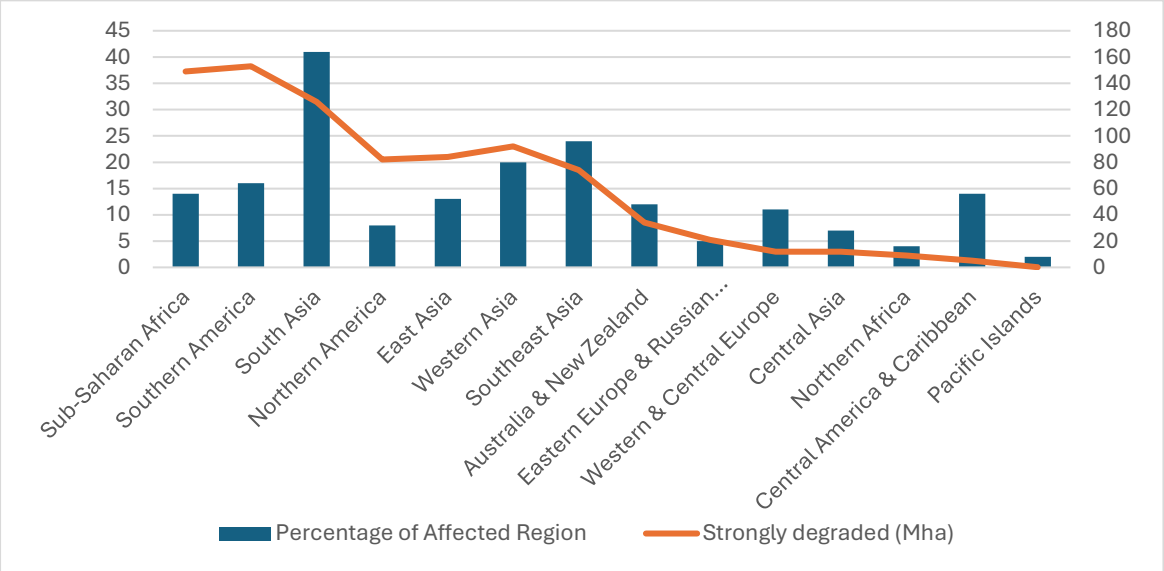
## 1. Introduction

Land and soil degradation is influenced by both natural forces and human activity and has serious global implications. Land degradation is defined as a continuous decline in ecosystem services over time (Millennium Ecosystem Assessment, 2005). The United Nations Convention to Combat Desertification (UNCCD) specifically refers to desertification as land degradation in drylands, resulting in reduced biological and economic productivity (UNCCD, 2022). This degradation, whether driven by climate variability or human-induced activities, directly impacts natural resource productivity and biodiversity (Shao et al., 2016).

Globally, approximately 3 billion people are affected by land degradation (van der Wiel et al., 2017; IPCC, 2019). Various assessments suggest that 20–40% of the world's land area is experiencing degradation to different degrees, with this degradation directly impacting half of the global population and posing risks to nearly 50% of the world's GDP (UNCCD, 2022). Environmental degradation poses a significant threat to 1.2 billion jobs globally, representing 40% of the world's workforce, as these jobs rely heavily on ecosystem services (ILO, 2022).

According to the FAO Synthesis Report on the State of the World's Land and Water Resources for Food and Agriculture (FAO, 2021), South Asia exhibits the highest level of land degradation globally, with 41% of its land – equivalent to 126 million hectares (Mha) – strongly degraded due to intense agricultural activity, deforestation, and population pressures (Figure 1).

**Figure 1: Anthropogenic-induced degradation in different world regions**



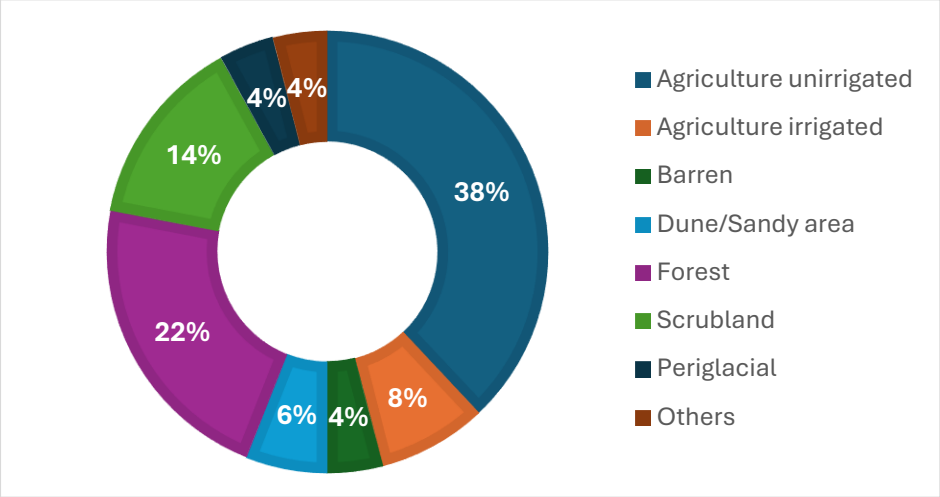

*Data Source: FAO (2021)*

Southern America follows with 16% of its land degraded, amounting to 153 Mha, largely driven by deforestation in the Amazon and cattle ranching. Sub-Saharan Africa has 14% of its land affected, with 149 Mha degraded, primarily due to desertification and unsustainable farming. Western and Southeast Asia also experience significant degradation, with 20% and 24% of their lands affected, respectively, largely due to agricultural expansion and water scarcity. Australia and New Zealand face lower degradation levels at 12%, with 34 Mha impacted. In Western & Central Europe and Eastern Europe & the Russian Federation, degradation rates are lower at 11% and 5%, but these regions still face issues like soil erosion, with 12 Mha and 21 Mha strongly degraded. Central America & the Caribbean, Northern

America, and the Pacific Islands show varying levels of degradation, with the Pacific Islands having the least at just 2%.

India, home to over 1.3 billion people, faces significant challenges with 29.77% of its geographic area (97.85 Mha) under degradation as of 2018–19, an increase of 3.32 Mha. since 2003–05 (SAC, 2021). Factors such as water erosion, vegetation degradation, and wind erosion are primary drivers of this degradation, which is concentrated in states like Rajasthan, Maharashtra, and Telangana. The analysis of degraded land in India reveals considerable variation across different land use types (Figure 2).

**Figure 2: Percent degraded land in India as per land use type**

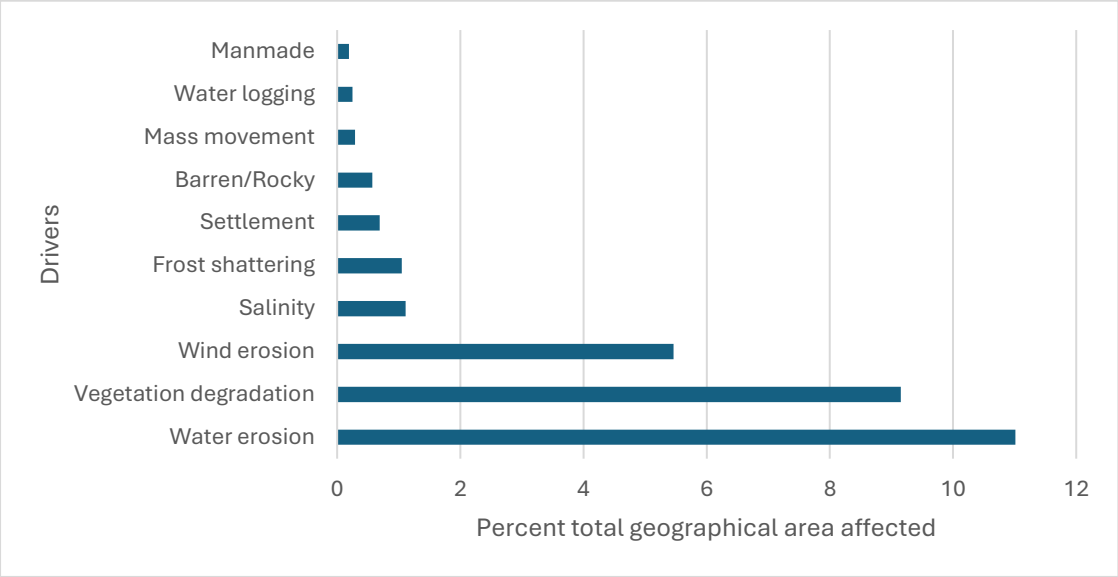



*Data Source: SAC (2021)*

Unirrigated agricultural land stands out with the highest degradation rate at 38%, largely due to soil erosion, nutrient loss, and water stress. In contrast, irrigated agricultural land shows a lower degradation rate of 8%, benefiting from irrigation but still facing challenges like salinization. Barren lands (4%) and periglacial areas (4%) are prone to degradation due to natural factors, while dune/sandy areas (6%) experience wind erosion. Forests (22%) suffer from deforestation and overgrazing, and scrublands (14%) are affected by land clearing and desertification. The "Others" category (4%) encompasses various land types, each with unique degradation drivers. Overall, unirrigated agricultural and forest lands are the most affected, highlighting the urgent need for targeted land management strategies in these critical areas.

The analysis of the drivers of land degradation in India highlights several significant factors impacting land quality across the country's geographical area (Figure 3). Water erosion is the most critical driver, affecting 11% of the area, often exacerbated by deforestation and poor agricultural practices. Vegetation degradation follows closely at 9.15%, driven by deforestation and overgrazing, leading to increased soil erosion and loss of biodiversity. Wind erosion affects 5.46% of land, particularly in arid regions, due to inadequate land management. Other notable drivers that include salinity (1.11%), frost shattering (1.05%), and urban settlement (0.69%) emphasize the urgent need for effective land management strategies, reforestation, and sustainable agricultural practices to combat these drivers and enhance land health.

**Figure 3: Drivers of degradation and the percent total geographical area affected by these drivers**




*Data Source: SAC (2021)*

The need for sustainable land management practices has gained prominence as nations strive to restore degraded lands with a view to protect environment while ensuring food security and inclusive growth. Globally, efforts like the Bonn Challenge aim to restore 350 Mha of degraded land by 2030, and the UN Sustainable Development Goals (SDGs), particularly Goal 15, emphasize land restoration as vital to achieving ecological sustainability. In alignment with these international commitments, India has pledged to restore 26 Mha of degraded land by 2030 (Dave et al., 2019).

This paper examines India's initiatives in biodiversity conservation and land restoration, comparing them to global practices and highlighting opportunities for greater impact through South-North collaboration.

## 2. Biodiversity Conservation & Land Restoration: Key to Sustainable Development

### 2.1 Significance and Role in Global Environmental Goals

Restoration of degraded land and improved land management are crucial strategies for achieving global environmental sustainability. United Nations Environment Programme (UNEP) highlights that achieving the goals of the UN Decade on Ecosystem Restoration could help restore 350 Mha of degraded land by 2030, potentially removing 13 to 26 gigatonnes of greenhouse gases from the atmosphere and generating $9 trillion in ecosystem services.

Restoration and land management can directly contribute to climate change mitigation by enhancing terrestrial carbon storage (Griscom et al., 2017; Strassburg et al., 2019). Moreover, they improve ecosystem resilience, helping adapt to climate risks such as flash floods and landslides, while improving soil quality, which enhances resilience to extreme weather events like droughts and floods (Abhilash et al., 2016; Sanz et al., 2017).

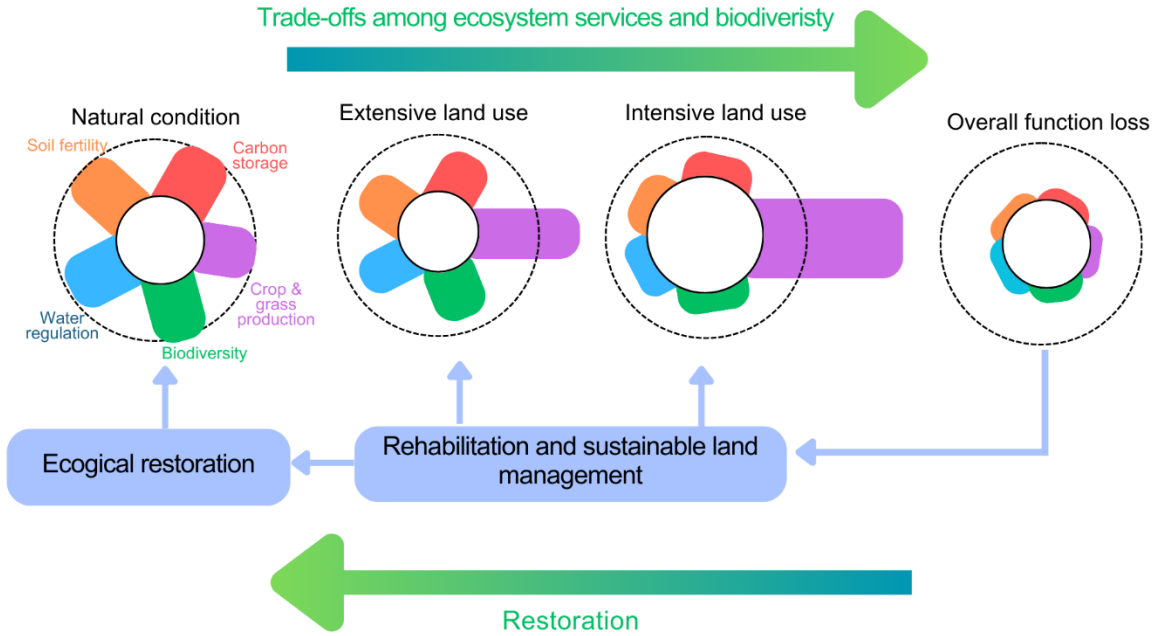
Land-based restoration under different ecosystems provides distinct yet interconnected benefits that contribute to the well-being of people and the environment (Table 1).

**Table 1: Benefits of restoring various land-based ecosystems worldwide**

| Ecosystem | Restoration Benefits | Data | Sources |
|---|---|---|---|
| **Farmlands (Agricultural Lands)** | Increased soil fertility, water retention, carbon sequestration, biodiversity restoration | - Carbon sequestration: 0.7–1.1 tonnes $CO_2$/ha/year<br>- Water retention: 10–20%<br>- Biodiversity: 30–50% richer | Lal, R. (2020)<br>FAO (2011) |
| **Forests** | Carbon storage, water cycle improvement, biodiversity conservation, flood risk reduction | - Carbon sequestration: 3.7–6 tonnes $CO_2$/ha/year<br>- Species richness: up to 50%<br>- Water: 15–40% increase | Griscom et al. (2017)<br>FAO & UNEP (2020)<br>Ellison et al. (2017) |
| **Grasslands, Shrublands, Savannahs** | Carbon sequestration, soil health improvement, biodiversity increase, drought resilience | - Carbon sequestration: up to 1.5 tonnes $CO_2$/ha/year<br>- Soil carbon: 30–40% increase<br>- Biodiversity: 25–50% | Conant et al. (2017)<br>FAO (2015)<br>White et al. (2000) |
| **Mountains** | Carbon storage, slope stabilization, enhanced water retention, erosion control, unique biodiversity | - Carbon sequestration: up to 3 tonnes $CO_2$/ha/year<br>- Water retention: 10–30%<br>- Erosion control: up to 70% | UNEP (2022)<br>Körner et al. (2017) |
| **Peatlands** | Carbon sinks, water retention, flood control, habitat for unique species | - Carbon storage: up to 500 tonnes $CO_2$/ha<br>- Water retention: 10–20x more water<br>- Biodiversity: 30–60% | Joosten (2009)<br>Bonn et al. (2016) |
| **Urban Areas** | Improved air and water quality, carbon storage, heat island reduction, biodiversity increase, recreational space improvement | - Carbon sequestration: up to 5 tonnes $CO_2$/ha/year<br>- Temperature reduction: 2–3°C<br>- Air pollutants: 10–20% | Nowak et al. (2018)<br>Bowler et al. (2010) |

Restoration and improved land management approaches are recognized as cross-cutting instruments under the Rio Conventions—covering biodiversity conservation, desertification, land degradation, and climate change—and support a broad range of Sustainable Development Goals (SDGs). Although these efforts yield benefits on different temporal scales, they may also present trade-offs, particularly in land use and food security (IPBES, 2018; Navarro et al., 2017; IRP, 2019). Restoration improves key ecosystem services like carbon sequestration, water retention, and soil fertility, while trade-offs may include temporary reductions in land available for agriculture (Figure 4).

