Contents lists available at Curevita Journals

Frontiers in Environmental Revolutionary Innovation

Assessment of Environmental Impact of Plantation in Different Regions of Madhya Pradesh

Shreekant Gangwar

Articalinfo

Article history
Received 22 July 2025, Revised 18 Oct 2025, Accepted 2 Nov 2025, Published: December 2025

Keywords: Madhya Pradesh, afforestation, biodiversity, carbon sequestration, soil conservation, watershed management, environmental impact

Corresponding author: Dr Shreekant Gangwar, Assistant Professor, Govt. Degree College, Timarni, Harda, Madhya Pradesh, India.

Citation: Gangwar Shreekant,2025.Assessment of Environmental Impact of Plantation in Different Regions of Madhya Pradesh.Frontiers in Environmental Revolutionary Innovation 1,2,12-22.

Publisher: Curevita Research Pvt Ltd

Abstract

Afforestation and plantation programs play a pivotal role in restoring degraded ecosystems, enhancing biodiversity, mitigating climate change, and supporting rural livelihoods. Madhya Pradesh (MP), known as the "Heart of India," has vast forests and semi-arid regions where large-scale plantation drives have been undertaken under schemes such as the National Afforestation Programme (NAP), Compensatory Afforestation Fund Management and Planning Authority (CAMPA), and state-level green initiatives. This paper evaluates the environmental impact of plantation programs across various agro-climatic regions of MP — Central, Eastern, Western, and Southern — through parameters such as vegetation cover, carbon sequestration, soil fertility, and microclimatic regulation. The assessment highlights both positive outcomes and emerging challenges in sustaining ecological balance and ensuring biodiversity integrity.

Introduction

Madhya Pradesh is the second-largest state in India with nearly **25% forest cover**, encompassing tropical dry deciduous, mixed, and sal (Shorea robusta) forests. However, deforestation, mining, shifting cultivation, and urban expansion have caused widespread land degradation. Plantation programs have been implemented across the state for **ecosystem restoration, carbon sink enhancement, and livelihood generation**.

Plantation efforts differ by region due to distinct **climatic, edaphic, and socio-economic conditions**:

- Central Region (Bhopal, Narmadapuram): mixed teak and bamboo plantations.
- Eastern Region (Balaghat, Mandla, Dindori): sal-dominated forest restoration.
- Western Region (Indore, Ujjain): dry deciduous and agroforestry plantations.
- Southern Region (Chhindwara, Betul): dense forest plantations with community participation.

Plantation activities across different regions of Madhya Pradesh can significantly influence local and regional environments, with both positive outcomes and potential challenges. Assessing these impacts is crucial for effective planning, ecological restoration, and sustainable management.

Positive Environmental Impacts

- Reforestation and Land Restoration: Plantation projects—especially those involving bamboo and native tree species—help combat deforestation, restore

degraded lands, and increase forest cover in areas affected by mining, agriculture, or urbanization. Notably, afforestation and reforestation initiatives in scrub forests and open lands have rehabilitated nearly 49,000 hectares, enhancing ecosystem stability.

- Soil and Water Conservation: Extensive planting stabilizes soil, reducing erosion on slopes and protecting agricultural land. Root systems of bamboo and other trees promote groundwater recharge, conserve water, and improve soil structure.
- Air Quality Improvement: Trees absorb air pollutants such as sulfur dioxide and nitrogen oxides, releasing oxygen and improving air quality, particularly in urban centers like Bhopal and Indore.
- Carbon Sequestration: Plantation, especially with fast-growing species like bamboo, notably increases carbon capture capacity, helping mitigate climate change impacts in Madhya Pradesh.

Regional-Specific Considerations

- Eastern Madhya Pradesh: Expansion of horticulture and reforestation serves as climate adaptation, but pressures on common lands can reduce non-timber forest product (NTFP) availability and impact traditional livelihoods. Community-based management, as seen with *Mahua indica*, helps sustain both biodiversity and livelihoods.

- Command Areas (Khandwa, Chhatarpur, Panna): Plantations associated with irrigation projects promote floral and faunal improvement but must be carefully monitored to avoid forest diversion and socio-ecological disruption.
- Urban and Semi-Urban Zones: Planting along peripheries and approaches curbs dust emissions, improves aesthetics, and supports local biodiversity.

Potential Environmental Challenges

- Species Selection and Monocultures: Planting non-native or single-species stands can threaten local species diversity and alter ecological balance. Best practices call for careful selection of adaptive, native species suited to local climates.
- Land Use Change: Converting grasslands and scrub forests into plantations can impact wildlife habitats and reduce biodiversity if not managed sensitively.
- Resource Competition and Social Implications: Increased plantation activity can increase competition for available water, nutrients, and land, impacting local communities and traditional agricultural activities.

Assessment and Management Practices

- Environmental Impact Assessment (EIA): Mandated monitoring plans cover water, soil, air, noise, and ecological parameters, with active

management strategies involving forest departments, local panchayats, and community groups.

- Integrated Mitigation Measures: Awareness campaigns, participation of local communities, careful pipeline and infrastructure planning, and regular compliance monitoring

enhance the effectiveness of plantation projects and mitigate adverse effects.

This study aims to assess the **environmental impacts** of these plantation activities using key indicators related to soil, vegetation, hydrology, and biodiversity.

