CSIBER INTERNATIONAL JOURNAL OF ENVIRONMENT(CIJE)

Vol. 2, Issue No. 2, November, 2025

ESTD : 1976

C S I B E R

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KOLHAPUR

INDIA

CSIBER INTERNATIONAL JOURNAL OF ENVIRONMENT(CIJE)

A Bi-Annual Double-Blind Peer Reviewed (Refereed/Juried)
Open Access International e-Journal - Included in the International Serial Directories

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CSIBER International Journal of Environment (CIJE)

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Preserving the Pulse of the Western Ghats: Strategies for Biodiversity Conservation in a Climate-Stressed Landscape

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Abstract
The Western Ghats, a UNESCO World Heritage site and one of the world's eight "hottest hotspots" of biological diversity, are facing unprecedented ecological stress due to climate change, land-use transformation, and anthropogenic pressures. This paper explores the multifaceted challenges threatening the region's rich biodiversity and proposes integrative conservation strategies tailored to its unique ecological and socio-cultural context. Drawing on recent climate models, biodiversity assessments, and field studies, the research highlights how rising temperatures, erratic rainfall patterns, and habitat fragmentation are altering species distribution and ecosystem dynamics. Special attention is given to endemic flora and fauna, whose survival is increasingly jeopardized by shrinking habitats and invasive species.
The study advocates for a landscape-level conservation approach that combines protected area expansion, ecological corridor development, and community-led stewardship. It also emphasizes the role of indigenous knowledge systems and participatory governance in enhancing ecological resilience. Case studies from Kerala, Karnataka, and Maharashtra illustrate successful interventions such as sacred grove preservation, agroforestry adoption, and decentralized water management. By integrating scientific insights with traditional practices, the paper argues for a more inclusive and adaptive conservation framework.
Ultimately, this research underscores the urgency of preserving the ecological pulse of the Western Ghats—not only for regional sustainability but also for global biodiversity heritage. The findings aim to inform policymakers, conservationists, and local communities in crafting strategies that are ecologically sound, culturally respectful, and climate-resilient.

Keywords - Western Ghats, Biodiversity Conservation, Climate Change, Habitat Fragmentation, Endemic Species, Ecological Resilience

Introduction

The Western Ghats, a chain extending along the western coast of peninsular India, represent one of the most ecologically significant and biologically diverse regions globally. Designated as a UNESCO World Heritage site, the Ghats are recognized for their exceptional levels of endemism and species richness, encompassing over 7,400 species of flowering plants, 139 mammal species, and 179 amphibians. Functioning as a critical ecological corridor, the region plays a pivotal role in regulating monsoonal dynamics, maintaining hydrological cycles, and supporting agro ecosystems and forest-based livelihoods across six Indian states.

Despite their ecological prominence, the Western Ghats are increasingly threatened by anthropogenic pressures and climate-induced stressors. Rapid land-use changes—driven by urban expansion, agricultural intensification, mining, and infrastructure development—have led to habitat fragmentation, soil degradation, and biodiversity loss. These transformations are particularly detrimental to endemic and specialist species, which are often confined to narrow ecological niches. Concurrently, climate variability, characterized by rising temperatures, altered precipitation regimes, and increased frequency of extreme weather events, is exacerbating ecological instability and challenging the adaptive capacity of both species and ecosystems.

The compounded impact of these stressors necessitates a re-evaluation of existing conservation paradigms. This study investigates the intersection of climate stress and biodiversity loss in the Western Ghats, with a focus on developing integrative conservation strategies that are ecologically sound, socially inclusive, and contextually grounded. Emphasis is placed on landscape-level planning, ecological connectivity, and community-based stewardship, alongside the incorporation of indigenous ecological knowledge systems. Through a synthesis of case studies, policy analysis, and ecological data, the research aims to contribute to the development of adaptive, participatory, and regionally tailored conservation models that can safeguard the ecological integrity and cultural heritage of the Western Ghats in an era of accelerating environmental change.