**Figure 4: Ecosystem function and trade-offs in land restoration**




*Source: Adapted from van der Esch (2022)*

### 2.2 Co-Benefits for Food Security and Agricultural Productivity

Land restoration and conservation strategies also contribute to food security by safeguarding ecosystem services vital to agriculture, including soil protection, pollination, nutrient cycling, and water retention (Bommarco et al., 2013; Foley et al., 2011; Bossio et al., 2010). By supporting short- and long-term agricultural productivity, they help avert biodiversity loss and species extinction (Strassburg et al., 2019). However, trade-offs may occur, for instance, when land is set aside for restoration, reducing agricultural production temporarily (Dudley et al., 2005; IRP, 2019).

Strategic planning is essential to balance conservation needs and food security requirements, ensuring sustainable land use without compromising long-term ecological or agricultural goals.

### 2.3 Broader Socio-Economic Impacts

Healthy and productive landscapes, supported by restoration and sustainable land management, address broader human security concerns. This includes improving livelihoods, employment, health, and education opportunities, thus fostering socio-economic stability and peace (Lonergan, 2012; Abhilash et al., 2016). Restored lands and secure land tenure can diversify livelihoods beyond agriculture, contributing to long-term socio-economic resilience and stability (Mach & Etkins, 2019).

### 2.4 Synergies Between LDN and the SDGs

The concept of Land Degradation Neutrality (LDN) was introduced at the 2012 Rio+20 Conference as a global goal to maintain or enhance land productivity while restoring degraded lands. Defined by the UN Convention to Combat Desertification (UNCCD), LDN aims to ensure that the quality and quantity of land resources remain stable or increase within specific temporal and spatial scales (Mukherjee & Samanta, 2018).

LDN has co-benefits across climate change mitigation, adaptation, biodiversity conservation, food security, and sustainable livelihoods. Achieving LDN requires three key actions:

- Avoiding new land degradation by protecting healthy lands.
- Reducing existing degradation through sustainable land management practices.
- Restoring degraded lands to a natural or more productive state.

The successful implementation of LDN aligns the goals of the UNCCD, Convention on Biological Diversity (CBD), and UN Framework Convention on Climate Change (UNFCCC), enabling countries to achieve multiple benefits from land restoration investments.

Land restoration and improved land management contribute significantly to achieving multiple SDGs, with strong synergies across several goals (Table 2). For instance, landscape restoration mitigates climate change (SDG 13), supports food production (SDGs 1, 2), improves air and water quality (SDGs 3, 6, 14), and promotes biodiversity (SDG 15). Additionally, restored lands create job opportunities, contributing to social equity and economic growth (SDGs 1, 5, 8, 10).

However, trade-offs may arise, such as between agricultural production and conservation goals when land is repurposed for restoration. A balanced, well-planned approach is essential to maximize synergies and minimize negative impacts on food security and livelihoods.

**Table 2: SDGs and land restoration**

| SDGs | Contribution from Land Restoration |
|---|---|
| **SDG 1 (No Poverty)** | Creates rural jobs, economic diversification |
| **SDG 2 (Zero Hunger)** | Enhances food production and security |
| **SDG 3 (Good Health and Well-being)** | Improves air and water quality, recreational opportunities |
| **SDG 6 (Clean Water)** | Increases water retention and quality |
| **SDG 13 (Climate Action)** | Increases carbon sequestration, resilience to climate risks |
| **SDG 15 (Life on Land)** | Enhances biodiversity, restores ecosystems |

## 3. Biodiversity and Land Restoration: Global Initiatives

Ecosystem restoration, including improved land management, has gained significant traction as a critical tool for achieving global sustainability objectives. These efforts are reflected in major global frameworks, such as the United Nations Convention to Combat Desertification (UNCCD), the Convention on Biological Diversity (CBD), and the United Nations Framework Convention on Climate Change (UNFCCC). Restoration ambitions are also embedded within the Sustainable Development Goals (SDGs) and feature in various other international and regional agreements and initiatives (Suding et al., 2015; Chazdon et al., 2017).

Numerous initiatives have emerged to enhance knowledge-sharing and capacity development, such as the Global Partnership on Forest and Landscape Restoration (established in 2003), the Bonn Challenge (launched in 2011), and the New York Declaration on Forests (announced in 2014). Most notably, the United Nations declared 2021–2030 as the UN Decade on Ecosystem

Restoration, an effort led by the Food and Agriculture Organization (FAO) and the UN Environment Programme (UNEP). This initiative is supported by a range of collaborating agencies, including the three Rio Conventions, other international treaties, and regional actors like the International Union for Conservation of Nature (IUCN).

Restoration efforts are recognized as cross-cutting solutions under these conventions (Rio Conventions, 2012) and are key to sustainable development (Navarro et al., 2017). They can concurrently contribute to the objectives of all three Rio Conventions—biodiversity conservation, desertification prevention, and climate change mitigation—offering co-benefits across multiple SDGs. However, these outcomes may unfold at varying timescales and involve trade-offs (IRP, 2019). The inherent synergies between restoration efforts and global targets create opportunities to develop integrated frameworks for restoration measures, policy coherence, and cost-effective actions (Akhtar-Schuster et al., 2017).

*Biodiversity conservation and land restoration play a central role in addressing interconnected global challenges, including climate change, food security, and sustainable development. Achieving Land Degradation Neutrality and implementing sustainable land management practices are crucial steps towards safeguarding ecological, social, and economic well-being. By aligning goals across international frameworks and leveraging synergies across SDGs, countries can create more resilient, productive landscapes and foster a more sustainable future.*

The growing emphasis on restoration is in response to persisting land degradation and adverse impact on natural and human systems as highlighted in high-profile scientific reports that have underscored the interconnected threats of climate change, land degradation, deforestation, and biodiversity loss. Noteworthy publications include the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Assessment Report on Land Degradation and Restoration (2018), the Intergovernmental Panel on Climate Change (IPCC) Special Report on Climate Change and Land (2019), and the UNCCD Global Land Outlook (2017). Additionally, academic studies on reforestation potential and nature-based solutions have fuelled further interest (Bastin et al., 2019; Griscom et al., 2017; Roe et al., 2019; Strassburg et al., 2019).

### 3.1 Overview of International Agreements and Initiatives on Land Restoration

A wide array of multilateral environmental agreements (MEAs) and multi-actor initiatives exist that include land restoration and improved land management as central goals. These initiatives are driven by both public and private actors, often blending international and regional efforts.

#### Multilateral Environmental Agreements (MEAs):

Key MEAs, such as the three Rio Conventions (UNFCCC, CBD, UNCCD), aim to address climate change, biodiversity loss, and land degradation. Restoration targets are also linked to conventions such as the Ramsar Convention on Wetlands, the Sendai Framework for Disaster Risk Reduction, and the UN Forum on Forests (UNFF). Additionally, the SDGs include several targets focused on restoration, particularly in areas relevant to climate action, clean water, zero hunger, and life on land (SDGs 2, 6, 13, 15).

### Multi-actor Initiatives:

Beyond the formal conventions, hybrid initiatives have emerged at various scales, involving governments, corporations, civil society, and non-state actors. Prominent examples include the Trillion Tree Campaign, which focuses on large-scale reforestation; the 4 per 1000 Initiative, which targets soil restoration; and efforts like the Bonn Challenge and the New York Declaration on Forests, which aim to restore landscapes to address climate change, human well-being, and biodiversity loss.

## 3.2 International Commitments and Restoration Targets

Countries have made significant commitments to restore degraded lands through a variety of platforms, including the Bonn Challenge, the Rio Conventions, and regional initiatives. A global commitment range of 765 million to 1 billion hectares is projected for restoration by 2030, depending on how different national commitments overlap or align across conventions and initiatives. Approximately 450 Mha are targeted under national voluntary programmes aimed at Land Degradation Neutrality, while 250 Mha are included in Nationally Determined Contributions (NDCs) under the Paris Agreement. Additionally, around 90 Mha are committed through National Biodiversity Strategies and Action Plans (NBSAPs) under the CBD.

The Bonn Challenge alone has set a target of restoring 150 Mha by 2020, which has been extended to 350 Mha by 2030 under the New York Declaration on Forests. The Kunming-Montreal Global Biodiversity Framework, established under the CBD, sets ambitious goals such as reducing the loss of high-biodiversity areas to near-zero by 2030, restoring at least 30% of degraded ecosystems, and conserving 30% of terrestrial, inland water, coastal, and marine areas. Similarly, the UN Convention to Combat Desertification (UNCCD) aims for achieving Land Degradation Neutrality (LDN) by 2030, directly aligning with Sustainable Development Goal (SDG) Target 15.3, which emphasizes combating desertification and restoring degraded land.

The SDGs themselves integrate biodiversity and land restoration across multiple targets, including SDGs 2.4 (sustainable food production), 6.6 (protection of water-related ecosystems), 13.1 (resilience to climate impacts), and 15 (life on land). The UN Strategic Plan for Forests 2030 aims to halt deforestation and forest degradation, with a target of increasing global forest area by 120 million hectares (Mha) by 2030. The Ramsar Convention on Wetlands prioritizes the wise use and conservation of wetlands, addressing the drivers of wetland degradation. Meanwhile, the Sendai Framework for Disaster Risk Reduction focuses on minimizing disaster risks through ecosystem-based adaptation and fostering resilient development.

The G20 Global Land Initiative sets a goal to voluntarily reduce degraded land by 50% by 2040. In addition, during India's G20 Presidency in 2023, the inception of a Global Alliance focused on restoring lands affected by forest fires and mining was introduced as part of the Gandhinagar Implementation Roadmap and the Gandhinagar Information Platform (GIR-GIP).

The Paris Agreement’s focus on mitigation and climate adaptation, along with the ambitious goals of the Kunming-Montreal Global Biodiversity Framework, reflects a collective effort to halt the degradation of essential ecosystems. These conventions promote restoration initiatives and enhance conservation practices worldwide. Moreover, they align with broader sustainable development goals, highlighting the interconnectedness of land, biodiversity, and climate action. Achieving these ambitious targets requires coordinated action across public, private, and civil society sectors, aligning international and national commitments and driving on-

ground implementation. Table 3 presents key global conventions on restoration and biodiversity conservation.

**Table 3: Key global conventions on restoration and biodiversity conservation**

| Global Conventions | Remarks |
|---|---|
| **Paris Agreement (UNFCCC)** | - Focus on mitigation through agriculture, forestry, and other land use (AFOLU), forest conservation and carbon stock enhancement (Article 5, REDD+), and climate adaptation (Article 7.1) |
| **Kunming-Montreal Global Biodiversity Framework (CBD)** | - Goals include bringing the loss of areas of high biodiversity importance, close to zero by 2030, restoration of at least 30% of degraded ecosystems, and conservation of at least 30% of terrestrial, inland water, and coastal and marine areas |
| **Achieving Land Degradation Neutrality (LDN) (UNCCD)** | - The goal to combat desertification and restore degraded land by 2030. Aligns with SDG Target 15.3 |
| **Sustainable Development Goals (SDGs)** | - Targets cover land restoration, biodiversity, and sustainable resource management (SDGs 2.4, 6.6, 13.1, 15.1–15.7) |
| **UN Strategic Plan for Forests 2030 (UNFF)** | - Aims to halt deforestation and forest degradation, with a target of increasing forest area by 120 Mha by 2030. |
| **Ramsar Convention on Wetlands** | - Focuses on the wise use and conservation of wetlands to address degradation drivers |
| **Sendai Framework for Disaster Risk Reduction** | - Aims to reduce disaster risk through ecosystem-based adaptation and resilient development |
| **Bonn Challenge** | - Aims to restore 150 Mha by 2020, extended to 350 Mha by 2030 under the New York Declaration on Forests |
| **G20 Global Land Initiative** | - Aims to achieve a 50% reduction in degraded land by 2040 on a voluntary basis.<br>- Inception of a Global Alliance on land restoration of forest fire and mining affected areas under the Gandhinagar Implementation Roadmap and the Gandhinagar Information Platform (GIR-GIP) - G20 Initiatives under India's Presidency, 2023 |

*Achieving these restoration goals will require cooperation across multiple sectors and stakeholders, including governments, civil society, and the private sector. Successful implementation of restoration initiatives can address the critical challenges of biodiversity loss, land degradation, and climate change, while simultaneously contributing to human well-being and economic development.*

## 4. Biodiversity and Land Restoration: India's Initiatives

### 4.1 Historical Context and Policy Framework

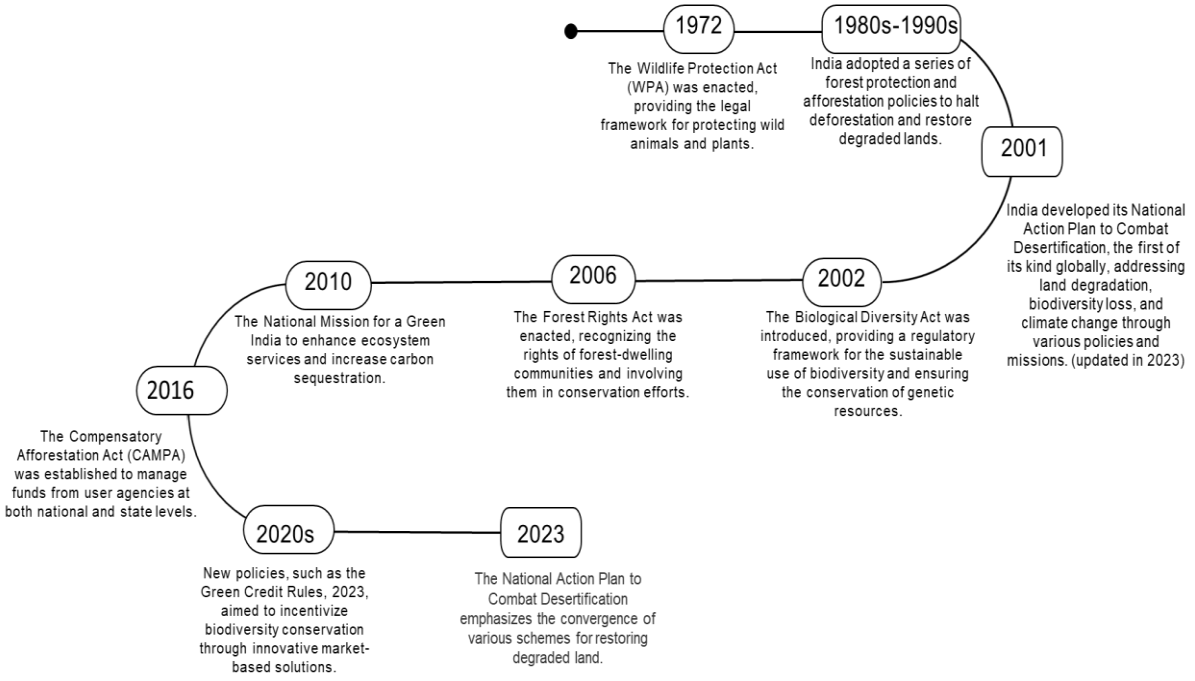
**Evolution of Biodiversity and Land Restoration Policies in India**

After gaining independence, India's efforts towards biodiversity conservation and land restoration have evolved significantly. Initially, conservation efforts focused on wildlife protection, but the scope expanded to include ecosystems, forests, wetlands, and landscapes in subsequent decades. The Constitution of India, through its Directive Principles, established the state's responsibility to protect and improve the environment and safeguard forests and wildlife. Over time, these principles have been supported by comprehensive policies and programmes, positioning India at the forefront of global conservation efforts.

