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Restoration Ecology in India: A Synthesis of Recent Trends, Key Actors, and Future Directions

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Abstract: *Ecological restoration has become a critical global priority. India plays a central role in this effort. This is because India has large areas of degraded land and very high biodiversity. This paper reviews developments in restoration ecology in India between 2014 and 2024. It looks at government-led initiatives, community-based efforts, individual environmental leadership, and ongoing methodological debates. The paper analyses major programmes such as the National Mission for a Green India. It also analyses the Compensatory Afforestation Fund Management and Planning Authority. It highlights a key imbalance: large-scale afforestation and monoculture plantations have often been prioritised over holistic ecosystem restoration.*

The paper also examines small public movements. These include community-led conservation efforts. It also covers citizen mobilisation inspired by figures such as Peepal Baba. The paper further discusses the growing popularity of the Miyawaki method. It compares this method with assisted natural regeneration and other ecologically informed approaches. The review argues that restoration success in India depends on three things. First, policy ambition must be integrated with local ecological knowledge. Second, the focus must shift from tree-planting targets to overall ecosystem functionality. Third, robust long-term scientific monitoring must be established.

Keywords: Ecological restoration; ecosystem restoration; afforestation; community participation; biodiversity conservation; land degradation; assisted natural regeneration; India.

I. INTRODUCTION

The 21st century has seen environmental degradation on an unprecedented scale. An estimated 2 billion hectares of land worldwide are deforested or degraded and need restoration [1]. In response, the United Nations declared 2021-2030 the Decade on Ecosystem Restoration. This declaration has galvanised a global movement to prevent, halt, and reverse ecosystem degradation.

India occupies a central position in this effort. This is because of its distinctive ecological and socio-economic context. Nearly 30% of the country's total geographical area is undergoing land degradation. This amounts to 97.85 million hectares [2]. This degradation threatens biodiversity. It also compromises essential ecosystem services such as water security and soil fertility. In addition, it affects the livelihoods of millions of people who depend on natural resources.

In response, India has made significant international commitments. These include its Bonn Challenge pledge to restore 26 million hectares of degraded land by 2030 [3]. Meeting this commitment requires a multi-pronged strategy. This strategy must involve federal and state government agencies, local communities, non-governmental organisations (NGOs), and, increasingly, charismatic individuals who inspire grassroots restoration movements.

However, restoration in India remains complex and contested. Large-scale government programmes have often been criticised for their narrow focus on afforestation. In these programmes, success is measured mainly through tree planting. It is measured far less through the recovery of ecosystem structure, function, and biodiversity [4, 5]. This approach has contributed to the spread of monoculture plantations, including non-native species. These plantations

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frequently fail to support local biodiversity. They also often fail to provide the full range of ecosystem services associated with native forests [6].

This paper provides a critical review of the restoration ecology landscape in India over the last ten years. It has three aims:

1. Analyse the major government-led restoration programmes and their outcomes.
2. Examine the role and impact of non-state actors, including local communities and individual environmental leaders.
3. Synthesise the key challenges and propose future directions for a more effective, science-based restoration paradigm in India.

II. MATERIALS AND METHODS

This study adopts a systematic review approach to examine literature published between January 2014 and May 2024. A comprehensive search was conducted across major academic databases, including Scopus, Web of Science, and Google Scholar, using combinations of the following keywords: "ecological restoration India," "forest restoration India," "afforestation challenges India," "National Mission for a Green India," "community-based restoration India," and "Miyawaki method India."

The review gives priority to peer-reviewed research articles, review papers, and meta-analyses. These were relevant to restoration ecology, forest restoration, afforestation policy, community-led conservation, and restoration methods in India. Non-academic sources were also included where necessary. These helped capture policy developments, the role of non-government groups, and current public discussion.

These sources included reports from government bodies such as the Ministry of Environment, Forest and Climate Change (MoEFCC). They also included articles from well-known national publications. These publications included The Hindu, The Indian Express, and Down To Earth.

The collected material was studied and grouped by theme. The findings were organised into three broad categories. These were: government-led initiatives, community and individual restoration efforts, and methodological approaches. This approach allowed for a full assessment of recent trends. It also helped identify the key people and groups involved. It also helped highlight the debates shaping restoration ecology in India.

III. RESULTS AND DISCUSSION

3.1 Government-Led Restoration: Ambition and Critique

The Indian government has launched several large-scale programmes. These programmes aim to increase national forest and tree cover. The most notable ones are the National Mission for a Green India (GIM) and the Compensatory Afforestation Fund Management and Planning Authority (CAMPA). GIM is a flagship mission. It falls under the National Action Plan on Climate Change. GIM aims to increase forest and tree cover across 5 million hectares. It also aims to improve forest quality across an additional 5 million hectares [7]. CAMPA funds are meant to compensate for a specific problem. This problem is the diversion of forest land for non-forest purposes. This compensation happens mainly through afforestation and related restoration activities.