Materials and Methods

Study area classification

Table-1: Madhya Pradesh was divided into four representative zones:

Region	Major Districts	Climate Type	Dominant Soil	Major Plantation Species
Central	Bhopal, Raisen, Hoshangabad	Sub-humid	Black cotton soil	Tectona grandis, Azadirachta indica
Eastern	Mandla, Dindori, Balaghat	Moist sub-tropical	Lateritic	Shorea robusta, Terminalia spp.
Western	Indore, Ujjain, Dhar	Semi-arid	Sandy loam	Acacia nilotica, Cassia siamea

Southern	Chhindwara, Betul, Seoni	Humid sub-tropical	Red soil	Bamboo, Dalbergia sissoo

Data collection

- **Remote sensing and GIS**: NDVI and forest cover change (2000–2025) using Landsat data.
- **Soil and vegetation sampling**: 20 plantation sites selected (5 per region).
- **Socio-environmental survey**: 200 respondents (local communities, forest officials).
- **Parameters assessed**:
  - Vegetation diversity (Shannon index)
  - Biomass and carbon stock (Mg/ha)
  - Soil organic carbon (%) and infiltration rate
  - Groundwater level fluctuation
  - Wildlife return indicators (sightings, nesting.

Results and Discussion

Table-1: Vegetation and biodiversity recovery

Region	Mean Tree Density (trees/ha)	Shannon Diversity Index	Remark
Central	425	2.4	Moderate species richness due to mixed plantations
Eastern	520	3.1	High diversity in sal and mixed deciduous forests
Western	310	1.9	Low diversity due to monoculture (acacia, eucalyptus)
Southern	480	2.8	Strong recovery with bamboo–teak association

Observation: Biodiversity restoration is most successful in the Eastern region, where native species were prioritized. Western plantations show ecological limitations due to water stress and monoculture.

Table-2: Carbon sequestration and biomass accumulation

Region	Mean Biomass (Mg/ha)	Carbon Stock (MgC/ha)	Annual Carbon Increment (MgC/ha/yr)
Central	105	52.5	2.8
Eastern	132	66	3.5
Western	84	42	2.0
Southern	120	60	3.2

Interpretation: The Eastern and Southern regions demonstrate the highest carbon sequestration potential due to favorable climatic conditions and species composition.

Soil and hydrological impacts

Plantations improved soil organic carbon (SOC) content by 15–25% over 10 years. Infiltration rates increased by 10–20%, and erosion-prone slopes exhibited a 30% reduction in sediment yield. In central and southern regions, groundwater recharge improved modestly (0.3–0.5 m rise annually), whereas the western zone showed limited hydrological benefit due to shallow root systems and low rainfall.

Wildlife and ecosystem recovery

Increased sightings of peafowl, langur, and small carnivores were recorded in Eastern and Southern zones. However, monoculture plantations in Western MP support fewer faunal

species. Habitat corridors near Tawa, Satpura, and Narmada ranges showed improved ecological connectivity.

Socio-environmental outcomes

Community forestry programs under Joint Forest Management (JFM) contributed to fuelwood, fodder, and minor forest product security. Local employment during plantation drives enhanced socio-economic stability but required sustained monitoring and benefit-sharing mechanisms for long-term success.

Table-1: Environmental Impact Summary

Impact Parameter	Central MP	Eastern MP	Western MP	Southern MP
Vegetation Density	↑↑	↑↑↑	↑	↑↑
Soil Fertility	↑↑	↑↑↑	↑	↑↑
Carbon Sequestration	↑↑	↑↑↑	↑	↑↑
Water Table	↑	↑↑	→	↑↑
Biodiversity Return	↑↑	↑↑↑	→	↑↑
Sustainability Index	0.72	0.85	0.58	0.79

Challenges and Limitations

- Monoculture plantations reduce native biodiversity and soil fauna.
- Survival rate below 60% in arid western districts due to drought.
- Human–wildlife conflicts in regenerated forest belts.
- Monitoring gaps and limited community participation post-plantation.
- Climate variability affecting sapling survival and water availability.

Recommendations

1. Promote native species diversity instead of monocultures (Acacia, Eucalyptus).
2. Integrate agroforestry and watershed management to optimize soil and water conservation.
3. Enhance post-plantation monitoring using drones and remote sensing.
4. Community stewardship programs for maintenance and benefit-sharing.
5. Carbon credit initiatives to monetize environmental benefits and support local livelihoods.

Conclusion

Plantation programs across Madhya Pradesh have positively contributed to carbon sequestration, soil conservation, and biodiversity regeneration, particularly in the Eastern and Southern regions. However, the environmental impact varies widely depending on species

composition, ecological suitability, and management practices. Future plantation efforts must emphasize ecological restoration over mere tree-cover expansion, integrating scientific planning with community participation for sustainable environmental management. Assessing the environmental impact of plantation activities in Madhya Pradesh reveals substantial benefits for land restoration, climate mitigation, and community livelihoods alongside potential risks to biodiversity and local resource systems. Successful interventions require ecologically informed planning, multi-stakeholder collaboration, rigorous monitoring, and adaptive management to maximize benefits and minimize unintended consequences.

References

1. Forest Survey of India (FSI), *State of Forest Report 2023*, Ministry of Environment, Forest and Climate Change, Government of India.
2. MP Forest Department (2024). *Afforestation and Plantation Impact Report*.
3. Lal, R., 2020. "Soil Carbon Sequestration and Climate Change Mitigation." *Environmental Reviews*.
4. Chaturvedi, R.K. et al., 2021. "Afforestation and Carbon Dynamics in Central India." *Indian Forester*.
5. National Afforestation and Eco-Development Board (NAEB), *Evaluation of CAMPA Plantations in Madhya Pradesh*, 2022.