**Key Legislations & Programmes**

- **The Biological Diversity Act (2002):** Focuses on conservation of biodiversity, sustainable use of its components, and equitable sharing of benefits arising from biological resources.
- **National Action Plan on Climate Change (NAPCC) (2008):** A comprehensive plan to address climate change, comprising eight missions, including the Green India Mission, which focuses on afforestation and land restoration.
- **Forest Conservation Act (1980):** Regulates deforestation and promotes the conservation of forest resources.
- **The Wildlife Protection Act (1972):** Provides a framework for wildlife protection and the creation of national parks, sanctuaries, and conservation reserves.
- **The Compensatory Afforestation Act (CAMPA) (2016)**: Established authorities at the national and state levels to manage funds from user agencies. These funds are for compensatory afforestation and related purposes under the Forest (Conservation) Act of 1980.
- **National Action Plan to Combat Desertification (2023):** Calls for synergized planning and convergence of afforestation schemes to boost eco-restoration efforts. It focuses on sustainable management of forests and natural resources, targeting vulnerable sites for effective restoration, but does not include financial assistance provisions.

**Figure 5: Key milestones of India's biodiversity and land restoration policies**




## 4.2 Institutional Framework for Biodiversity Conservation and Land Restoration in India

India's commitment to restoring 26 Mha of degraded land by 2030 under the Bonn Challenge is guided by a robust policy and legal framework, including the Constitution of India, the Environmental Protection Act (1986), the Biological Diversity Act (2002), and the Forest (Conservation) Act (1980). These policies provide a foundation for environmental protection, sustainable use of resources, and regulatory mechanisms to control land diversion and degradation. Implementation of land restoration efforts involves key institutions at various levels. At the central level, the Ministry of Environment, Forest, and Climate Change (MoEFCC) leads national initiatives such as the Green India Mission and the National Afforestation Programme (NAP).

It also coordinates international commitments like the Bonn Challenge and Land Degradation Neutrality (LDN) targets. The National Biodiversity Authority (NBA) implements the Biological Diversity Act, while the National Afforestation and Eco-Development Board (NAEB) promotes ecological restoration. Other central institutions like the Ministry of Rural Development (MoRD) and the Ministry of Agriculture and Farmers Welfare (MoAFW) support restoration through programmes like the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) for afforestation and the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) for water management.

At the state level, implementation is carried out by State Biodiversity Boards (SBBs), Forest Departments, and local institutions such as Panchayati Raj Institutions (PRIs), Joint Forest Management Committees (JFMCs), and Eco-Development Committees (EDCs). Community-based organizations like Self-Help Groups (SHGs) and NGOs play a crucial role in facilitating local participation in restoration efforts.

India's restoration strategy is implemented through various national-level programmes, including the NAP, Green India Mission, CAMPA, PMKSY, and the Integrated Watershed

Management Programme (IWMP). These programmes focus on key areas such as degraded forest lands, agricultural lands, wetlands, grasslands, and arid and semi-arid regions. Techniques such as agroforestry, assisted natural regeneration, eco-restoration, watershed management, and community-led conservation practices are employed to enhance vegetation cover, soil health, and biodiversity.

Monitoring and reporting of progress are essential components of this framework. The National Biodiversity Action Plan (NBAP) guides national priorities, while State Biodiversity Action Plans (SBAPs) address state-specific needs. Local Biodiversity Management Committees (BMCs) work with communities to document and protect biodiversity.

The Indian Space Research Organization (ISRO), through its National Remote Sensing Centre (NRSC), provides critical satellite data and GIS tools for tracking land cover changes and degradation. The Desertification and Land Degradation Atlas, developed by ISRO, helps identify vulnerable areas. ISRO employs satellite-based imagery and advanced remote sensing techniques to enhance the monitoring and management of forest resources, degraded lands, and wildlife tracking in India.

Utilizing satellites like the Indian Remote Sensing (IRS) series, ISRO captures high-resolution images for forest cover mapping, which aids in assessing deforestation rates and identifying areas of land degradation. The Forest Survey of India (FSI) conducts biennial assessments of forest cover. FSI, in collaboration with ISRO, conducts regular assessments that provide critical information for national forest policies. LiDAR (Light Detection and Ranging) technology further enhances this effort by creating detailed three-dimensional representations of forest structures, allowing for accurate measurements of tree height, canopy density, and biomass, which are essential for managing forestry resources and assessing degraded lands.

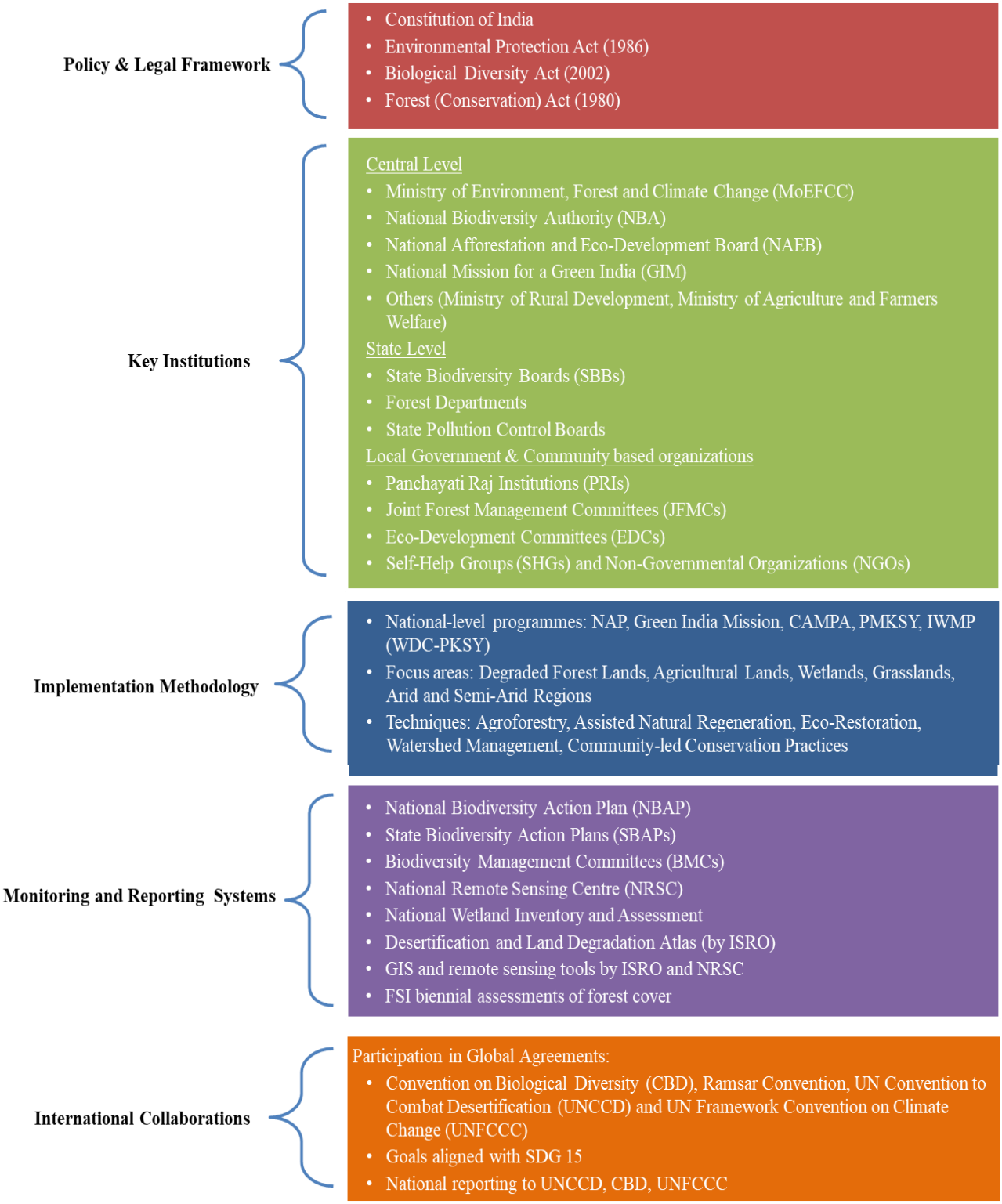
In wildlife management, ISRO employs satellite telemetry to track animal movements in real-time, aiding in understanding habitat usage and migration patterns. Geographic Information Systems (GIS) complement these efforts by mapping wildlife habitats and corridors, facilitating informed conservation decisions. Through these integrated technologies, ISRO significantly contributes to the sustainable management of natural resources and biodiversity in India.

International collaboration is a key aspect of India's restoration efforts. The country actively participates in global agreements such as the Convention on Biological Diversity (CBD), the Ramsar Convention, the UN Convention to Combat Desertification (UNCCD), and the UN Framework Convention on Climate Change (UNFCCC).

These align with national goals, particularly those related to Sustainable Development Goal 15 (SDG 15) and Land Degradation Neutrality (LDN). India reports its progress to these international bodies through mechanisms like the UNCCD, providing updates on efforts to combat desertification and restore degraded lands.

The participatory and multi-institutional approach, combined with advanced monitoring systems, ensures that India is on track to achieve its ambitious restoration targets by 2030, fostering sustainable land management and biodiversity conservation across diverse ecosystems.

**Figure 6: Institutional framework for conservation and land restoration efforts in India**



### 4.3 Financing of Biodiversity Conservation and Land Restoration Efforts in India

The financing of biodiversity conservation and land restoration efforts in India involves a combination of government funding, international support, public-private partnerships, and innovative financial mechanisms. The Indian government plays a crucial role in this landscape through its budget allocations and dedicated initiatives. For example, the Ministry of Environment, Forest and Climate Change (MoEFCC) allocated approximately ₹30.8 billion for the 2023–24 fiscal year, marking a 24% increase over the revised estimates of 2022–23. About 25% of this allocation is directed towards initiatives related to Environment, Forestry, and Wildlife, which include the Green India Mission and Project Tiger (PRS Legislative research, 2023).

A detailed Biodiversity Expenditure Review (2018) revealed that between 2012–13 and 2016–17, approximately ₹200 billion crore ($2.64 billion) per year flowed from 116 schemes across 24 ministries and 29 departments (Ansari et al., 2018). Despite these efforts, the required funds significantly exceed the available resources. A Biodiversity Financial Needs Assessment estimates that around ₹900 billion ($12 billion) annually would be needed to effectively implement the National Biodiversity Action Plan (NBAP) (Soundrapandi, 2017).

International funding complements domestic efforts. Organizations like the Global Environment Facility (GEF) have supported projects in ecologically sensitive regions like the Western Ghats and Sundarbans, while bilateral partnerships with countries such as Germany and Japan have also bolstered conservation initiatives. These collaborations are crucial for India's ambitious commitments under the Bonn Challenge. However, achieving such targets requires further financial support and cooperation from global partners.

Public-private partnerships (PPPs) have gained momentum, with corporate entities and NGOs increasingly contributing to conservation projects. Companies like ITC Limited have invested in sustainable forestry in Rajasthan, integrating their corporate social responsibility (CSR) goals with conservation. Tata Steel, among others, has adopted sustainable land management practices that align with biodiversity goals. These private-sector investments play a vital role, especially when they are integrated into broader governmental programmes such as the Mahatma Gandhi National Rural Employment Guarantee Scheme (MNREGA), which supports tree-plantation drives and other activities that benefit biodiversity and rural livelihoods.

Innovative financing mechanisms are being explored to bridge the funding gap. Payments for Ecosystem Services (PES) schemes, like those in Uttarakhand, reward communities for maintaining vital ecosystem services such as watershed management, thereby incentivizing sustainable land management.[1] Crowdfunding platforms like Ketto[2] have further enabled local conservation projects to raise funds directly from the public, supporting initiatives in regions like the Western Ghats. The green bond market in India has emerged as a significant source of sustainable finance. By 2021, India's green bond market had grown to a total of $18.9 billion, reflecting increasing interest in green investments. In February 2023, the Government of India issued its first sovereign green bonds worth ₹160 billion.[3] The "Framework for Sovereign Green Bonds" outlines criteria for what qualifies as 'Green Projects,' enabling these projects to secure funding through the issuance of green bonds and to request a share from the central government's green bond proceeds. The process for securing such funding involves the

[1] https://library.fes.de/pdf-files/bueros/indien/21166.pdf
[2] https://www.ketto.org/fundraiser/support-community-led-nature-conservation-in-northeast-india
[3] https://www.business-standard.com/opinion/columns/tiger-bonds-will-encourage-private-capital-participation-in-conservation-123041400596_1.html

MoEFCC submitting an initial evaluation report to the Green Finance Working Committee (GFWC). The GFWC then evaluates the project, after which bonds are issued, with allocation and management overseen by the Public Debt Management Cell (PDMC) of the Ministry of Finance. However, the use of green bonds to fund the restoration of degraded forests in India has not picked up yet (Ranjan, 2022).

Despite these diverse funding streams, significant challenges remain in scaling up and coordinating biodiversity finance. A 2020 study focusing on Maharashtra highlighted that biodiversity finance in India is highly fragmented, with multiple institutions directing funds without sufficient coordination or tracking mechanisms to ensure optimal use (Pandey et al., 2020).

## 4.4 Biodiversity Conservation Efforts

### Major Biodiversity Conservation Programmes

India has launched several significant biodiversity conservation programmes that have gained international recognition for their success in protecting endangered species and ecosystems, while also engaging local communities in conservation efforts. India is notably one of the 17 megadiverse countries, housing 8% of the world’s species on just 2.4% of the planet's land area.

**Flagship Conservation Projects and Initiatives**

- **Project Tiger (1973)**: India's iconic conservation initiative, aims to protect tigers as a key species for ecosystem biodiversity. The reserves use a core/buffer strategy: core areas designated as national parks or sanctuaries, and buffer zones comprising mixed-use land. The project focuses on a tiger-centric agenda within core areas while promoting a people-oriented approach in the buffers.

