RESEARCH PAPER

Biodiversity Conservation and Climate Change Adaptation in Kerala (2024-2025): An Analytical Study within the Indian Context

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ABSTRACT

Kerala has made significant progress in climate governance during 2024–2025 through institutional strengthening, policy frameworks, and research-driven interventions. This study evaluates key initiatives led by the State Climate Change Cell (SCCC) and allied institutions, focusing on the implementation of the revised State Action Plan on Climate Change (SAPCC 2.0), greenhouse gas (GHG) inventory development, research projects, and capacity-building programs. In addition, the study examines the status of biodiversity in India and Kerala, with particular emphasis on endemism, ecosystem diversity, and threatened species. By integrating biodiversity assessment with climate governance analysis, the paper highlights Kerala's commitment to climate resilience, environmental sustainability, and long-term carbon neutrality.

Keywords: Biodiversity, Climate Governance, SAPCC 2.0, GHG Inventory, Kerala, Western Ghats, Conservation

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1. Introduction

Climate change poses significant risks to environmental systems and human well-being, affecting health, livelihoods, food security, and water availability. The primary drivers of global warming include excessive reliance on fossil fuels, deforestation, and rapid industrialization. Limiting global temperature rise to 1.5°C is widely recognized as essential to avoid severe and irreversible impacts.Global institutions such as the Intergovernmental Panel on Climate Change (IPCC) and the World Bank emphasize ecosystem protection and improved efficiency as key mitigation strategies. India, despite constitutional provisions for environmental protection, continues to face challenges such as pollution, deforestation, and inadequate waste management.Kerala, located in the Western Ghats biodiversity hotspot, is particularly vulnerable due to its ecological sensitivity, high population density, and rapid developmental activities. The increasing frequency of floods, landslides, and coastal erosion highlights the urgent need for integrated climate governance and biodiversity conservation.

2.Review of Literature

A growing body of literature highlights the interlinkages between biodiversity conservation and climate change governance, particularly in ecologically sensitive regions such as India and the Western Ghats.

Intergovernmental Panel on Climate Change (2023) emphasizes that climate change is a major driver of biodiversity loss, affecting ecosystems through rising temperatures, altered precipitation patterns, and extreme weather events. The report underscores that ecosystem-based adaptation and conservation strategies are essential for mitigating climate risks and enhancing resilience.

According to United Nations Environment Programme (2023), the global biodiversity crisis is closely linked with climate change, and integrated policy approaches are necessary to address both challenges simultaneously. The study highlights the importance of nature-based solutions, such as forest conservation and wetland restoration, in achieving sustainable development goals.

World Bank (2024) reports that countries like India face significant climate vulnerabilities due to high population density and dependence on natural resources. The report stresses the need for improved governance frameworks, climate finance mechanisms, and institutional capacity to address environmental challenges effectively.

In the Indian context, Ministry of Environment, Forest and Climate Change (2024) provides comprehensive insights into biodiversity status and conservation efforts

through national reports. These studies reveal that while India hosts rich biodiversity, increasing anthropogenic pressures and climate change pose serious threats to ecosystems and species survival.

Focusing on Kerala, Kerala State Biodiversity Board (2024) highlights the state's rich biodiversity and ongoing conservation initiatives, including People's Biodiversity Registers (PBRs) and Biodiversity Management Committees (BMCs). The report emphasizes community participation as a key driver of successful conservation.

Research on the Western Ghats indicates high levels of endemism and ecological sensitivity (Myers et al., 2000). Studies suggest that climate change is likely to significantly alter species distribution and ecosystem stability in this region, necessitating targeted conservation strategies.

Recent studies by Ravindranath N. H. (2019) highlight the importance of state-level climate action plans in addressing regional climate challenges. The research points out that while frameworks such as SAPCC provide strategic direction, their effectiveness depends on implementation capacity, monitoring systems, and stakeholder engagement.

Furthermore, Madhav Gadgil has emphasized the need for decentralized environmental governance and community-based conservation in ecologically fragile regions like Kerala. His work underscores the importance of integrating traditional ecological knowledge with modern scientific approaches.

