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Opinion

Ecosystem Services of Sacred Forests in the Contemporary Scenario of Climate Change in the 21st Century

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Abstract

Sacred forests represent a unique biocultural approach to climate resilience and biodiversity conservation. These community-governed, spiritually significant forest patches deliver intertwined ecological and cultural benefits, functioning as living climate infrastructure. They sustain biodiversity comparable to adjacent natural forests, conserve species and habitats, and maintain genetic reservoirs critical for ecosystem stability. Sacred forests store substantial carbon in biomass and soils, contributing meaningfully to climate mitigation goals. Their dense vegetation buffers local microclimates, stabilizes soils, and enhances water security by supporting aquifer recharge and riparian corridors. These attributes collectively reduce vulnerability to droughts and floods, while promoting soil health and nutrient cycling. Beyond ecological services, sacred forests uphold cultural heritage and traditional ecological knowledge, reinforcing community stewardship and spiritual values. They provide medicinal plants, non-timber forest products, and livelihood opportunities, strengthening socio-economic resilience. Recognizing sacred forests as Other Effective Area-Based Conservation Measures (OECMs) and integrating them into national adaptation and mitigation strategies can accelerate progress toward global biodiversity and climate targets such as 2030 and Nationally Determined Contributions (NDCs). Policy instruments like ecosystem-based adaptation frameworks and community climate finance can further scale their impact while safeguarding custodian rights. This opinion communication emphasizes the multifunctional role of sacred forests in biodiversity conservation, climate regulation, and cultural preservation. By bridging traditional governance systems with modern conservation and climate policies, sacred forests offer a cost-effective, socially inclusive pathway to achieve sustainability goals. Their recognition and integration into formal planning frameworks are essential for amplifying ecological benefits and honoring the cultural ethos that sustains these landscapes.

Keywords: Sacred forests; sacred groves; OECM; biodiversity; ecosystem services; adaptation; mitigation; environmental protection; nature-based solutions

Key Highlights:

- Sacred forests can store ~400 tC/ha as total ecosystem carbon.
- Meta-analysis confirms biodiversity levels comparable to protected forests.
- Riparian sacred groves buffer floods and sustain baseflows.
- Microclimate moderation observed in Himalayan temple forests.
- OECM recognition and community carbon finance can scale impact.

Graphical Abstract

(Figure 1) Potential of Sacred Forests.

Figure 1: Potential of Sacred Forests.

Why Sacred Forests Matter Now

Sacred forests are increasingly recognized as critical biocultural assets for biodiversity and climate resilience. Global syntheses confirm that sacred natural sites deliver positive biodiversity outcomes across continents (Zannini et al., 2021), and meta-analyses show they harbor species richness comparable to adjacent forests, with particularly strong effects for plants [1,2]. The IPBES Global Assessment [3] emphasizes strengthening Indigenous and local stewardship as a cornerstone of conservation. Designating sacred forests as Other Effective Area-Based Conservation Measures (OECMs) enables contributions to global targets such as 30×30 while safeguarding custodianship [4,5].

How Sacred Forests are effective in Biodiversity Conservation

Sacred forests play a pivotal role in sustaining biodiversity and ecosystem integrity. They maintain high plant diversity and structural complexity, supporting species-rich habitats [2,6]. Regional studies from Central India report 109 tree species with mean total carbon stocks (tree biomass plus soil organic carbon at 0–30 cm) around 154 tC/ha, with maxima exceeding 450 tC/ha [7]. These forests also enhance microclimatic stability and favor sensitive taxa such as lichens, indicating their ecological significance [8-10].

Can Sacred Forest aid in Climate Change Adaptation

Sacred forests contribute significantly to climate adaptation through their strategic hydro-ecological placement near streams and recharge zones, providing riparian buffering and mitigating local flood and drought risks [6,11] (Table 1). The IPCC AR6 [12] identifies ecosystem-based adaptation as a high co-benefit pathway, and sacred forests exemplify this approach with strong social legitimacy. Their integration into mixed governance systems enhances durability and adaptive capacity [13,14]. By combining ecological functionality with cultural stewardship, sacred forests offer nature-based solutions that strengthen resilience in vulnerable landscapes.

How can Sacred Forests facilitate Climate Change Mitigation (Carbon Storage)

Sacred forests serve as significant carbon sinks, storing biomass and soil carbon at densities comparable to or exceeding managed landscapes. Zagros oak groves report total carbon stocks of approximately 339 tC/ha, including soil organic carbon (SOC), compared to 113 tC/ha in silvopastoral lands, with SOC alone reaching 125 tC/ha versus 71 tC/ha [15]. Central and eastern Indian and sacred groves range from 45 to 455 tC/ha [7,16], while Ethiopian sites store 128–319 tC/ha in biomass [17]. Additional evidence from Southwest Nigeria and Uttar Dinajpur shows above-ground carbon between 24 and 198 tC/ha [14,18] (Table 2).

Table 1: Policy and finance standards for adoption of sacred-forest climate solutions.

Standards	Action	Rationale
OECM recognition	Map with custodians; apply national OECM process	Counts toward 30×30; respects FPIC [4]
Co-management compacts	Blend customary rules with legal overlays	Improves durability and compliance [13]
Community climate finance	Measure multi-pool C; social safeguards; share benefits	High co-benefits; aligns with IPCC EbA [12]
Hydro-ecological zoning	Prioritize riparian groves in urban/regional plans	Supports adaptation outcomes [11]

Table 2: Surveillance and Monitoring priorities.

Criteria	Minimal standard requirements
Carbon accounting comparability	Report pools (AGB, BGB, DW, litter, SOC), depths, methods; co-produce with custodians
Beyond plants	Include fungi, bryophytes, lichens, invertebrates; standardized protocols
Adaptation metrics	Pair microclimate, infiltration, hydrology with indigenous knowledge

Environmental Protection through Sacred Forest Ecosystems

Sacred forests play a crucial role in maintaining soil and watershed health. Their soils typically exhibit higher carbon and nitrogen percentages and lower bulk density compared to adjacent land uses, which reduces erosion and enhances water infiltration [19,20]. These characteristics help stabilize landscapes and support groundwater recharge. Reviews consistently link sacred forests to watershed protection and hydrological regulation [8]. Furthermore, cultural and spiritual values embedded in these ecosystems foster strong community stewardship, creating co-benefits for environmental protection and sustainable resource management [4].

Sacred Forests are essential: Ecosystem Services and their Necessities

Sacred forests deliver multifunctional ecosystem services that integrate ecological and cultural dimensions. They conserve biodiversity by maintaining species richness, genetic diversity, and microhabitat integrity [2,6]. Climate regulation services include carbon sequestration in biomass and soils, microclimate buffering, and riparian protection, reducing flood and drought risks [7,9,15]. Cultural and livelihood services encompass spiritual heritage, traditional ecological knowledge, medicinal plants, non-timber forest products, and eco-cultural tourism opportunities [1,3,17]. These services collectively strengthen resilience, support global biodiversity targets, and uphold community stewardship, positioning sacred forests as cost-effective nature-based solutions for sustainability.

Conclusions

Sacred forests are biocultural climate solutions: they conserve biodiversity effectively, store substantial carbon (often rivaling formally protected forests), buffer microclimates and water regimes, and deliver cultural values that sustain stewardship. Recognizing them as OECMs, aligning with REDD+ finance and safeguards, and upgrading monitoring can amplify their role in 21st century climate adaptation, mitigation, and environmental protection while honoring the communities who have conserved them for generations.

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