- **Project Elephant (1992)**: This initiative focuses on the conservation of elephants and their habitats, mitigating human–elephant conflicts.

- **Biodiversity Heritage Sites (2002)**: These sites are recognized for their rich biodiversity and receive special protection and management under the Biological Diversity Act of 2002.

**Wetland, Forest, and Coastal Ecosystem Conservation**

- **National Plan for Conservation of Aquatic Ecosystems (NPCA) (2013):** A government initiative to protect and restore wetlands, lakes, and other aquatic ecosystems.

- **National Coastal Mission (2014):** The government aims to protect, sustain, conserve, and enhance mangrove forests through a Central Sector Scheme under the National Coastal Mission Programme focused on the conservation and management of mangroves and coral reefs. Assistance is provided to coastal states and union territories for the implementation of action plans that include survey and demarcation, alternative and supplementary livelihoods, protective measures, and education and awareness activities.

- **Mangrove Initiative for Shoreline Habitats & Tangible Incomes (MISHTI) (2023):** Aims to promote and conserve mangroves as a unique natural ecosystem with high biological productivity and carbon sequestration potential, while also functioning as a bio-shield.

- **Amrit Dharohar Initiative (2023):** Focuses on conserving the unique ecological and cultural values of Ramsar Sites in India, aiming to create models that can be replicated and scaled up for other important wetlands. It emphasizes safeguarding biodiversity, supporting nature tourism and local livelihoods, and promoting sustainable wetland management to maintain ecological balance and enhance ecosystem services.

- **Protected Areas Network (1972)**: Established under the Wildlife Protection Act of 1972, this network includes national parks, wildlife sanctuaries, and marine protected areas, highlighting the need for habitat connectivity to reduce fragmentation.

**Community-led Conservation**

- **Eco-Development Committees (EDCs) (1990)**: These committees are modelled after Joint Forest Management Committees (JFMCs) for communities around Protected Areas (PAs) and nearby forested areas. Their primary goal is to protect wildlife and biodiversity while promoting eco-development activities in villages to encourage community participation in conservation.

### Achievements Under Biodiversity Conservation Initiatives

India has made significant strides in biodiversity conservation through a series of targeted initiatives. The Biological Diversity Act, 2002, plays a central role in these efforts, aiming to conserve the country's biological resources and regulate access to ensure equitable sharing of benefits. Key measures under the Act include the establishment of State Biodiversity Boards (SBBs) and Union Territory Biodiversity Councils (UTBCs) across all states and UTs, the declaration of Biodiversity Heritage Sites (BHS), and the identification of threatened species in 18 states and 2 Union Territories. Additionally, 2.77 lakh Biodiversity Management Committees (BMCs) and 2.67 lakh People's Biodiversity Registers have been established across 28 states and 7 Union Territories, further bolstering conservation efforts.[4] Project Tiger has also contributed to a 42.3% increase in the tiger population between 2014 and 2022, with the All India Tiger Estimation (2018–19) earning a Guinness World Record for being the largest camera-trap wildlife survey.[5] Efforts to conserve elephants include the development of an ATLAS of Elephant Reserves using geospatial layers, leading to a rise in the wild elephant population to 29,964 in 2017 from 27,669–27,719 in 2007. The country has notified 33 Elephant Reserves covering 8.08 Mha as key management units for these species.[6]

Community participation has been vital in India's conservation strategy, especially in the protection of Biodiversity Heritage Sites (BHS). A total of 47 BHSs have been declared, reflecting the involvement of local communities and the integration of indigenous traditional knowledge in biodiversity protection.[7] India has also expanded its network of protected areas,

[4] https://pib.gov.in/PressReleasePage.aspx?PRID=1914420
[5] https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/jul/doc2023729230301.pdf
[6] https://moef.gov.in/project-elephant-pe
[7] http://nbaindia.org/content/106/29/1/bhs.html

with 998 sites now covering 5.3% of the country's land area. To mitigate habitat fragmentation, 104 wildlife corridors have been developed, marking an 18% increase over the past decade.[8]

Wetland conservation has seen considerable progress, with a 0.64 million hectare increase in wetland area and the identification of 18,810 additional wetlands compared to earlier estimates. The country has also seen significant growth in various wetland types, such as mangroves, which have expanded by 7% since 2010, covering 0.5 Mha and offering critical coastal protection. Overall, mangrove cover in India increased by 252 km² between 2015 and 2021, while coral reef areas saw an expansion of 2,784 hectares (1.9%). The number of Ramsar sites, or Wetlands of International Importance, has grown from 26 in 2014 to 85 in 2024, covering a total area of 1.35 Mha.[9] Table 4 presents India's achievements in various biodiversity conservation initiatives and programmes.

**Table 4: India's achievements in various biodiversity conservation initiatives and programmes**

| Initiative/Programme | Achievement |
|---|---|
| Project Tiger | - 42.3% increase in tiger population (2014–2022)<br>- Guinness World Record for the largest camera-trap wildlife survey (All India Tiger Estimation 2018–19) |
| Project Elephant | - Development of an ATLAS of Elephant Reserves<br>- Wild elephant population increased from 27,669–27,719 in 2007 to 29,964 in 2017<br>- 33 Elephant Reserves notified, covering 8.08 Mha |
| Biological Diversity Act, 2002 | - Establishment of State Biodiversity Boards and Union Territory Biodiversity Councils across all states and UTs<br>- 47 biodiversity heritage Sites (BHSs) declared, involving local communities and integrating indigenous knowledge in biodiversity protection<br>- 2.77 lakh Biodiversity Management Committees (BMCs) established |
| Amrit Dharohar Initiative | - Focus on Ramsar Sites to conserve ecological and cultural values, support nature tourism, and enhance sustainable wetland management |
| Protected Areas Network | - Expanded network of protected areas to 998 sites covering 5.3% of the country's land area<br>- 104 wildlife corridors developed, marking an 18% increase over the past decade to mitigate habitat fragmentation |
| Eco-Development Committees (EDCs) | - Approximately 2,000 functioning EDCs established, engaging local communities in natural resource management and enhancing grassroots biodiversity conservation efforts |
| Wetland Conservation | - Increase of 0.64 Mha in wetland area, with 18,810 additional wetlands identified<br>- Mangrove cover expanded by 7% since 2010 (0.5 Mha)<br>- Coral reef areas expanded by 2,784 hectares (1.9%) |
| Ramsar Sites | The number of Ramsar sites increased from 26 in 2014 to 85 in 2024, covering a total area of 1.35 Mha |

[8] https://pib.gov.in/PressReleasePage.aspx?PRID=1914420
[9] https://moef.gov.in/uploads/2022/02/wetland_atlas_LISS3_final-SAC.pdf

Moreover, India's focus on community-led conservation initiatives has been reinforced through the establishment of approximately 2,000 functioning Eco-Development Committees (EDCs). These committees engage local communities in the management and protection of natural resources, thereby enhancing grassroots biodiversity conservation efforts. These achievements underscore India's commitment to preserving its rich natural heritage through a balanced approach that integrates policy implementation, community engagement, and strategic conservation measures.

### 4.5 Land Restoration Efforts

India has made significant progress in land restoration, especially through afforestation programmes and efforts to combat desertification and land degradation. As part of its global restoration commitments, India has pledged to restore 26 Mha of degraded land by 2030 under the Bonn Challenge.

#### Key Land Restoration Initiatives

India has embarked on various initiatives to restore degraded lands, increase forest cover, and combat desertification.

**National Afforestation Programme (NAP) (2001):** Managed by the National Afforestation & Eco-Development Board (NAEB), this programme implemented since 2001 and now merged into Green India Mission (GIM) focuses on promoting afforestation initiatives, particularly in degraded forest areas. The programme prioritizes the involvement of local communities and encourages eco-restoration activities. A key objective of NAP is to enhance and expedite the ongoing process of delegating forest conservation, protection, management, and development responsibilities to Joint Forest Management Committees (JFMCs) at the village level, which operate as registered societies. The scheme is executed through a three-tier institutional framework, which includes the State Forest Development Agency (SFDA) at the state level, the Forest Development Agency (FDA) at the forest division level, and the JFMCs at the village level.

**Green India Mission (GIM) (2015):** Part of the National Action Plan on Climate Change (NAPCC), the National Mission for a Green India aims to restore degraded ecosystems and increase forest cover through afforestation and reforestation. It promotes ecosystem services such as carbon sequestration, water regulation, and biodiversity conservation.

**Compensatory Afforestation Fund Management and Planning Authority (CAMPA):** Established under the Compensatory Afforestation Act (2016), CAMPA manages funds generated from compensatory afforestation, and afforestation projects undertaken to compensate for forest land diverted for non-forest purposes. These funds are crucial for restoring ecosystems and enhancing forest cover.

**Green Credit Rules (2023):** Introduced as part of the broader green growth strategy, these rules provide financial incentives for entities involved in biodiversity conservation, tree plantation, and ecosystem restoration projects. The aim is to create a voluntary market for green credits, where industries can offset their environmental impacts.

**Devolution of Resources for Forest and Ecosystem Protection:** In addition to specific afforestation programmes like the NAP, financial support for forest and ecosystem protection is provided through a unique initiative under the devolution of resources by the Finance Commissions of India. The Finance Commissions allocate a portion of total funds to states,

with 10% of these resources linked to the achievement of environmental goals, particularly the protection and expansion of forest cover. By linking financial resources to forest cover and environmental outcomes, this initiative fosters greater accountability and incentivizes states to integrate ecological sustainability into their planning and development processes. This approach supports India's broader goals of biodiversity conservation, carbon sequestration, and achieving commitments under international frameworks like the UNFCCC and the Convention on Biological Diversity (CBD).

### Other Initiatives

India is promoting natural and organic farming methods and has implemented several pivotal programmes to support sustainable agriculture and climate adaptation. These initiatives aim to ensure long-term food security and environmental conservation. Additionally, they complement various state-level efforts that foster sustainable agricultural practices.

**Integrated Watershed Management Programme (IWMP) (2010)**: This programme (amalgamated as the Watershed Development Component of Pradhan Mantri Krishi Sinchayee Yojana (WDC-PMKSY) in 2015–16), aims to enhance the productive potential of rainfed and degraded land through integrated watershed management. It seeks to strengthen community-based local institutions to promote livelihoods and ensure the sustainability of watersheds.

**National Project on Organic Farming (NPOF):** This project was launched in 2004 to promote organic farming by increasing the availability of organic inputs, such as bio-fertilizers and bio-pesticides. The project also aimed to reduce the use of chemical fertilizers and pesticides.

**Paramparagat Krishi Vikas Yojana (PKVY):** This programme has been in place since 2015–16 and provides financial assistance to farmers to promote organic farming.

**Soil Health Card:** Initiated in 2015, this programme by the Government of India monitors soil fertility nationwide. It offers crop-specific fertilizer recommendations based on twelve parameters, helping farmers improve productivity and maintain soil health.

**National Mission on Natural Farming (NMNF):** Launched in 2023–24, the scheme focuses on the adoption of chemical-free, eco-friendly agricultural practices by farmers to restore soil health, improve soil biodiversity, enhance water retention, and increase crop resilience, particularly in rain-fed areas.

**PM Programme for Restoration, Awareness, Nourishment, and Amelioration of Mother Earth (PM-PRANAM):** Launched in 2023–24, this scheme promotes balanced fertilizer use alongside organic and biofertilizers based on soil tests, enhancing fertility, reducing pollution, and supporting long-term agricultural productivity.

### Achievements Under Land Restoration Initiatives

India has made significant advancements in land restoration through various national initiatives and programmes. The Government of India has launched multiple schemes to combat desertification, including afforestation efforts.

Between the Indian State of Forest Report (ISFR) 2017 and ISFR 2021, the country witnessed an increase in forest cover of 0.55 Mha. From 2015–16 to 2021–22, the Government of India, based on submissions from 17 States, set a target to increase tree and forest cover by 53,377 hectares and improve the quality of degraded forests by 166,656 hectares. As of December 2022, tree and forest cover had increased by 26,287 hectares, and the quality of forests had

improved over 102,096 hectares across these 17 states.[10] The country's tree cover (small patches outside the forest) is estimated at 9.57 Mha accounting for 2.91% of its total geographical area. Compared to the 2019 assessment, there has been an increase of 0.07 Mha in tree cover.

The MoEFCC also launched the Nagar Van Yojana, aiming to develop 600 urban forests (Nagar Vans) and 400 urban gardens (Nagar Vatika) between 2020–21 and 2026–27 to enhance green cover in urban and peri-urban areas while supporting local biodiversity. Various other afforestation efforts are carried out under programmes such as the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), the National Bamboo Mission, and the Sub-Mission on Agroforestry, as well as through state government initiatives and partnerships with NGOs, civil societies, and corporate bodies. These multi-departmental and collaborative efforts have significantly contributed to conserving and expanding forest cover across India.

India is committed to global restoration efforts, as demonstrated by the Bonn Challenge, in which the country pledged to restore 26 Mha by the year 2030. So far, India has restored 9.8 Mha from 2011 to 2017, achieving significant progress across several states.[11] Additionally, the Desertification and Land Degradation Atlas, developed by ISRO, has identified that 30% of India's land is either degraded or desertified, helping target key areas for intervention.

Community-driven restoration is a core aspect of the **watershed development programmes.** Evaluation reports of the WDC-PMKSY show significant improvements in surface and groundwater availability, productivity, vegetative cover, and household incomes in project areas. From 2021 to 2026, the target is 4.9 Mha. Since 2014–15, 0.7 million water harvesting structures have been created or rejuvenated, and 1.5 Mha have been brought under protective irrigation by 2020–21.[12]

Sustainable land management practices are further supported by the **Soil Health Management Scheme**, which has issued over 25 million soil health cards to farmers. Additionally, the **National Agroforestry Policy** promotes agroforestry across 10 Mha. contributing to biodiversity enhancement and soil health restoration.

The **National Mission on Natural Farming (NMNF)** to restore soil health and enhance farm resilience has covered 1 Mha across 16 states in the country.[13] Success stories from pilot regions like Gujarat, Maharashtra, and Andhra Pradesh, where natural farming has shown a potential increase in farmers' incomes by 25–50%. Under **Paramparagat Krishi Vikas Yojana (PKVY)**, 38,043 clusters, each covering 20 hectares, have been established, collectively encompassing an area of 0.84 Mha[14] and a target of 0.6 Mha has been set for coverage during 2023–2026.[15] As per the 2024 FiBL and IFOAM statistics, India ranks among the top countries in organic agricultural land, covering 4.7 Mha. It also accounts for 55% of

[10] https://www.thehindu.com/sci-tech/energy-and-environment/states-come-up-short-in-targets-to-plant-trees-improve-forest-cover/article66436049.ece
[11] https://www.bonnchallenge.org/pledges/india
[12] https://pib.gov.in/PressReleasePage.aspx?PRID=1696246
[13] https://naturalfarming.niti.gov.in/
[14] https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=152048&ModuleId=3&reg=3&lang=1
[15] https://agriwelfare.gov.in/Documents/New_component_of_PKVY_Scheme_implementing_PUB_1April2023.pdf

the world's organic producers, with 2.5 million farmers, and includes states like Sikkim, which became fully organic in 2016 (Willer et al., 2024).