Table 1: Overview of Major Government-Led Restoration Initiatives in India

Initiative	Primary Objective	Target (as per policy documents)	Key Criticisms from Published Research	Source(s)
National Mission for a Green India (GIM)	Increase forest/tree cover and improve forest quality to enhance carbon sinks and ecosystem services.	10 million hectares (5 Mha afforestation, 5 Mha improvement) by 2020.	Slow implementation; focus on tree cover metrics over ecological function; low survival rates of saplings.	MoEFCC [7], Rana & Pathak [8]
CAMPA Funds	Compensatory afforestation for forest	Varies based on forest diversion; over ₹50,000	Promotion of monocultures (e.g., Eucalyptus); plantations	Vanak et al. [6], Narain

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	land diverted for development projects.	crore (approx. $6.7 billion) disbursed to states.	on non-forest lands like grasslands, displacing native ecosystems and local communities.	[9]
Bonn Challenge Pledge	Restore 26 million hectares of degraded and deforested land.	26 million hectares by 2030.	Ambiguity in defining 'restoration' vs. 'afforestation'; risk of meeting targets through commercial plantations.	Lewis et al. [5]

These initiatives show substantial financial and political commitment. However, their ecological effectiveness remains contested. Vanak et al. (2017) drew attention to a specific problem. CAMPA funds were used for afforestation in non-forest ecosystems. These included grasslands and savannahs in the Western Ghats. These grasslands and savannahs are ancient and biodiverse ecosystems in their own right [6]. Such interventions reflect a forest-centric bias. They may cause ecological harm rather than restoration. In addition, target-driven plantation programmes often favour fast-growing or non-native species. These species provide limited support for native fauna. They may also adversely affect local hydrology [4, 9]. As shown in Fig. 1, areas with high degradation frequently overlap with ecologically sensitive landscapes. In these landscapes, inappropriate plantation can be especially damaging.

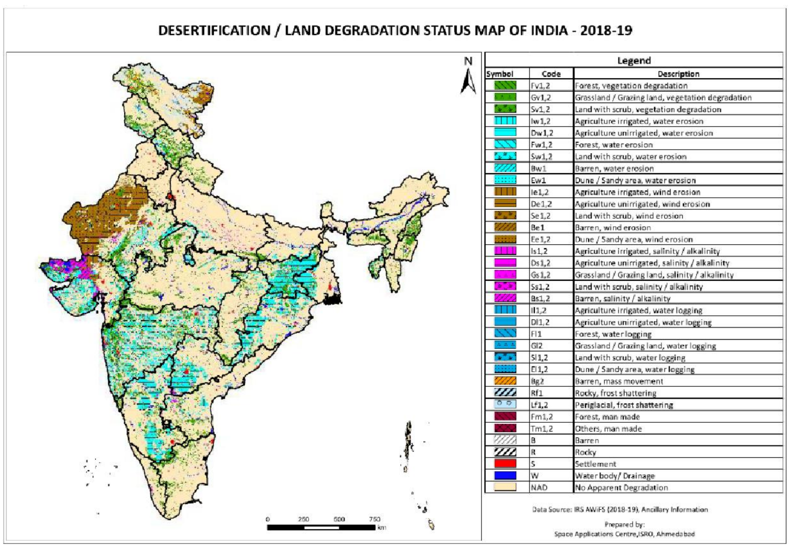

Fig. 1: Map of Land Degradation in India: State-wise distribution of degraded land in India. A significant portion of these areas are non-forest ecosystems where traditional afforestation may be ecologically inappropriate. **Source:** Adapted from data presented in the *Desertification and Land Degradation Atlas of India*, Space Applications Centre, ISRO (2021) [2].

3.2 The Rise of Bottom-Up Restoration: Communities and Individual Heroes

Alongside state-led programmes, a growing ecosystem of bottom-up restoration initiatives has gained momentum across India. These efforts, led by local communities, NGOs, and motivated individuals, often offer a more context-specific alternative to top-down, target-driven approaches.

Community-Led Restoration

Community-based approaches draw on traditional ecological knowledge. They also align restoration goals with local livelihood needs. Studies of sacred grove restoration in Kodagu district, Karnataka, show something important.

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Community protection and customary belief systems can help preserve biodiversity-rich landscapes [10]. Similarly, community-led mangrove restoration has taken place in the Sundarbans and coastal Odisha. This restoration has often proved more resilient and sustainable than externally driven plantation efforts. This is because local stakeholders have a direct interest in long-term success [11]. This participatory model contrasts with exclusionary "fortress conservation" approaches. It also aligns with wider evidence. This evidence shows that empowering Indigenous and local communities improves conservation outcomes [12].