3. Objectives of the Study

- To assess the status and distribution of biodiversity in India and Kerala with emphasis on endemism and threatened species
- To evaluate biodiversity conservation initiatives and climate governance mechanisms in Kerala during 2024–25

4. Methodology

4.1 Research Design

This study adopts a descriptive and analytical research design to examine biodiversity patterns and climate governance frameworks.

4.2 Justification of Study Period

The period 2024–25 is selected as it marks a critical phase in the implementation of SAPCC 2.0 and recent climate policy interventions, enabling the assessment of updated governance practices.

4.3 Data Sources and Review Method

The study relies on secondary data from:

- Government reports (2023–2025)
- Ministry of Environment, Forest and Climate Change publications
- Reports from international organizations (IPCC, World Bank, UNEP)

A systematic review approach involving data classification, comparison, and thematic analysis was adopted to ensure consistency and reliability.

5.Biodiversity in India

Floral Diversity

India hosts over 47,000 plant species, including more than 20,000 flowering plants. Approximately 33% of these species are endemic, reflecting the country's unique evolutionary history. However, over 1,800 plant species are currently classified as endangered, indicating increasing ecological stress.

Faunal Diversity

India supports 1,04,561 faunal species across multiple ecological niches. Soil species (22,404), freshwater species (9,436), and mangrove-associated species (5,023) contribute significantly to this diversity.Endemism is notably high, with over 28,900 species (28%) restricted to the region. Nearly 10% of the total flora and fauna are categorized as threatened, underscoring the urgency of conservation measures.

Ecosystem Diversity

India exhibits diverse ecosystems including forests, grasslands, wetlands, deserts, and marine systems. Four global biodiversity hotspots are present:

- Western Ghats
- Himalayas
- North-East India
- Nicobar Islands

Protected Area Network

India has established an extensive conservation framework:

- 106 National Parks
- 564 Wildlife Sanctuaries
- 99 Conservation Reserves
- 18 Biosphere Reserves
- 80 Ramsar Wetlands (as of 2025)

6.Biodiversity in Kerala

Kerala is experiencing a rise in climate-induced hazards, including floods, landslides, and sea-level rise, which necessitates urgent prioritization of climate resilience. Notably, approximately 80% of the state's greenhouse gas emissions originate from the energy sector. Transitioning to renewable energy sources, improving

energy efficiency, strengthening infrastructure, and promoting electric mobility are critical strategies for emission reduction. Integrating these measures into development planning is essential to ensure environmental sustainability alongside economic growth.The state's climate challenges are further shaped by its geographical features, high population density, land-use changes, and rapid developmental activities. In recent years, these factors have contributed to an increase in extreme weather events such as intense rainfall, floods, landslides, and droughts.To address these challenges, the Department of Environment and Climate Change (DoECC) has taken a leading role in coordinating climate initiatives. Kerala's first State Action Plan on Climate Change (SAPCC) was developed with stakeholder support and endorsed by the Government of India in 2014. In line with updated guidelines from the Ministry of Environment, Forest and Climate Change, the Climate Change Cell revised the SAPCC, and the updated version was approved by the State Government in January 2023.The revised SAPCC (2023–2030) serves as the central framework guiding Kerala's climate action, aligning state-level strategies with national and international climate commitments. It emphasizes both mitigation and adaptation across key sectors, including agriculture, livestock, fisheries, health, water resources, forests, and biodiversity, with a focus on enhancing resilience to climate impacts.

Species Richness and Discoveries

Kerala has emerged as a leading biodiversity discovery hotspot. In 2024 alone, 101 new faunal species were documented, including 80 species new to the world and 21 new to India. This highlights the region's unexplored ecological potential.

Threatened Flora

Recent assessments indicate that over 300 tree species in Kerala are threatened. Habitat loss, climate change, and human interventions are key contributing factors.

Ecosystem Diversity

Kerala's ecosystems include tropical rainforests, sacred groves (kavus), wetlands, mangroves, agroecosystems, and coastal-marine habitats. These ecosystems provide critical ecological services such as carbon sequestration, water regulation, and biodiversity conservation.