While challenges remain in scaling these efforts, the government's policies, backed by state-led programmes and scientific support, signal a strong movement towards soil health restoration and sustainable agricultural practices across India.

India’s land restoration efforts emphasize community involvement, targeted restoration goals aligned with global commitments, and effective monitoring through satellite and GIS data. These programmes collectively contribute to restoring degraded lands, enhancing ecosystem services, and building resilience across the country's landscapes. Table 5 shows India’s achievements in various land restoration initiatives and programmes.

**Table 5: India's achievements in various land restoration initiatives and programmes**

| Initiative/Programme | Achievement |
|---|---|
| Afforestation initiatives | - 0.55 Mha increase in forest cover between 2017 and 2021<br>- From 17 states, there was an increase of 26,287 hectares and an improvement in forest quality over 102,096 hectares between 2015/16 and 2021/22, compared to targets of 53,377 hectares and 166,656 hectares, respectively<br>- 0.07 Mha increase in tree cover outside of forest since 2019 |
| Bonn Challenge Commitment | - India pledged to restore 26 Mha and has restored 9.8 Mha from 2011 to 2017, with ongoing efforts |
| Desertification and Land Degradation Atlas | - Atlas developed by ISRO to target areas for land restoration interventions<br>- 30% of land identified as degraded or desertified |
| Nagar Van Yojana | - 600 urban forests and 400 urban gardens planned<br>- Significant progress in several states on degraded lands |
| National Agroforestry Policy | - Promotes agroforestry practices on 10 Mha to support biodiversity and soil health restoration |
| Green Credit Rules (2023) | - Established voluntary market for green credits<br>- Incentivized biodiversity conservation, tree plantation, and ecosystem restoration |
| Integrated Watershed Management Programme (IWMP) (now part of WDC-PMKSY) | - Restored over 6 Mha of degraded land since inception<br>- Significant improvements in water availability, productivity, and household incomes in project areas |
| Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) | - Enhanced irrigation facilities for the restoration of degraded agricultural land<br>- Achieved water conservation across over 2 Mha |
| Paramparagat Krishi Vikas Yojana (PKVY) | - Promoting organic farming with financial support to farmers<br>- Established 38,043 clusters, each covering 20 hectares, totalling 0.84 Mha |

| | |
|---|---|
| | - Aims to cover an additional 0.6 Mha during 2023–2026 |
| Soil Health Management Scheme | - Issued over 25 million soil health cards to farmers<br>- Promoted sustainable land management practices and improved productivity |
| National Mission on Natural Farming (NMNF) | - Focuses on chemical-free, eco-friendly practices across 1 Mha<br>- Enhanced soil biodiversity and crop resilience, especially in rain-fed areas |
| PM-PRANAM (2023–24) | - Promotes balanced fertilizer use, enhancing soil fertility and reducing pollution<br>- Supports long-term agricultural productivity |

### 4.6 Success Stories

**Kaziranga National Park – A Success in Rhino Conservation:** Kaziranga National Park, located in Assam, is home to the largest population of the Indian one-horned rhinoceros. Effective anti-poaching strategies and habitat management have increased the park's rhino population to over **2,600 individuals**, making it a global success story in species conservation.

**Community Forest Management in Odisha:** The State Government of Odisha recognized the importance of community involvement in forest conservation and became the first in India to introduce the **Joint Forest Management (JFM)** policy in August 1988, even before the National Forest Policy came into effect later that year. This initiative aimed to engage local communities in protecting nearby forests by assigning them specific roles and offering benefits, such as access to firewood and small timber under the Odisha Forest Act, 1972. The JFM policy also focused on promoting employment and social empowerment for those living near forest areas. The success of community-led initiatives has resulted in the protection of vast tracts of forest lands, restoration of biodiversity, and sustainable livelihoods for the local population.

**Mangrove Restoration in Sundarbans:** The Sundarbans mangrove forest in West Bengal, the largest in the world, has undergone important community-driven restoration efforts in the past decade. Studies show a loss of about 107 km² of mangrove area between 1975 and 2013 due to erosion and human activities. Supported by government and non-governmental organizations, these initiatives have successfully recovered mangrove cover and reduced coastal vulnerability. National policies, such as the **National Conservation Strategy (1992)** and the **National Environmental Policy (2006)**, emphasize sustainable management and community engagement, fostering collaboration among stakeholders to enhance coastal livelihoods and ecological health, ultimately empowering local communities in the Sundarbans.

**Kerala Ecorestoration Policy, 2021:** The policy marks a significant step towards large-scale ecological restoration by focusing on the transition from monoculture plantations to more diverse, resilient ecosystems. The policy aims to restore vast areas of degraded land, particularly those dominated by monoculture crops like rubber, tea, and eucalyptus, which have contributed to biodiversity loss, soil degradation, and water scarcity (to be implemented in an area of about 27,000 hectares). By promoting mixed-species plantations and agroforestry systems, the policy seeks to enhance biodiversity, improve soil health, and increase carbon sequestration. Furthermore, it incorporates community participation, integrating traditional knowledge and sustainable livelihoods, to ensure long-term success in restoring the ecological

balance. This initiative aligns with Kerala's broader efforts to combat climate change, preserve biodiversity, and promote sustainable land-use practices across the state.

**Role of Indigenous Communities and Traditional Knowledge:** Indigenous communities, such as the Gond and Bhil tribes, have played an essential role in conserving biodiversity through their traditional knowledge of forest management. Programmes like **Eco-Development Committees (EDCs)**, involving these communities, have not only resulted in better conservation outcomes but also provided economic incentives through eco-tourism and sustainable forest resource management.

**Andhra Pradesh Community-Managed Natural Farming (APCNF):** APCNF is the world's largest agroecology programme, reaching over a million smallholder farmers, mostly women, across 500,000 hectares. It focuses on regenerative agriculture, promoting bio-stimulants, cover crops, and minimal tillage to enhance soil health and conserve biodiversity. The programme aims to convert 6 million farmers to natural farming by 2027, reducing input costs by 20–40% and increasing resilience to climate variability.[16]

These conservation initiatives in India have yielded notable successes (Table 6). Kaziranga National Park's anti-poaching efforts since 2016 have resulted in an 86% reduction in rhino poaching, boosting the rhino population to over 2,850 in Assam by 2022.[17] In Odisha, community forest management covers around 14,000 square kilometres, enhancing forest cover and livelihoods.[18] The Sundarbans has seen significant community involvement in mangrove restoration projects, including the Sundari Project, which planted 600,000 trees and engaged 450 families while protecting 1,434 species of fauna; the State Department of Forests, which successfully planted 123.77 million mangroves by March 2022 with funding from the West Bengal government and the MGNREGS, involving thousands of locals; and the Livelihoods-NEWS project, which restored 5,011 hectares of mangroves, resulting in increased populations of fish, birds, and crustaceans in the region. Kerala's eco-restoration policy has transformed 2,000 hectares of monoculture into diverse ecosystems.[19] Meanwhile, Andhra Pradesh's natural farming initiative has reached 600,000 farmers, aiming to expand sustainable practices across 6 Mha by 2027.

India's approach to biodiversity conservation and land restoration is characterized by a holistic strategy that integrates ecological preservation with socio-economic priorities. Through a combination of legislative measures, targeted programmes, and active community involvement, India is making notable progress in achieving its environmental goals. However, challenges like desertification, climate change, and habitat degradation continue to pose significant hurdles.

[16] https://apcnf.in/
[17] https://ebnw.net/empowerment/success-story/kaziranga-achieves-86-drop-in-rhino-poaching-since-2016-a-conservation-success-story/
[18] https://www.odishaforest.in/admin/data/documents/publication_file_560907019.pdf
[19] https://climatechange.envt.kerala.gov.in/wp-content/uploads/2024/05/EcorestorationPolicy_2021_English.pdf

**Table 6: Key conservation and restoration successes: case studies from India**

| Initiative | Key Focus Areas | Achievement |
|---|---|---|
| **Kaziranga National Park** | Anti-poaching and habitat management | Rhinos population increased to over 2,600; 86% reduction in rhino poaching since 2016, with numbers rising to over 2,850 by 2022 |
| **Community Forest Management in Odisha** | Community involvement in forest conservation | Covers approximately 14,000 square kilometres; promotes sustainable livelihoods and biodiversity restoration |
| **Mangrove Restoration in Sundarbans** | Community-driven restoration and ecological health | Restoration of 5,011 hectares; Sundari Project planted 600,000 trees involving 450 families; State Department planted 123.77 million mangroves |
| **Kerala Ecorestoration Policy, 2021** | Transition from monoculture to diverse ecosystems | Aims to restore 27,000 hectares; successfully transformed 2,000 hectares of monoculture plantations into diverse ecosystems |
| **Role of Indigenous Communities** | Integration of traditional knowledge in conservation efforts | Participation in Eco-Development Committees (EDCs) leads to better conservation outcomes and economic incentives through eco-tourism |
| **Andhra Pradesh Community-Managed Natural Farming** | Regenerative agriculture and sustainable farming practices | Reached over 1 million smallholder farmers; aims to convert 6 million farmers to natural farming by 2027, impacting 500,000 hectares |

The country's successes underscore the importance of engaging local communities, leveraging traditional knowledge, and implementing innovative policy frameworks to enable large-scale conservation and restoration. Under the Biological Diversity Act of 2002, the creation of 2.77 lakh Biodiversity Management Committees (BMCs) and 2.67 lakh People's Biodiversity Registers has greatly strengthened grassroots conservation efforts. Key initiatives like Project Tiger have contributed to a 42.3% rise in the tiger population between 2014 and 2022, reflecting effective wildlife management. Additionally, the establishment of 33 Elephant Reserves spanning 8.08 million hectares further underscores India's dedication to protecting its vital species.

India reported a 0.55 Mha increase in forest cover between the ISFR 2017 and ISFR 2021 reports as part of land restoration efforts. From 2015–16 to 2021–22, the government aimed to enhance tree cover by 53,377 hectares and improve the quality of degraded forests by 166,656 hectares; the achieved increases were 26,287 hectares in tree cover and 102,096 hectares in forest quality. India has significantly advanced environmental restoration, establishing 9.57 Mha of tree cover and restoring 9.8 Mha of degraded land between 2011 and 2017 as part of the Bonn Challenge.

From increasing forest cover to wildlife conservation and wetland restoration, India has made remarkable progress towards achieving its environmental goals. However, challenges remain in reaching the Kunming-Montreal Global Biodiversity Framework (GBF) targets, particularly in forest cover and restoring degraded land. As India continues its journey towards sustainable development, its commitment to biodiversity and land restoration will remain crucial in mitigating climate change and protecting its rich natural heritage.

**Box 1: Key Highlights of India's Achievements in Biodiversity & Land Restoration**

**Megadiversity Ranking**: India ranks 12th among the world's 17 megadiverse countries, housing about 8% of the global species diversity.

**Species Diversity**: Home to approximately 45,000 plant and 91,000 animal species, despite covering only 2.4% of the world's land area.

**Forest Cover**: Total forest cover stands at 21.71% of India's geographical area, with a target to reach 30% as per the Kunming Montreal GBDF.

**Biodiversity Hotspots**: Contains 4 out of 36 global biodiversity hotspots, which host over 30% of the country's plant and animal species.

**Biosphere Reserves**: India has 18 Biosphere Reserves covering about 5% of the total land area, with 12 included in UNESCO's World Network.

**Forest Growth**: Forest and tree cover has consistently increased, with 21,000 sq. km added in the last decade, reflecting a growth rate of 2.91%.

**Tiger Population**: Achieved a 42.3% increase in the tiger population from 2014 to 2022.

**Wildlife Corridors**: Developed 104 wildlife corridors to mitigate habitat fragmentation, marking an 18% increase over the last decade.

**Mangrove Restoration**: Expanded mangrove cover to 4,992 sq. km, indicating a significant increase of 7% (or 4662 sq. km) since 2010.

**Marine Protected Areas**: 1.07% of India's Exclusive Economic Zone (EEZ) is designated as Marine Protected Areas (MPAs), representing a 114% increase over the past decade.

**Protected Areas**: Established 998 protected areas, covering 5.3% of the total land area.

**Restoration Initiatives**: 19 Mha (73%) of the 26 Mha target under the Bonn Challenge have already been restored.

**Ramsar Sites**: Increased Ramsar sites from 26 in 2014 to 85, covering 1.3 Mha of wetlands.

**Community Involvement**: A total of 47 BHSs have been declared, showcasing local community involvement and indigenous knowledge in biodiversity protection. Functioning 2,000 Eco-Development Committees (EDCs) for community-led conservation, showing a 300% increase in numbers over the last decade. 18,000 Joint Forest Management Committees (JFMC) managing 22 Mha of degraded forestlands.

## 5. Biodiversity and Land Restoration in Developed Countries

### 5.1 Overview of Policies and Legal Frameworks

**Key Policies and International Commitments:** Developed countries have a strong legal and policy framework aimed at addressing biodiversity loss and promoting land restoration. These frameworks are aligned with global conventions like the Convention on Biological Diversity (CBD) and the Paris Agreement, committing to both conservation and ecosystem restoration.

- **European Union Biodiversity Strategy 2030**: This is part of the European Green Deal and aims to protect 30% of EU land and sea areas by 2030. It focuses on halting biodiversity loss and reversing ecosystem degradation through the creation of legally binding restoration targets.

- **US Endangered Species Act (ESA)**: Enacted in 1973, this law provides for the conservation of species that are endangered or threatened and their ecosystems. It plays a key role in preventing extinction and promoting the recovery of listed species, safeguarding vital habitats.

- **Australia's Environment Protection and Biodiversity Conservation (EPBC) Act (1999)**: The EPBC Act serves as Australia's central environmental legislation, managing the protection of nationally significant flora, fauna, and ecosystems. It is a critical tool for biodiversity conservation and land restoration, integrating sustainable land management.

Additionally, many developed nations are parties to the Bonn Challenge and the UN Decade on Ecosystem Restoration 2021–2030, emphasizing large-scale restoration activities.

### 5.2 Major Conservation and Restoration Programmes in Developed Countries

#### European Union

- **Natura 2000 Network**: This is the largest coordinated network of protected areas in the world, covering more than 18% of EU land and nearly 9% of its marine environment. It is the backbone of EU biodiversity conservation efforts, ensuring that ecosystems and their services are maintained.

- **LIFE Program**: An EU funding instrument for the environment and climate action, the LIFE programme has supported over 5,400 projects since its inception in 1992. It focuses on biodiversity conservation, climate change adaptation, and environmental governance.

#### North America

- **Canada's National Greening Program (NGP)**: Run by Tree Canada, this programme focuses on reforestation and afforestation across the country. It aims to increase forest cover and contribute to biodiversity conservation by restoring degraded lands.

- **US Conservation Reserve Program (CRP)**: Administered by the USDA, the CRP pays farmers to remove environmentally sensitive land from agricultural production and plant species that improve environmental quality. This has helped restore millions of acres of wetlands, grasslands, and forests in the US.

#### Other Regions

- **Australia's Bushcare Program**: A large-scale conservation initiative focusing on the rehabilitation of degraded landscapes through community engagement and government

funding. It is part of Australia's broader National Landcare Program, which integrates biodiversity conservation and sustainable land management.