Individual Heroes as Catalysts

A distinctive feature of the Indian restoration landscape is the role of individual environmental leaders. These leaders mobilise public participation with limited institutional support.

A prominent contemporary example is Swami Prem Parivartan. He is popularly known as Peepal Baba. Over more than four decades, he and his volunteers have been credited with planting over 20 million trees. They have placed emphasis on native species such as Peepal (Ficus religiosa) and Neem (Azadirachta indica). These trees were planted along roadsides, community lands, and institutional compounds [13]. As reported in The Hindu, his organisation, Give Me Trees Trust, places strong emphasis on post-planting care. This care is an essential but often neglected part of mass plantation drives [14].

Peepal Baba's work illustrates something important. It shows the potential of citizen-led ecological action. Such action can mobilise social networks. It can foster environmental responsibility. It can also generate visible landscape-level change. Such initiatives encourage volunteer ownership and long-term aftercare. By doing so, they may avoid some bureaucratic constraints associated with formal programmes. They may also contribute to higher sapling survival rates.

3.3 Methodological Debates: Miyawaki vs. Natural Regeneration

The choice of restoration method is another significant area of debate. In recent years, the **Miyawaki method** has gained popularity in urban and peri-urban India.

This technique was developed in Japan. It involves creating dense, multi-layered plantations using native species. Its appeal lies in two promises. It promises rapid growth. It also promises the creation of compact forest patches within a few decades [15].

Corporations, municipalities, and citizen groups have adopted this method. They have used it to establish "mini-forests" on small plots of degraded or unused land.

Ecologists, however, have urged caution. The Miyawaki method may help start vegetation recovery in highly degraded urban soils. But it is resource-intensive. It typically requires substantial soil improvement, irrigation, and maintenance during the establishment phase [16].

Critics also raise a question. They ask whether dense, rapidly planted stands can copy the structural complexity of naturally evolved forests. They also ask whether such stands can copy their successional dynamics and biodiversity over the long term.

Its suitability for large-scale restoration therefore remains limited. Its suitability for non-forest ecosystems also remains limited.

Assisted Natural Regeneration (ANR) offers an alternative approach. This approach is often more cost-effective and ecologically grounded. ANR involves removing barriers to natural succession. These barriers include fire, grazing pressure, invasive species, and repeated disturbance. Once these barriers are removed, natural recovery is allowed to proceed with minimal intervention. Evidence comes from tropical forests in the Western Ghats and Central India. This evidence suggests something important. Where root stock or nearby seed sources remain, ANR can support resilient and biodiverse ecosystem recovery. It can do this at a lower cost than intensive planting [17]. Its main limitation is that recovery is slower. It is also less visually immediate. This makes it less attractive for projects driven by short-term numerical targets.

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IV. CONCLUSION

Restoration ecology in India is at a critical juncture. The country has the political commitment needed to pursue ambitious restoration goals. It also has the financial mechanisms and public enthusiasm needed for this pursuit. However, evidence from the past decade reveals something important. There is a persistent gap between policy ambition and ecological reality.

The dominant paradigm remains strongly centred on afforestation and numerical targets. In this paradigm, success is frequently measured by the number of saplings planted. It is measured far less by the recovery of ecosystem health, structure, function, and biodiversity. This approach can fail to deliver genuine restoration. It may even damage native non-forest ecosystems.

A more effective path forward requires a shift. This shift must move restoration efforts away from being tree-centric. Instead, restoration efforts must become ecosystem-centred.

Community-led projects demonstrate the value of bottom-up, participatory models. The work of individual environmental leaders, such as Peepal Baba, demonstrates this value too. Their strength lies in local ownership, contextual knowledge, and long-term commitment. All of these qualities are essential. They are needed for restoration outcomes that endure beyond initial planting campaigns.

Future restoration efforts in India should therefore be guided by the following principles:

1. **Embrace holistic restoration goals:** Restoration should prioritise ecosystem functionality, structure, biodiversity, and resilience rather than afforestation alone.
2. **Apply the right intervention in the right place:** Restoration plans should be ecologically informed, using active planting methods such as the Miyawaki approach only where appropriate, while prioritising ANR where natural recovery potential exists. Non-forest ecosystems such as grasslands should be protected rather than converted into plantations.
3. **Integrate top-down and bottom-up approaches:** Government policy and funding should support community-led initiatives, strengthen local institutions, and incorporate traditional ecological knowledge.
4. **Invest in long-term monitoring:** Success should be assessed through scientific indicators of ecological recovery, including soil health, hydrology, vegetation composition, habitat quality, and the return of native biodiversity.

By aligning scientific principles with locally grounded action, India can move beyond simplistic tree-planting targets and develop a restoration paradigm that is ecologically sound, socially inclusive, and globally relevant.

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