Agro-Biodiversity and Nutraceutical Value

Kerala exhibits significant agro-biodiversity:

- 520 medicinal plant species
- 71 rice landraces
- 68 spice varieties
- 126 banana varieties
- 33 coconut varieties

This diversity contributes to food security, traditional medicine, and economic sustainability.

Terrestrial and Aquatic Diversity

Kerala supports a wide range of species:

- 547 bird species
- 118 mammals
- 134 amphibians
- 328 butterflies
- 213 freshwater fish species
- 830 marine biodiversity species

Such diversity emphasizes Kerala's role as a critical conservation region.

7.Environmental Governance Initiatives in Kerala

During 2024–25, Kerala made notable progress in biodiversity conservation and environmental governance through a range of integrated initiatives. The state strengthened biodiversity management by enhancing the capacity of Biodiversity Management Committees (BMCs), updating and digitizing People's Biodiversity Registers (PBRs), and promoting community participation in conservation efforts. Significant achievements include the restoration of sacred groves, conservation of 84 red-listed species through multiple projects, establishment of biodiversity parks, and implementation of habitat restoration and riparian plant multiplication programs that produced large numbers of saplings. Marine and inland biodiversity also received attention through participatory biodiversity records, inland fish breeding programs, and initiatives such as the removal of ghost nets in collaboration with research institutions. Additionally, pond ecosystem restoration, agro-biodiversity documentation, and the conservation of wild edible plant varieties further contributed to strengthening ecological sustainability across the state.

Efforts in research and Access and Benefit Sharing (ABS) mechanisms were expanded, with BMCs established across all local bodies and increased integration of biodiversity action plans into local governance. Training programs, financial support to BMCs, and the preparation of Local Biodiversity Strategy and Action Plans (LBSAPs) improved institutional effectiveness. The declaration of Biodiversity Heritage Sites, restoration projects like Vellayani Lake, and management of invasive species highlighted focused ecological interventions. At the same time, biodiversity awareness and education initiatives engaged thousands of students through Student

Biodiversity Clubs, training programs, fellowships, internships, and innovation challenges. Campaigns such as Kavinu Kavalayi promoted community-led conservation of sacred groves and cultural landscapes. Overall, these combined efforts reflect a holistic approach that integrates science, policy, and community action, thereby enhancing Kerala's ecological resilience and ensuring the long-term conservation of its rich biodiversity.

Kerala has introduced several innovative initiatives to strengthen biodiversity conservation while integrating community knowledge and inclusive development. One such initiative is the Kerala Traditional Knowledge Digital Library (KTKDL), which aims to systematically document and digitally archive the state's rich traditional ecological knowledge related to biodiversity, healthcare, and agriculture. By creating a comprehensive digital repository, the initiative not only helps prevent bio-piracy but also promotes fair and equitable benefit-sharing. Furthermore, it serves as an important resource for research, policy formulation, and intellectual property protection, while empowering local communities to preserve and assert their rights over indigenous knowledge systems.

Another significant initiative is the She-Bio programme, implemented by the Kerala State Biodiversity Board in collaboration with Kudumbashree, which focuses on empowering women through biodiversity-based livelihoods. The programme promotes women-led enterprises grounded in traditional ecological knowledge, such as medicinal plant cultivation, processing of non-timber forest products, and production of bio-resource-based wellness goods. By building the capacity of women's collectives and linking their activities with Local Biodiversity Funds and state biodiversity strategies, She-Bio creates a sustainable and inclusive development model. Additionally, the People's Marine Biodiversity Registers (PMBRs) initiative plays a crucial role in documenting marine biodiversity across Kerala's coastal districts, including species diversity, habitats, and traditional knowledge of coastal communities. These registers support climate adaptation planning by addressing challenges such as sea-level rise and changes in marine ecosystems, while promoting community-based conservation and sustainable coastal development.