### Large-Scale Restoration Projects

- **The Great Green Wall Initiative (EU-Inspired)**: While the original Great Green Wall initiative focuses on Africa, several EU projects mirror this approach, targeting the restoration of degraded landscapes in Southern and Eastern Europe, especially in combating desertification.

- **Australia's 20 Million Trees Program**: Part of the EPBC Act, this programme aims to plant 20 million native trees and vegetation to restore habitats for threatened species. The goal is to rehabilitate ecosystems and improve biodiversity.

## 5.3 Technological and Financial Investments

### Advanced Technology in Biodiversity Monitoring and Restoration

- **Remote Sensing and Geographic Information Systems (GIS)**: Satellite data, drones, and GIS are widely used in developed countries to monitor land degradation, forest cover, and biodiversity. These technologies provide real-time data and help identify areas for restoration.

- **AI and Machine Learning**: Advanced AI tools are increasingly applied to identify species, track animal populations, and monitor ecosystem health. In the US, the use of machine learning models to predict species migration patterns and habitat suitability is gaining traction.

- **DNA Barcoding and Environmental DNA (eDNA)**: This emerging technology is used to monitor species presence through genetic material found in soil and water, providing a non-invasive method for biodiversity monitoring.

### Financial Investments and Funding Mechanisms

- **Public Funds and Grants**: Developed countries invest heavily in biodiversity through public funds. For instance, the EU's LIFE program alone has allocated billions of euros to biodiversity projects. The European Investment Bank also funds restoration projects under the Natural Capital Financing Facility (NCFF).

- **Green Bonds**: Many developed countries are using green bonds as a tool for financing biodiversity and land restoration efforts. For example, France issued a green bond in 2017 that raised over €7 billion for environmental projects, including biodiversity conservation.

- **Private Sector and Public-Private Partnerships (PPP)**: Companies in sectors like agriculture, forestry, and energy are increasingly involved in financing biodiversity restoration projects. The involvement of private enterprises through PPPs has helped mobilize significant funds for these initiatives, particularly in reforestation efforts.

## 5.4 Success Stories and Case Studies

### Biodiversity and Restoration

- **Yellowstone Ecosystem Restoration (US)**: One of the most famous biodiversity restoration projects globally, Yellowstone National Park's reintroduction of wolves in the 1990s led to a trophic cascade that revitalized ecosystems, balancing species populations and restoring vegetation.

- **The Netherlands' Oostvaardersplassen**: A prime example of a rewilding project in Europe, this area was transformed from reclaimed land into a thriving nature reserve. Large herbivores were introduced to manage vegetation naturally, leading to a restored ecosystem with diverse flora and fauna.

- **Costa Rica's Reforestation Program**: While Costa Rica is often classified as a developing nation, its reforestation initiatives funded by eco-tourism and international investments provide a model for developed countries. The programme reversed decades of deforestation, achieving one of the highest forest cover recoveries globally.

### Citizen Science and Public-Private Partnerships

- **iNaturalist and Citizen Science Initiatives**: In developed countries, citizen science has significantly contributed to biodiversity monitoring and restoration efforts. Platforms like *iNaturalist* have enabled the public to participate in species identification and habitat restoration, improving the scale and quality of data collected.

- **UK's National Trust and Private Sector Collaboration**: The National Trust's partnerships with private companies, such as the Sainsbury's Forest Partnership, have resulted in large-scale restoration projects. The collaboration integrates private sector resources and expertise with conservation goals, leading to successful restoration efforts.

Developed countries are working on biodiversity conservation and land restoration through strong legal frameworks, innovative technological applications, significant financial investments, and successful public-private partnerships. While challenges remain, their policies and programmes provide crucial lessons for global efforts to restore ecosystems and protect biodiversity.

## 6. Comparative Analysis of India's Initiatives vis-à-vis Developed Countries

### 6.1 Policy and Governance

### Comparison of Policy Frameworks and Governance Structures

India's biodiversity and land restoration efforts are governed by key policies such as the Wildlife Protection Act (1972), Biological Diversity Act (2002), National Forest Policy (1988), National Action Plan on Climate Change (NAPCC), and the National Afforestation Programme. India's participation in international conventions like the Convention on Biological Diversity (CBD) and the Bonn Challenge further solidifies its policy commitments. Governance involves both the central and state governments, with oversight by bodies like the National Biodiversity Authority and State Biodiversity Boards. India also integrates biodiversity and ecosystem services in its National Action Plan for Conservation of Migratory Species and Green India Mission. The statutory frameworks of developed countries often differ from India's in their scope, comprehensiveness, and implementation mechanisms. For instance, the US has the Endangered Species Act, which provides detailed procedures for the conservation of threatened and endangered species, along with stringent penalties for non-compliance. Similarly, the EU's Biodiversity Strategy 2030 includes ambitious targets for restoring ecosystems and addressing biodiversity loss across member states, while Australia's Environment Protection and Biodiversity Conservation (EPBC) Act establishes a robust framework for environmental protection, including specific guidelines for managing impacts on biodiversity.

Developed countries have typically benefitted from longer-standing legal and institutional frameworks that enable more comprehensive policy integration across various sectors, including agriculture, forestry, and urban planning. This has resulted in more cohesive and effective conservation strategies, such as the EU's Natura 2000 network, which facilitates collaboration among member states to achieve biodiversity goals.

While India is making significant strides in biodiversity and land restoration, its efforts are relatively recent and face challenges in comprehensive policy integration and enforcement. In this context, India needs to strengthen its legal frameworks and governance structures to enhance the efficiency of its biodiversity conservation and restoration efforts.

### Analysis of Regulatory Enforcement and Policy Implementation

India's progress in biodiversity conservation, while commendable, faces significant challenges, particularly in regulatory enforcement, land ownership disputes, and illegal deforestation. Despite efforts to promote decentralization, inconsistencies in policy execution across states remain a major hurdle. Overlapping jurisdictions, bureaucratic delays, and inadequate monitoring mechanisms hinder effective implementation of conservation laws. For instance, laws such as the Wildlife Protection Act (1972) and Biological Diversity Act (2002) lack consistent enforcement, as political will, administrative capacity, and resource allocation differ widely among states. Additionally, the land tenure system in India, characterized by a variety of ownership models, often leads to disputes regarding rights and responsibilities related to land use and conservation. The absence of clear legal definitions regarding community rights over land exacerbates tensions between conservation efforts and local livelihoods. Monitoring illegal logging is also a challenge, as remote forest areas are difficult to patrol, and insufficient resources contribute to the persistence of illegal activities.

In comparison, developed countries exhibit more target-based regulatory frameworks; for example, the US Conservation Reserve Program (CRP) offers financial incentives to landowners for conservation, supported by clear legal mandates. Programmes like Australia’s Bushcare Program effectively engage local communities in conservation efforts on public or private bushland, ensuring accountability and transparency. India must address these regulatory gaps to enhance its biodiversity conservation initiatives by strengthening enforcement mechanisms, clarifying land ownership rights, improving monitoring capabilities, fostering community participation in decision-making, and performance-based or ecosystem-based payments. Implementing these changes will require a concerted effort from central and state governments and collaboration with local communities and stakeholders.

## 6.2 Scale, Scope, and Impacts of Initiatives

### 6.2.1 Scale of Biodiversity Conservation and Land Restoration Efforts

India’s conservation and restoration efforts are large-scale, considering its vast landmass and biodiversity hotspots. Initiatives like the Green India Mission and Compensatory Afforestation Fund aim to restore millions of hectares of degraded land. India is also involved in global programmes like the Bonn Challenge, committing to restore 26 Mha by 2030.

Developed countries operate at a similarly large scale but often focus on intensive restoration projects over smaller areas. The EU’s LIFE Program and the US’s Conservation Reserve Program are prime examples, with restoration efforts covering hundreds of thousands of hectares. The scale in developed countries tends to be more concentrated, with advanced technology enabling precise monitoring.

### 6.2.2 Scope in Terms of Ecosystems and Species Targeted

India's efforts cover a broad range of ecosystems, including forests, wetlands, grasslands, and coastal areas. Projects like Project Tiger and Project Elephant focus on key species, while the National Action Plan for Climate Change targets ecosystem-based adaptation across the country.

In developed countries, the scope often targets specific ecosystems (e.g., forests in Canada or wetlands in the US) or keystone species (e.g., wolves in Yellowstone). EU countries focus heavily on marine ecosystems and coastal areas, while Australia's programmes emphasize drylands and bush ecosystems.

### 6.2.3 Impacts of Initiatives on Conservation and Restoration

India's restoration initiatives have had mixed impacts. Large-scale afforestation projects have improved forest cover, but monoculture plantations often provide limited biodiversity benefits. Conservation initiatives for tigers, elephants, and rhinos have been successful in stabilizing populations, but the degradation of other ecosystems, such as grasslands and wetlands, continues to be a concern.

The impacts in developed countries have been more measurable due to advanced monitoring and reward to communities. Rewilding efforts in the EU and North America have successfully restored ecosystems and species populations, such as the reintroduction of wolves in the US or forest restoration in the UK. Conservation projects often emphasize ecosystem services, such as carbon sequestration, flood mitigation, and soil health.

## 6.3 Technological Innovations Used in Conservation and Restoration

India increasingly relies on technology such as GIS mapping, remote sensing, and drones for biodiversity monitoring. Platforms like the Indian Biodiversity Information System (IBIS) are improving data collection on species and habitats. However, the use of cutting-edge technologies such as artificial intelligence (AI) and environmental DNA (eDNA) is still limited compared to developed countries.

Developed nations employ more advanced technologies for biodiversity conservation. The use of AI, machine learning, eDNA, and precision conservation tools is common. The US, EU, and Australia extensively utilize remote sensing, drones, and AI models to monitor species, predict land degradation, and optimize restoration practices.

## 6.4 Financial Resources

Financing of biodiversity conservation and land restoration in India and developed countries is shaped by economic capacities and institutional frameworks. In India, public funding through national and state budgets forms the backbone of conservation efforts, supporting programmes like the National Mission for Green India and the National Afforestation Programme. However, funding gaps often limit the reach of these initiatives. Developed countries, such as those in the EU and North America, allocate more substantial public resources, with strategies like the EU Biodiversity Strategy and the US Conservation Reserve Program (CRP) and the Land and Water Conservation Fund (LWCF) provide significant funding, as well as broader agricultural policies that integrate environmental funding.

International and multilateral funds like the Global Environment Facility (GEF) and the Green Climate Fund (GCF) support many large-scale projects for biodiversity protection and land restoration, though navigating access to these resources can be challenging. REDD+ (Reducing Emissions from Deforestation and Forest Degradation) funds set up by some of the developed

countries have also played a role. However, compared to India, developing countries in the Global South, such as Indonesia, Latin American countries, and those in Africa, have benefited from more international funds for REDD+ initiatives.

Private sector engagement is growing in India through public-private partnerships (PPPs) and corporate social responsibility (CSR) initiatives, though the scale remains limited. Market-based tools like biodiversity offsets and payments for ecosystem services (PES) are in their early stages. In contrast, developed countries have established mechanisms like carbon credits, conservation banks, and the EU's eco-schemes that align private investment with conservation goals.

Innovative financing is being explored in both contexts, but developed countries have a more mature ecosystem. The EU's green bond market and the US's environmental impact bonds provide scalable ways to fund conservation. India is experimenting with green bonds and blended finance models, though challenges remain in scaling them. Community-driven conservation is integral to India's approach, supported by micro-finance and grants, but would benefit from more formalized PES schemes. Developed countries often integrate community efforts into structured programmes, like the EU's LEADER initiative (Links between actions for the development of the rural economy), providing technical support and resources.

## 6.5 Socio-Economic and Cultural Factors

### 6.5.1 Role of Socio-Economic Conditions in Shaping Biodiversity Policies

In India, socio-economic factors like poverty, rural livelihoods, and land tenure disputes shape biodiversity policies. Restoration efforts are often tied to rural development, with afforestation projects providing employment through the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). However, these socio-economic drivers can also lead to conflicts between conservation and human needs.

In developed countries, socio-economic conditions are generally more favourable for biodiversity conservation. Economic stability allows for long-term investments in biodiversity. However, in some rural areas of the US and EU, land restoration efforts still face resistance due to conflicting agricultural and conservation interests.

### 6.5.2 Influence of Cultural Heritage and Traditional Knowledge on Conservation Strategies

India's biodiversity strategies are deeply influenced by cultural heritage and traditional knowledge. Indigenous and local communities play a vital role in conserving biodiversity through practices like agroforestry, sacred groves, and traditional water management systems. The Forest Rights Act (2006) recognizes community ownership of forest resources, integrating traditional knowledge into conservation.

In developed countries, the role of traditional knowledge is less pronounced but growing. Indigenous groups in countries like Canada, the US, and Australia are increasingly involved in conservation initiatives. However, mainstream conservation tends to rely more on scientific research and modern ecological principles than on traditional practices.

Table 7 summarizes the comparison of India's biodiversity conservation and land restoration efforts with those of developed countries, emphasizing key differences in scale, scope, impacts, technological and financial resources, socio-economic factors, and cultural influences.

**Table 7: India's approach and capabilities in biodiversity conservation and land restoration compared to those of developed countries**

| Key Differences | India | Developed Countries |
|---|---|---|
| **Scale of Efforts** | Large-scale initiatives integrated with rural development goals, such as the Green India Mission and Bonn Challenge commitment to restore 26 Mha by 2030 | Large-scale but often focused on intensive restoration projects over smaller areas (e.g., EU's LIFE Program, US's Conservation Reserve Program) |
| **Scope of Ecosystems and Species Targeted** | Broad coverage of ecosystems (forests, wetlands, grasslands) and key species (tigers, elephants) under initiatives like Project Tiger and Project Elephant | Often targets specific ecosystems (e.g., forests in Canada, wetlands in the US) or keystone species (e.g., wolves in Yellowstone). |
| **Impact of Initiatives** | Mixed results; large-scale afforestation has improved forest cover but often through monoculture plantations. Successful stabilization of key species populations but ongoing ecosystem degradation | More measurable impacts due to advanced monitoring; successful rewilding efforts and ecosystem restoration projects (e.g., reintroduction of wolves, forest restoration in the UK) |
| **Technological Resources** | Increasing reliance on technology (e.g., GIS, remote sensing, drones) but limited use of cutting-edge technologies like AI and eDNA | Advanced technologies (e.g., AI, machine learning, eDNA) are widely used for monitoring species, predicting land degradation, and optimizing restoration practices |
| **Financial Resources** | Funding mainly from domestic sources and some international support; relatively modest compared to developed countries | Higher financial commitment, with billions allocated through programmes like EU's LIFE initiative and US's Land and Water Conservation Fund |
| **Socio-Economic Factors** | Restoration efforts tied to rural development, with initiatives like MGNREGA providing employment; socio-economic conditions influence conservation outcomes | Generally favourable socio-economic conditions; investments in biodiversity less affected by poverty and land tenure issues |
| **Role of Traditional Knowledge** | Deeply integrated into biodiversity strategies; local communities play a vital role in conservation (e.g., Forest Rights Act, agroforestry, sacred groves) | Traditional knowledge is growing in importance but is often less pronounced in mainstream conservation practices, relying more on scientific research |
| **Community Involvement** | Emphasizes community-led initiatives like JFM, empowering | Often involves public-private partnerships and significant civil |

| | | |
|---|---|---|
| | local communities in managing forest lands | society engagement, fostering collaborative restoration efforts |
| **Global Integration** | Blends traditional knowledge with modern conservation strategies; potential for adopting global best practices in monitoring, technology, and policy coherence | Stronger integration of biodiversity goals with agricultural practices and significant civil society involvement in restoration initiatives |

## 6.6 Challenges and Limitations

### 6.6.1 Common Challenges Faced by India and Developed Countries

- **Habitat Fragmentation and Urbanization**: Both India and developed countries face the challenge of habitat fragmentation due to urban expansion, agricultural intensification, and infrastructure development.