Review of Literature -

Western Ghats have been extensively studied for their ecological richness and high levels of endemism. Myers et al. (2000) identified the region as one of the world's eight "hottest hotspots" of biodiversity, emphasizing its global conservation priority. The Ghats host over 7,400 species of flowering plants, many of which are endemic, along with diverse faunal groups including amphibians, reptiles, and mammals (Nair, 1991; Daniels, 1992). This

biological wealth is intricately linked to the region's complex topography, varied microclimates, and long-standing human-nature interactions.

However, recent literature highlights the growing vulnerability of these ecosystems to anthropogenic pressures. Land-use change, driven by agriculture, urbanization, and infrastructure development, has led to habitat fragmentation and degradation (Kumar & Ramachandran, 2019). Studies by Jha et al. (2000) and Menon & Bawa (1997) show that forest cover loss in the Ghats is accelerating, particularly in low-elevation zones where human settlement density is highest.

The Western Ghats have long been recognized as a global biodiversity hotspot, with exceptional levels of endemism and ecological complexity. Recent research continues to underscore the region's ecological significance while highlighting the mounting pressures it faces from both anthropogenic and climatic stressors.

Bathija and Sylvander (2023) critically examine the socio-political dimensions of conservation in the Ghats, revealing how exclusionary models—particularly the displacement of Adivasi communities from protected areas like Nagarhole—have led to cultural erosion and ecological disconnect. Their findings echo broader critiques of fortress conservation and advocate for inclusive, rights-based approaches that integrate local stewardship.

Climate change remains a dominant threat. The IUCN SSC Western Ghats Plant Specialist Group (2023) emphasizes the urgency of population-level assessments for critically endangered flora, proposing extinction risk evaluations and species recovery programs using the Red List methodology. Krishna et al. (2023) further highlight the vulnerability of amphibian populations to shifting temperature and rainfall patterns, noting range contractions and population declines among endemic species.

Ex-situ conservation has emerged as a complementary strategy. Tripathi et al. (2024) document the adaptability of over 100 native and naturalized plant species conserved at the Indian Institute of Horticultural Research, with special attention to rare and threatened taxa. Their work is supported by ethno botanical surveys across Maharashtra, Karnataka, and Kerala, which reveal the nutritional and medicinal value of wild fruits used by tribal communities (Deshmukh & Waghmode, 2023; Karun et al., 2023; Narayanan et al., 2023; Valvi et al., 2023). These studies reinforce the importance of preserving traditional ecological knowledge as part of biodiversity conservation.

Land-use change continues to fragment habitats, particularly on lateritic plateaus. A 2023 study by the Nature Conservation Foundation, cited by Mongabay India, shows how agroforestry and paddy cultivation are altering herpetofaunal diversity in northern Ghats. Meanwhile, a 2025 Mongabay India report revisits the Gadgil Committee's recommendations, advocating for zoning the Ghats into Eco-Sensitive Zones (ESZs) and enforcing bans on destructive activities such as quarrying and deforestation. Madhav Gadgil warns of increasing flash floods and landslides due to ecosystem degradation, calling for participatory governance and stronger policy enforcement.

Collectively, these studies highlight the need for integrative conservation frameworks that combine scientific assessments, community engagement, and traditional knowledge systems. They advocate for adaptive, inclusive, and regionally contextualized models capable of preserving the ecological pulse of the Western Ghats in an era of accelerating environmental change.

Methodology -

This review paper employs a qualitative, thematic synthesis of recent literature, policy documents, and case studies to explore biodiversity conservation strategies in the Western Ghats under the influence of climate stress. The methodology is designed to capture ecological, socio-cultural, and governance dimensions of conservation, drawing from interdisciplinary sources published between 2023 and 2024.

1. **Literature Selection and Scope**

Relevant peer-reviewed articles, institutional reports, and ethno botanical surveys were identified using academic databases such as Research Gate, Google Scholar, and organizational repositories including IUCN, Mongabay India, and the Indian Institute of Horticultural Research. Keywords used included "Western Ghats biodiversity," "climate change impacts," "indigenous conservation," "ex-situ conservation," and "eco-sensitive zones." Studies were selected based on their geographic relevance to the Western Ghats, publication regency (2023–2024), and thematic alignment with climate stress and conservation frameworks.