The Kerala State Climate Change Adaptation Mission, established in 2023, represents a comprehensive effort to address climate challenges by reducing greenhouse gas emissions, promoting cleaner technologies, and strengthening resilience through effective adaptation strategies. The mission focuses on safeguarding human settlements, infrastructure, and livelihoods, while also encouraging skill development and reskilling for green jobs, facilitating climate adaptation financing, integrating climate and disaster risk considerations into development planning, and restoring essential ecosystem services. As part of these efforts, a three-part Climate Change Series was conducted during 2024–25 to support informed decision-making and adaptive planning. The first dialogue, held on 28 October 2024 at the Alappuzha Coir Corporation Convention Centre, focused on developing a climate-based restoration plan for Vembanad Lake in collaboration with the Alappuzha Collectorate. The subsequent dialogues, conducted on 6th and 7th February 2025 in association with Mathrubhumi Daily, contributed to identifying strategies for reducing climate risks and enhancing resilience in vulnerable regions. Additionally, the International Conference on Climate Adaptation and Resilience (CARE 2025), organized in collaboration with Cochin University of Science and Technology (CUSAT) from 24 to 25 March 2025, aimed at advancing carbon reduction efforts and establishing a unified framework for carbon accounting and grading in the state.

While policy frameworks such as the State Action Plan on Climate Change (SAPCC 2.0) and greenhouse gas (GHG) inventory systems in India and Kerala represent important steps toward climate governance, their current implementation reveals several limitations.

First, SAPCC 2.0 largely adopts a sectoral and top-down approach, with insufficient integration of biodiversity-specific indicators, particularly at the ecosystem level. In a biodiversity-rich region like the Western Ghats, this limits the ability to capture localized ecological vulnerabilities such as species endemism and habitat fragmentation.

Second, GHG inventories primarily focus on emission accounting, often overlooking ecosystem services and carbon sinks such as forests, wetlands, and coastal ecosystems. This results in an incomplete representation of climate–biodiversity linkages, especially in regions like Kerala where ecosystems play a critical role in climate mitigation and adaptation.

Third, there is a governance gap in data integration and monitoring. Existing frameworks rely heavily on aggregated secondary data, with limited real-time, spatially disaggregated datasets. This restricts evidence-

based policymaking and reduces responsiveness to emerging environmental risks.

Additionally, institutional coordination remains weak, with fragmented responsibilities across departments (forestry, climate, fisheries, agriculture), leading to overlaps and inefficiencies in implementation.

To strengthen policy effectiveness, the following measures are recommended:

1) Integrate biodiversity metrics into SAPCC 2.0
   Include indicators such as species endemism, habitat quality, and ecosystem resilience to ensure more holistic planning.
2) Expand GHG inventories to include ecosystem-based accounting
   Incorporate blue carbon (coastal ecosystems) and green carbon (forests) to better reflect ecological contributions.
3) Strengthen data systems and monitoring
   Use GIS-based tools, remote sensing, and biodiversity informatics platforms for real-time tracking and localized analysis.
4) Enhance interdepartmental coordination
   Establish a unified environmental governance framework at the state level to reduce fragmentation.
5) Promote community-based conservation
   Engage local communities in biodiversity monitoring and climate adaptation strategies.
6) Periodic policy evaluation and feedback mechanisms
   Introduce adaptive governance through regular review and updating of SAPCC strategies.

Conclusion

The findings reveal that while Kerala has made substantial progress in biodiversity conservation and environmental governance through initiatives such as community-based conservation, biodiversity registers, ecosystem restoration, and climate adaptation programs significant challenges persist. High levels of endemism, increasing numbers of threatened species, and ecosystem degradation underline the urgency for more integrated and adaptive approaches. Moreover, despite the presence of policy frameworks like SAPCC 2.0 and GHG inventory systems, their effectiveness is constrained by limited incorporation of biodiversity indicators, inadequate ecosystem based accounting, data gaps, and institutional fragmentation.Addressing these challenges requires a paradigm shift from sectoral and descriptive policy approaches to integrated, ecosystem based governance frameworks. Strengthening biodiversity climate linkages, enhancing real-time data systems, promoting interdepartmental coordination, and deepening community participation are essential for improving policy outcomes.

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