- **Climate Change**: Global warming and erratic climate patterns are affecting biodiversity and land restoration efforts in both regions. Changing precipitation patterns, rising temperatures, and extreme weather events pose significant risks to restoration initiatives.

### 6.6.2 Specific Challenges Unique to India Due to Socio-Economic and Environmental Factors

- **Population Pressure**: India's high population density puts immense pressure on land resources, leading to conflicts between conservation goals and the need for agricultural expansion, industrialization, and urbanization.

- **Poverty and Rural Livelihoods**: In rural India, dependence on forests and biodiversity for livelihoods complicates conservation efforts. The need for fuel, fodder, and food often leads to over-exploitation of resources.

- **Institutional and Capacity Gaps**: India faces challenges in terms of institutional capacity and funding for biodiversity conservation. Coordination between various government bodies, NGOs, and local stakeholders is often fragmented.

In contrast, developed countries face fewer socio-economic pressures and have more robust institutional frameworks, which allows them to tackle biodiversity and restoration challenges more effectively. However, political and land-use conflicts, particularly with agriculture and forestry, still pose limitations.

While India and developed countries share several common challenges in biodiversity and land restoration, their approaches diverge due to differences in policy frameworks, technological capacity, financial resources, and socio-economic conditions. India's initiatives are vast in scale but face significant socio-economic and environmental hurdles, while developed countries benefit from advanced technologies, stronger financial mechanisms, and more cohesive governance structures. Both can learn from each other to build more resilient and effective biodiversity conservation and land restoration programmes.

## 7. Lessons Learned and Opportunities for Collaboration

### 7.1 Policy and Governance

Developed countries have demonstrated the importance of clear, enforceable policies with robust legal backing, such as the US Endangered Species Act and the EU Biodiversity Strategy. In India, the challenge of regulatory enforcement and inter-agency coordination highlights the need for a more streamlined and enforceable governance structure. India could learn from developed nations' use of decentralized governance systems that integrate biodiversity goals across sectors such as agriculture, forestry, and urban planning.

### 7.2 Technology

Developed countries' success in biodiversity monitoring and restoration is driven by their use of advanced technologies such as AI, drones, satellite monitoring, and eDNA for species tracking and habitat assessment. India's increasing adoption of GIS and remote sensing is promising, but there is potential to further incorporate cutting-edge technologies for better ecosystem restoration. India is utilizing satellite imagery and remote sensing to improve biodiversity conservation. The high-resolution images taken by the IRS series help map forest cover, assess deforestation, and identify land degradation. In addition, satellite telemetry is used to monitor wildlife movements in real-time, which enhances our understanding of habitat use and migration. While India's use of GIS and remote sensing is promising, there is potential to integrate more advanced technologies for better ecosystem restoration.

Collaboration with developed countries could play a crucial role in this technological advancement. By sharing expertise and resources, India can enhance its capacity for biodiversity monitoring and restoration. Joint initiatives could focus on training local professionals in the latest technological applications and creating platforms for data sharing and analysis.

### 7.3 Financial Resources

India can enhance its biodiversity conservation and land restoration financing through specific mechanisms and collaborations. By leveraging international expertise, India can learn from successful market-based mechanisms implemented in developed countries. For example, the EU LIFE Program provides substantial funding to enhance natural capital across Europe, a model that India could adapt for local contexts focusing on specific ecosystems.

Private sector engagement and the issuance of green bonds offer innovative funding mechanisms. A notable example is the World Bank's **Wildlife Conservation Bond**, or the '**Rhino Bond**,' which raised $150 million from institutional investors to support Black Rhino conservation in South Africa. Instead of traditional returns, a portion of the funds is directly tied to conservation outcomes, with $10 million going towards increasing the Black Rhino population. To make green bonds more effective, India should develop frameworks specifically targeting biodiversity initiatives, similar to San Francisco's issuance of green bonds for urban forestry programmes, linking financial returns to improvements in biodiversity.

India could implement a similar green bond strategy to fund critical environmental projects, such as wetland restoration or afforestation efforts in critically endangered ecosystems. By structuring green bonds to connect financial returns with successful biodiversity outcomes, India can attract both domestic and international investors who are committed to environmental sustainability.

**Box 2: Innovative Financing Approaches for Conservation and Land Restoration**

**EU LIFE Program**: The EU LIFE Program is a vital funding mechanism established by the European Union to support environmental and climate action across Europe. Since its launch in 1992, the programme has focused on addressing critical environmental challenges, emphasizing nature conservation and sustainable development. A key component is the LIFE Nature and Biodiversity sub-programme, which aims to protect and restore ecosystems while reversing biodiversity loss. It funds projects aligned with the EU Birds and Habitats Directives and supports the Natura 2000 network, essential for conserving various habitats and species. The sub-programme also tackles the impact of invasive alien species through the IAS Regulation. Furthermore, it plays a crucial role in implementing the EU Biodiversity Strategy for 2030 and promoting sustainable practices beneficial to both the environment and local communities. The LIFE Program's effectiveness stems from its collaborative approach, engaging multiple stakeholders and leveraging co-financing mechanisms to maximize impact (Source: https://cinea.ec.europa.eu/programmes/life_en).

**San Francisco's Green Bonds for Urban Forestry:** In 2015, San Francisco issued its first green bonds, raising approximately $20 million to finance various projects, with a significant portion allocated to urban forestry. The programme focuses on increasing the city's tree canopy, enhancing park facilities, and restoring natural habitats. By linking financial returns to the improvement of urban green spaces, the initiative not only addresses climate change but also enhances community well-being through better air quality, reduced urban heat, and improved aesthetics (Peters, 2017).

**Costa Rica's National PES Program:** Costa Rica's program is often referenced as a model for PES. It compensates landowners for reforestation, forest conservation, and sustainable forest management. Funded by a tax on fossil fuels, the programme has significantly increased forest cover, contributing to biodiversity conservation and carbon sequestration. Payments range based on the type of conservation service provided, with reforestation payments being higher than those for protection of existing forests. This has led to a notable increase in forest cover and biodiversity since its inception in 1997 (Pagiola, 2008).

**Australian Biodiversity Conservation Trust:** Australia has established a market-based mechanism for biodiversity conservation through programmes like the Biodiversity Conservation Trust in New South Wales (NSW). This programme uses biodiversity offset markets, where developers must offset their environmental impacts by paying for conservation activities elsewhere. Landholders receive payments for managing their land in ways that protect endangered species and restore degraded habitats. These offsets provide a way to balance development with conservation outcomes (Maron et al., 2016).

Payments for Ecosystem Services (PES) can incentivize local communities to engage in sustainable practices. For instance, Costa Rica's PES program compensates landowners for maintaining forest cover, and a similar initiative in India could reward communities for preserving traditional agricultural practices that promote biodiversity. Establishing regional green financing hubs, akin to the Green Climate Fund, can attract global investments for targeted conservation efforts in biodiversity hotspots like the Western Ghats.

Additionally, improving the carbon market by establishing clearer guidelines for biodiversity co-benefits will allow projects to generate carbon credits while supporting initiatives like forest restoration. The Government of India has already notified guidelines for green credits programme which is aimed at rewarding the efforts at environmental conservation and protection through a market mechanism. Engaging the private sector is crucial to raise demand for such credits. Corporate Social Responsibility funds can be used by the private sector to invest in such community efforts. Partnerships, such as those with companies like BASF that invest in ecosystem protection relevant to their supply chains, can mobilize additional funding. By implementing these targeted strategies, India can create a robust market-based financial ecosystem for biodiversity conservation and land restoration while supporting sustainable development and ecological resilience.

### 7.4 Socio-Economic and Cultural Factors

Both regions recognize the role of indigenous and local communities, but in India, there is a stronger integration of traditional knowledge systems into conservation. Developed countries can learn from India's community-based resource management systems, such as sacred groves and community forestry practices, to foster local participation in conservation. However, the socio-economic pressures in India—particularly poverty and dependence on natural resources—present unique challenges that must be addressed through sustainable livelihood alternatives.

### 7.5 Identification of Best Practices that can be Adapted to India's Context

- **Cross-Sectoral Integration:** Developed countries have successfully integrated biodiversity considerations into broader policy frameworks. India could adopt similar models by embedding biodiversity and land restoration goals into urban planning, industrial policy, and agricultural reforms, ensuring that these sectors align with national conservation objectives.

- **Use of Technology for Monitoring and Evaluation:** India can leverage lessons from developed countries by scaling up the use of *AI*, *eDNA*, and precision restoration technologies. Expanding biodiversity databases, like the Indian Biodiversity Information System (IBIS), and increasing partnerships with global tech companies for real-time biodiversity monitoring can enhance restoration outcomes.

- **Public-Private Partnerships:** Developed countries have shown the efficacy of public-private partnerships in funding and executing large-scale restoration projects. India can strengthen its engagement with private enterprises and multinational corporations to mobilize financial and technological support for biodiversity conservation, particularly through the creation of carbon offset projects and CSR initiatives.

### 7.6 Opportunities for South-North Collaboration

#### Potential Areas for Collaboration between India and Developed Countries

- ***Technology Transfer:*** Developed countries possess advanced technologies in biodiversity monitoring and ecosystem restoration that could be transferred to India. Joint initiatives focused on technology-sharing programmes, capacity building, and the development of open-source tools could accelerate India's restoration efforts. Collaboration on remote sensing, GIS, and machine learning platforms could enable better real-time monitoring of ecosystems.

- ***Joint Research and Capacity Building:*** India and developed countries can collaborate on research projects focusing on species conservation, ecosystem services valuation,

and sustainable land-use practices. Programmes modelled after EU Horizon 2020 could be co-funded, allowing for the exchange of expertise and innovative restoration strategies between Indian institutions and global research centres. Collaborative efforts on climate adaptation and resilience-building can also benefit both sides.

- ***International Funding and Climate Finance:*** International financial mechanisms such as the Green Climate Fund, Global Environment Facility, and the World Bank can serve as platforms for joint biodiversity projects. Developed countries could provide financial resources for India's large-scale restoration projects through debt-for-nature swaps, climate finance mechanisms, and blended finance models. Private-sector-driven green bonds and impact investment funds offer another avenue for collaboration.

### Role of International Organizations and Partnerships in Supporting India's Efforts

- ***United Nations Conventions:*** International conventions such as the Convention on Biological Diversity (CBD), the United Nations Convention to Combat Desertification (UNCCD), and the Bonn Challenge offer platforms for India and developed countries to align restoration goals and share best practices. The United Nations Decade on Ecosystem Restoration (2021–2030) presents opportunities for multilateral cooperation on large-scale restoration projects.

- ***Global Coalitions:*** India's participation in global coalitions like the Food and Land Use Coalition (FOLU) and Global Partnership on Forest and Landscape Restoration (GPFLR) can be strengthened through partnerships with developed nations. These coalitions can serve as knowledge-sharing platforms, enabling India to learn from countries that have successfully restored degraded landscapes while offering India's insights on community-led conservation approaches.

- ***Bilateral and Multilateral Partnerships:*** India can explore more bilateral and multilateral partnerships with developed nations, such as its ongoing cooperation with the European Union on sustainable agriculture and climate change mitigation. Future collaborations could focus on biodiversity corridors, coastal restoration, and integrated land-use planning.

## 7.7 Future Directions for India's Biodiversity and Land Restoration

### Recommendations for Enhancing India's Biodiversity and Land Restoration Initiatives

- ***Strengthen Policy Enforcement and Governance:*** India should work towards more robust enforcement of its existing biodiversity laws and regulations. Strengthening institutions like the National Biodiversity Authority and enhancing the capacities of State Biodiversity Boards will help ensure better coordination between national and state-level actors. Creating **cross-sectoral governance platforms** could help integrate biodiversity conservation across ministries, including agriculture, forestry, and urban planning.

- ***Scale-Up Technological Innovation:*** India needs to enhance its adoption of advanced biodiversity monitoring tools like drones, remote sensing, and AI-based platforms. Partnerships with global tech firms and research institutions should be encouraged to bring technological innovations to the forefront of biodiversity management. Creating **regional biodiversity observatories** equipped with cutting-edge technologies could accelerate restoration and conservation efforts.

- ***Strengthen Local Communities and Traditional Knowledge:*** India's rich heritage of traditional ecological knowledge offers valuable insights for sustainable land management and restoration. Empowering local communities through the Forest Rights Act and expanding community-managed conservation areas will ensure that restoration efforts are inclusive, sustainable, and culturally relevant. **Community-based forest and water conservation models** could be scaled up in collaboration with international partners.

- ***Focus on Capacity Building and Awareness:*** Capacity building among policymakers, local communities, and conservation practitioners is crucial for the success of biodiversity restoration programmes. Training programmes, both national and international, should focus on developing skills in **restoration ecology, adaptive management, and community engagement**. Additionally, raising public awareness on the importance of biodiversity and land restoration will foster stronger citizen engagement.

### The Need for Innovative Financing Models

Achieving the ambitious goals of biodiversity conservation and land restoration in India requires substantial financial resources. Traditional funding sources, such as government budgets and bilateral grants, are insufficient to address the scale of challenges. To bridge this gap, India must adopt innovative financing models that attract diverse capital sources and leverage international support. The following strategies can play a pivotal role:

- ***Diversifying Funding Sources:*** India can explore innovative mechanisms such as biodiversity offset markets, carbon credits, and public-private partnerships (PPPs). These approaches can attract private sector investments and align business interests with conservation objectives. For example, carbon credit markets can incentivize land restoration efforts by monetizing carbon sequestration activities.

- ***Leveraging International Finance:*** International finance mechanisms like debt-for-nature swaps, blended finance, and green bonds offer opportunities for mobilizing significant resources. These mechanisms can channel global investment into India's biodiversity projects, enabling large-scale restoration. For instance, green bonds issued by Indian banks have already been used for renewable energy projects, and a similar model can be applied to fund biodiversity initiatives.

- ***Establishing Payment for Ecosystem Services (PES):*** PES mechanisms can incentivize communities involved in conservation activities by compensating them for maintaining ecosystem services like carbon sequestration, water purification, and biodiversity preservation. Integrating PES into national biodiversity programmes would promote community participation and support sustainable land management, addressing rural livelihoods alongside ecological goals.

- ***Green Financing:*** Green financing offers a valuable opportunity to address the funding challenges of India's tiger reserves. The Government of India's 'Framework for Sovereign Green Bonds' outlines criteria for projects eligible to receive funds from green bonds, including those focused on the conservation of endangered species, habitats, and ecosystems. As Project Tiger aligns with these criteria, it can tap into these financial resources through bond issuance. Innovative financing mechanisms, like 'Tiger Bonds,' offer the potential to attract private investment, providing much-needed

support for conservation activities. These bonds allow investors to directly link their returns to conservation outcomes, creating a mutually beneficial arrangement where financial returns are tied to successful wildlife preservation efforts.