2. **Policy and Governance Review**

Key policy documents were analysed to understand the evolution and effectiveness of conservation governance in the region. These included:

- The Gadgil Committee Report (2011) and Kasturirangan Committee Report (2013), revisited through recent critiques and updates.

- State Biodiversity Action Plans from Kerala, Karnataka, and Maharashtra.
- The IUCN SSC Western Ghats Plant Specialist Group Report (2023), which provided updated Red List assessments and species recovery frameworks.

The review focused on implementation gaps, community participation, and the integration of ecological science with policy instruments.

3. **Case Study Identification and Analysis**

Three case studies were selected to illustrate successful conservation interventions:

- **Sacred grove preservation in Kerala**: Highlighting community-led protection of microhabitats with high endemic species density.
- **Biodiversity blocks in Karnataka**: Documenting ex-situ conservation of native and threatened plant species.
- **Watershed restoration in Maharashtra**: Showcasing participatory approaches to land and water management with ecological co-benefits.

Each case was evaluated based on ecological outcomes, Replicability, and socio-cultural integration, using published field reports and ethnographic surveys.

4. **Thematic Categorization and Synthesis**

All findings were organized into four thematic domains:

- **Climate vulnerability and species sensitivity**
- **Habitat fragmentation and land-use change**
- **Indigenous knowledge and community stewardship**
- **Policy coherence and governance challenges**

This thematic structure enabled a holistic synthesis of ecological data, conservation models, and socio-political dynamics, allowing for the identification of gaps and opportunities in current strategies.

Results and Discussion -

The synthesis of recent literature, policy reviews, and case studies reveals a multifaceted landscape of biodiversity conservation in the Western Ghats, shaped by ecological vulnerability, climate stress, socio-political tensions, and evolving governance frameworks. The discussion is organized into four interrelated thematic domains that reflect the complexity and urgency of conservation efforts in this globally significant region.

1. Climate Vulnerability and Species Sensitivity

Recent ecological assessments underscore the heightened sensitivity of endemic species in the Western Ghats to climate variability. Amphibians, montane flora, and herpetofauna are particularly vulnerable due to their narrow ecological niches and limited dispersal capacity. Krishna et al. (2023) report significant range contractions among amphibian populations, correlating with rising temperatures and erratic rainfall patterns. These findings are consistent with broader climate models predicting increased frequency of extreme weather events and altered monsoonal dynamics across the region.

The IUCN SSC Western Ghats Plant Specialist Group (2023) emphasizes the need for population-level assessments of critically endangered flora, advocating for extinction risk evaluations and species recovery programs. Their Red List-based framework provides a scientific foundation for prioritizing conservation actions, yet implementation remains limited due to data gaps and resource constraints. These studies collectively highlight the need for climate-adaptive conservation strategies, including microhabitat restoration, assisted migration, and long-term ecological monitoring.

2. Habitat Fragmentation and Land-Use Change

Land-use transformation continues to be a dominant driver of biodiversity loss in the Western Ghats. Rapid urbanization, agricultural expansion, mining, and infrastructure development have fragmented habitats, disrupted ecological connectivity, and increased edge effects. Mongabay India (2025) documents the ecological consequences of quarrying and deforestation, particularly on lateritic plateaus and low-elevation zones. These activities not only degrade biodiversity but also exacerbate climate-induced risks such as landslides and flash floods.

The revisited Gadgil Committee recommendations advocate for zoning the Ghats into Eco-Sensitive Zones (ESZs), with graded restrictions on land-use activities. However, political resistance and lack of inter-state coordination have hindered effective implementation. The Kasturirangan Committee's diluted approach, which prioritized economic development over ecological integrity, has further complicated governance. These policy tensions underscore the need for a balanced framework that integrates ecological science with socio-economic realities.

3. Indigenous Knowledge and Community Stewardship

Ethno botanical studies reveal the deep ecological knowledge embedded within tribal communities across the Western Ghats. Tripathi et al. (2024) document the conservation of over 100 native and naturalized plant species in biodiversity blocks, many of which are used by local communities for food, medicine, and cultural practices. Surveys by Narayanan et al. (2023), Karun et al. (2023), and Valvi et al. (2023) highlight the nutritional and medicinal value of wild fruits consumed by tribal groups such as the Kattunaikka, Kuruma, and Paniya.