- ***Encouraging Impact Investing:*** Impact investing aligns financial returns with measurable social and environmental benefits, making it an effective approach for supporting community-driven conservation efforts. Investments in sustainable agriculture ventures or community-based conservation projects can attract private capital focused on achieving ecological impact.

- ***Promoting Public-Private Partnerships (PPPs):*** Greater involvement of the private sector can bring both financial and technological resources to biodiversity conservation. Encouraging businesses in sectors like agriculture, forestry, and energy to invest through CSR initiatives, carbon sequestration projects, and biodiversity credits can support conservation goals while advancing sustainable business practices.

India's biodiversity and land restoration efforts will benefit significantly from strategic actions in policy enforcement, technological innovation, community engagement, and capacity building. However, these efforts require strong financial backing, making innovative financing models a critical component of future strategies. By diversifying funding sources, leveraging international finance, and fostering public-private collaboration, India can enhance its conservation and restoration initiatives. Learning from international best practices and building partnerships will further support the country in addressing the shared global challenges of biodiversity loss and land degradation. International cooperation, both South-South and South-North, will play a key role in addressing the shared challenges of biodiversity loss and land degradation on a global scale.

## 8. Conclusion

India's efforts have laid a strong foundation for sustainable land restoration despite facing challenges. By leveraging global partnerships, adopting cutting-edge technologies, and enhancing financial mechanisms such as payment for ecosystem services, India can lead global biodiversity conservation and climate resilience efforts. The convergence of global knowledge, technologies, and resources through international collaboration presents a powerful opportunity for India. By fostering partnerships with developed nations, scaling up innovations, and securing sustainable financing, India can lead in restoring degraded landscapes and protecting biodiversity. As India continues to integrate its sustainability goals with national development priorities, it stands poised to not only restore its ecosystems but also contribute significantly to international initiatives for environmental sustainability and resilience.

India's efforts at biodiversity conservation and land restoration are globally recognized for blending modern policy initiatives with rich traditional knowledge and community-driven approaches. Comprehensive legal frameworks like the Biological Diversity Act and Forest Rights Act safeguard ecosystems and support local communities. Initiatives such as the Green India Mission and the Compensatory Afforestation Fund aim to restore millions of hectares of degraded land, while programmes like Joint Forest Management (JFM) empower communities in forest conservation. The MGNREGA further integrates ecological restoration with rural employment, linking social and ecological goals.

Significant progress has been made, with approximately 18.94 million hectares afforested between 2011–12 and 2021–22, and 9.8 million hectares restored under the Bonn Challenge

since 2011. However, achieving larger goals requires innovative financing models beyond traditional sources. India needs to diversify its funding through mechanisms like carbon credits, biodiversity offset markets, and PPPs to attract private investment. Carbon credits, for example, can monetize carbon sequestration activities, generating funds for restoration projects.

International mechanisms such as debt-for-nature swaps, blended finance, and green bonds can mobilize global resources. Adapting green bonds to sustainability linked outcomes and greater involvement of private sector through green credits programme and the statutory mechanism of CSR could enhance availability of finance for biodiversity initiatives. PES offers another opportunity, incentivizing communities for maintaining vital ecosystem services like water purification and carbon storage.

With a solid foundation in policy and community engagement, India is poised to lead in global biodiversity and land restoration. By leveraging global partnerships, advanced technologies, and innovative financing, India can expand its restoration efforts and contribute to international sustainability goals. As the country aligns its ecological priorities with development, it stands ready to drive meaningful progress in conservation and climate resilience, offering a model for sustainable restoration worldwide.

## References

Abhilash, P. C., Kumar, V., & Singh, A. (2016). Sustainability of crop production from polluted lands. *Energy, Ecology and Environment, 1*(1), 54–65.

Akhtar-Schuster, M., Stringer, L. C., & Bhandari, M. (2017). Unpacking the concept of land degradation neutrality and addressing its operation through the Rio Conventions. *Journal of Environmental Management, 195*, 4–15.

Ansari, N.A., Hembrom N.,Barthwal D., & Mathur V.B. (2018). Biodiversity Expenditure Review (BER) at Central Government Level, India. Final Report, WII-UNDP Biodiversity Finance Initiative (BIOFIN) Project, Wildlife Institute of India, Dehradun. 75p.

Bastin, J.-F., Garcia, C., & Routh, D. (2019). The global tree restoration potential. *Science, 365*(6448), 76–79.

Bommarco, R., Kleijn, D., & Potts, S. G. (2013). Ecological intensification: Harnessing ecosystem services for food security. *Trends in Ecology & Evolution, 28*(4), 230–238.

Bonn, A., Allott, T., Evans, M., Joosten, H., & Stoneman, R. (2016). Peatland restoration and ecosystem services: an introduction. *Peatland restoration and ecosystem services: Science, policy and practice*, 1–16.

Bossio, D., Geheb, K., & Critchley, W. (2010). Managing water by managing land: Addressing land degradation to improve water productivity and rural livelihoods. *Agricultural Water Management, 97*(4), 536–542.

Bowler, D. E., Buyung-Ali, L., Knight, T. M., & Pullin, A. S. (2010). Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landscape and urban planning*, 97(3), 147–155.

Chazdon, R. L., Guariguata, M. R., & Harrison, R. D. (2017). A policy-driven knowledge agenda for global forest and landscape restoration. *Conservation Letters, 10*(2), 125–132.

Conant, R. T., Cerri, C. E., Osborne, B. B., & Paustian, K. (2017). Grassland management impacts on soil carbon stocks: a new synthesis. *Ecological Applications*, 27(2), 662–668.

Dave, R., Saint-Laurent, C., Murray, L., Antunes Daldegan, G., Brouwer, R., de Mattos Scaramuzza, C.A., Raes, L., Simonit, S., Catapan, M., García Contreras, G., Ndoli, A., Karangwa, C., Perera, N., Hingorani, S., & Pearson, T. (2019). *Second Bonn Challenge progress report: Application of the Barometer in 2018.* Gland, Switzerland: International Union for Conservation of Nature. xii + 80pp.

Dudgeon, D., Arthington, A.H., Gessner, M.O., Kawabata, Z.I., Knowler, D.J., Lévêque, C., Naiman, R.J., Prieur-Richard, A.H., Soto, D., Stiassny, M.L., & Sullivan, C.A. (2006). Freshwater biodiversity: Importance, threats, status and conservation challenges. *Biological Reviews, 81*(2), 163–182.

Dudley, N., Mansourian, S., & Vallauri, D. (Eds.). (2005). *Forest landscape restoration in context.* In *Forest Restoration in Landscapes: Beyond Planting Trees* (pp. 1–18). Springer.

Ellison, D., Morris, C.E., Locatelli, B., Sheil, D., Cohen, J., Murdiyarso, D., Gutierrez, V., Van Noordwijk, M., Creed, I.F., Pokorny, J., & Gaveau, D. (2017). Trees, forests, and water: Cool insights for a hot world. *Global Environmental Change, 43*, 51–61.

FAO and UNEP. (2020). *The state of the world's forests 2020: Forests, biodiversity and people.* Rome: Food and Agriculture Organization.

FAO. (2011). *The state of the world's land and water resources for food and agriculture (SOLAW): Managing systems at risk.* Rome: Food and Agriculture Organization.

FAO. (2015). Status of the World's Soil Resources-Main report. Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils, Rome, Food and Agriculture Organization.

FAO. (2021). *The state of the world's land and water resources for food and agriculture: Systems at breaking point, synthesis report 2021.* Rome: Food and Agriculture Organization.

Foley, J. A., Ramankutty, N., & Snyder, P. K. (2011). Solutions for a cultivated planet. *Nature, 478*(7369), 337–342.

Griscom, B. W., Adams, J., & Ellis, P. W. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences, 114*(44), 11645–11650.

ILO. (2022). Just transition: An essential pathway to achieving gender equality and social justice. UNFCCC Submission in response to Mandate Table 4, D.5, Annex to 3/CP.25.

IPBES. (2018). *Summary for policymakers of the assessment report on land degradation and restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* In S. L. N. Scholes et al. (Eds.). Bonn, Germany: IPBES.

IPCC. (2019). *Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.* Intergovernmental Panel on Climate Change.

IRP. (2019). *Land restoration for achieving the Sustainable Development Goals: An International Resource Panel think piece.* United Nations Environment Programme, Nairobi, Kenya.

Joosten, H. (2009). The global peatland CO2 picture. Wetlands International, Ede, 33, 431.

Körner, C., Jetz, W., Paulsen, J., Payne, D., Rudmann-Maurer, K., & M Spehn, E. (2017). A global inventory of mountains for bio-geographical applications. *Alpine botany*, 127, 1–15.

Lal, R. (2020). Soil carbon sequestration impacts on global climate change and food security. *Science, 304*(5677), 1623–1627.

Mach, K. J., & Ekins, P. (2019). Climate as a risk factor for armed conflict. *Nature, 571*(7766), 193–197.

Maron, M., Gordon, A., Mackey, B. G., Possingham, H. P., & Watson, J. E. (2015). Conservation: stop misuse of biodiversity offsets. *Nature, 523*(7561), 401–403.

Mitsch, W.J., Bernal, B., Nahlik, A.M., Mander, Ü., Zhang, L., Anderson, C.J., Jørgensen, S.E., & Brix, H. (2013). Wetlands, carbon, and climate change. *Landscape Ecology, 28*(4), 583–597.

Mukherjee, A., & Samanta, D. (2018). Atmospheric CO2 level and temperature affect degradation of Pretilachlor and Butachlor in Indian soil. *Bulletin of Environmental Contamination and Toxicology, 100*(6), 856–861.

Navarro, L. M., Pereira, H. M., & Boulton, C. (2017). Restoring degraded land: Contributing to Aichi Targets 14, 15, and beyond. *Current Opinion in Environmental Sustainability, 29*, 207–214.

Nowak, D. J., Hirabayashi, S., Doyle, M., McGovern, M., & Pasher, J. (2018). Air pollution removal by urban forests in Canada and its effect on air quality and human health. *Urban Forestry & Urban Greening*, 29, 40–48.

Pagiola, S. (2008). Payments for environmental services in Costa Rica. *Ecological Economics*, *65*(4), 712–724.

Pandey, R., Gupta, M., Sachdeva, P., Singh, A., & Sugand, S. (2020). *Biodiversity Conservation in India: Mapping Key Sources and Quantum of Funds*, Working Paper No. 311, National Institute of Public Finance and Policy, New Delhi.

Peters, M. (2017). Urban forestry financing: the role of green bonds in improving urban environments. *Journal of Urban Forestry & Urban Greening*, 25, 38–45.

PRS Legislative Research (2023). Demand for Grants 2023-24 Analysis Environment, Forests and Climate Change, https://prsindia.org/files/budget/budget_parliament/2023/DfG_2023-24_Analysis-Environment_Forest_and_Climate_Change.pdf

Ranjan, R. (2022). Linking green bond yields to the species composition of forests for improving forest quality and sustainability. *Journal of Cleaner Production*, *379*, 134708.

Roe, S., Streck, C., Obersteiner, M., Frank, S., Griscom, B., Drouet, L., Fricko, O., Gusti, M., Harris, N., Hasegawa, T., & Hausfather, Z. (2019). Contribution of the land sector to a 1.5 °C world. *Nature Climate Change*, *9*, 817–828.

SAC. (2021). *Desertification and Land Degradation Atlas of India (Assessment and Analysis of Changes over 15 Years Based on Remote Sensing).* Space Applications Centre, ISRO. Ahmedabad, India. 282 p.

Sanz, M. J., et al. (2017). Sustainable land management contribution to successful land-based climate change adaptation and mitigation: A report of the science-policy interface. Bonn, Germany: United Nations Convention to Combat Desertification (UNCCD).

Shao, Y., Zhang, X., & Wang, Z. (2016). An evaluation of time-series smoothing algorithms for land-cover classifications using MODIS-NDVI multi-temporal data. *Remote Sensing of Environment*, *174*, 258–265.

Soundrapandi, J. (2017). Biodiversity Financial Needs Assessment for the Implementation of India's National Biodiversity Action Plan. National Biodiversity Authority, Chennai. India. December, 2017.

Strassburg, B.B., Beyer, H.L., Crouzeilles, R., Iribarrem, A., Barros, F., de Siqueira, M.F., Sánchez-Tapia, A., Balmford, A., Sansevero, J.B.B., Brancalion, P.H.S., & Broadbent, E.N., (2019). Strategic approaches to restoring ecosystems can triple conservation gains and halve costs. *Nature Ecology & Evolution, 3*(1), 62–70.

Suding, K., Higgs, E., Palmer, M., Callicott, J.B., Anderson, C.B., Baker, M., Gutrich, J.J., Hondula, K.L., LaFevor, M.C., Larson, B.M., & Randall, A. (2015). Committing to ecological restoration. *Science, 348*(6235), 638–640.

UNCCD. (2022). *The Global Land Outlook, Second Edition.* Bonn, Germany: United Nations Convention to Combat Desertification.

UNEP, (2022). Global Peatlands Assessment – The State of the World's Peatlands: Evidence for action toward the conservation, restoration, and sustainable management of peatlands. Main Report. Global Peatlands Initiative. United Nations Environment Programme, Nairobi.

van der Esch, S., Sewell, A., Bakkenes, M., Berkhout, E., Doelman, J.C., Stehfest, E., Langhans, C., Fleskens, L., Bouwman, A., & Ten Brink, B. (2022). The global potential for land restoration: Scenarios for the Global Land Outlook 2. *PBL publication number: 4816.* PBL Netherlands Environmental Assessment Agency, The Hague.

White, R. P., Murray, S., & Rohweder, M. (2000). Pilot analysis of global ecosystems-Grassland Ecosystems: World Resources Institute. Washington, DC.

Willer, H., Trávníček, J., & Schlatter, B (Eds.) (2024): The World of Organic Agriculture. Statistics and Emerging Trends 2024. Research Institute of Organic Agriculture FiBL, Frick, and IFOAM – Organics International, Bonn.

Zedler, J. B. and Kercher, S. (2005). Wetland resources: Status, trends, ecosystem services, and restorability. *Annual Review of Environment and Resources, 30,* 39–74.

**Biodiversity and Land Restoration in India:**
***A narrative of India's sustainability efforts vis-à-vis the world***


## Abstract

This paper examines India's initiatives for biodiversity conservation and land restoration in the context of global sustainability goals, comparing them with efforts in developed countries. It analyses international frameworks, including the three Rio Conventions, and highlights India's progress in land restoration and biodiversity conservation through regulatory frameworks, dedicated policies and programmes, and community-driven conservation practices. Through a comparative analysis, the paper contrasts India's initiatives with those in the EU and North America, focusing on differences in technological adoption, financial resources, and community engagement. The findings provide insights into potential opportunities for collaboration, particularly in integrating traditional knowledge with modern conservation techniques, and underscore the necessity for innovative financing models to support these efforts.



## Keywords

Biodiversity conservation, land restoration, India, developed countries, global sustainability, community-based conservation, policy comparison

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