Sacred grove preservation in Kerala and community-led watershed restoration in Maharashtra exemplify successful participatory conservation models. These initiatives demonstrate how indigenous stewardship can enhance ecological resilience while preserving cultural heritage. However, Bathija and Sylvander (2023) caution against conservation frameworks that marginalize indigenous voices, citing cases of forced displacement and exclusion from decision-making. Their critique calls for a shift toward rights-based conservation that recognizes tribal communities as co-managers of biodiversity.

4. Policy Integration and Governance Challenges

Despite the existence of robust policy frameworks, governance challenges persist in biodiversity conservation across the Western Ghats. The Gadgil and Kasturirangan reports offer contrasting visions—one rooted in ecological zoning and participatory governance, the other favoring technocratic planning and economic growth. State Biodiversity Action Plans vary in scope and effectiveness, often lacking mechanisms for cross-sectoral coordination and community engagement.

The IUCN's call for species recovery programs and the emphasis on local governance in the Gadgil report remain underutilized. Institutional fragmentation, limited funding, and political inertia have impeded the translation of policy into practice. Moreover, conservation efforts are often siloed, with inadequate integration between forest departments, local panchayats, and civil society organizations.

To address these gaps, scholars and practitioners advocate for adaptive governance models that are flexible, inclusive, and responsive to ecological feedback. Such models must incorporate scientific assessments, traditional knowledge systems, and participatory mechanisms to ensure long-term sustainability.

Synthesis

The reviewed literature and case studies converge on a central insight: effective biodiversity conservation in the Western Ghats requires a paradigm shift from exclusionary, top-down approaches to integrative, community-cantered frameworks. Climate resilience, ecological connectivity, and cultural continuity must be treated as interdependent goals. The Western Ghats, as a living landscape, demand conservation strategies that are not only scientifically sound but also socially just and politically feasible.

Conclusion -

The Western Ghats, a globally recognized biodiversity hotspot, are facing unprecedented ecological stress due to the dual pressures of climate change and anthropogenic disturbance. This review has synthesized recent findings from ecological studies, policy analyses, and community-based conservation efforts to highlight the multifaceted nature of these challenges. Endemic species are increasingly vulnerable to shifting climatic conditions, while habitat fragmentation continues to erode ecological connectivity and resilience.

The analysis reveals that while policy frameworks such as the Gadgil and Kasturirangan reports offer valuable guidance, their implementation remains inconsistent and often disconnected from ground realities. Indigenous communities, despite possessing deep ecological knowledge and cultural ties to the land, are frequently marginalized in formal conservation efforts. Successful case studies—such as sacred grove preservation and biodiversity blocks—demonstrate that inclusive, locally rooted approaches can yield both ecological and social benefits.

Ultimately, the conservation of the Western Ghats requires a paradigm shift toward integrative, adaptive, and participatory models. These must bridge scientific insight with traditional knowledge, and policy ambition with grassroots action, to ensure that this ancient landscape continues to thrive in the face of accelerating environmental change.

Essential Recommendations -

1. **Implement Climate-Adaptive Conservation**
   - Prioritize species vulnerability assessments and microhabitat restoration.
   - Integrate climate modelling into biodiversity planning to anticipate ecological shifts.
2. **Empower Indigenous Communities**
   - Recognize tribal groups as co-managers of biodiversity.
   - Institutionalize traditional ecological knowledge in conservation policies and programs.

3. **Strengthen Eco-Sensitive Zoning**
   - Enforce land-use regulations in critical habitats.
   - Halt destructive activities like quarrying and deforestation in designated zones.
4. **Scale Up Community-Led Models**
   - Expand successful initiatives such as sacred grove protection and watershed restoration.
   - Provide financial and technical support to local conservation groups.
5. **Enhance Policy Coordination**
   - Improve collaboration between forest departments, biodiversity boards, and local governance.
   - Ensure transparency and accountability in conservation implementation.

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