



Review Article

# Biodiversity Protection Laws and Policies in India: A Critical Review of Biological Diversity Act 2002 and Its Implementation Gaps

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## Abstract

Biodiversity underpins human well-being through ecosystem services that support public health, food security, and climate resilience. India, a megadiverse nation, covers approximately 2.4% of the planet's land area yet harbours about 8% of the world's recorded species, including over 49,000 plants and approximately 102,000 animals (as of 2026). Accelerating anthropogenic pressures like habitat loss, overexploitation, climate-induced ecosystem disruption, and unauthorised appropriation of biological resources through biopiracy threaten this heritage, with an estimated one million species at risk of extinction within decades. This review critically examines India's Biological Diversity Act, 2002, the principal statute establishing a three-tier institutional framework comprising the National Biodiversity Authority (NBA), State Biodiversity Boards (SBBs), and Biodiversity Management Committees (BMCs). By September 2025, India had established 2,76,653 BMCs and 2,72,648 People's Biodiversity Registers, and between 2017 and 2025 mobilised Rs 216.31 crore through the Access and Benefit Sharing (ABS) mechanism. Using a qualitative, document-based methodology drawing on primary legal instruments, India's first Nagoya Protocol Implementation Report (2026), international treaties, and peer-reviewed scholarship, the review identifies ten major implementation gaps including weak institutional capacity, inadequate funding, low public awareness, incomplete PBRs, poor enforcement, and overlapping jurisdictional mandates. It further analyses the implications of the Biological Diversity (Amendment) Act, 2023, the Biological Diversity Rules, 2024, and the ABS Regulations, 2025 for community rights and conservation outcomes, and concludes with evidence-based recommendations aligned with the Kunming-Montreal Global Biodiversity Framework (2022) and India's 2030 commitments.

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**Statement of Sustainability:** This review supports sustainability by critically evaluating India's biodiversity governance framework and its role in conserving biological resources, protecting ecosystem services, and promoting equitable benefit sharing. By identifying implementation challenges and assessing recent legal reforms, the study contributes to strengthening biodiversity conservation, community participation, and sustainable resource management. The recommendations align with the Kunming-Montreal Global Biodiversity Framework and India's 2030 biodiversity commitments, advancing long-term ecological resilience, social well-being, and sustainable development in the face of increasing environmental pressures.

## 1. Introduction

Biodiversity, the full range of life on Earth, from genes and species to entire ecosystems, underpins human well-being through agriculture, medicine, cultural traditions, and climate adaptation. The Convention on Biological Diversity (CBD), adopted at the 1992 Rio Earth Summit, was the first multilateral instrument to formally recognise this dependence. Since then, the global biodiversity crisis has accelerated: species are now disappearing at rates 10 to 100 times higher than the historical background rate, and an estimated one million species face extinction within the coming decades (IPBES Global Assessment, 2019; LSE/IPBES, 2025). The CBD's 196 parties, guided by the Kunming-Montreal Global Biodiversity Framework adopted in December 2022, are obligated



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to align national biodiversity legislation with the Framework’s 23 targets, most prominently the commitment to safeguard 30% of the planet’s land and ocean area by 2030. Ecosystems provide four broad categories of services: provisioning (food, water, timber, medicine, genetic materials), regulating (climate stability, flood control, pollination, disease regulation), cultural (recreation, spiritual and aesthetic value), and supporting (nutrient cycling, soil formation, oxygen production) (Table 1). Approximately 80% of the world’s population relies on plant-based remedies for primary healthcare, and nature-based tourism generates more than US\$800 billion annually (World Bank, 2008; TEEB, 2010; FAO, 2025).

Table 1. Importance of biodiversity in different sectors.

Sector	Ecosystem Services	Significance (2025 Context)
Provisioning Services	Food, freshwater, timber, medicine, fibre, genetic resources	~3.8 billion people depend on wild species for food security (IPBES, 2024)
Regulating Services	Climate regulation, flood control, pollination, carbon sequestration	Forests absorb ~30% of global CO <sub>2</sub> annually; pollinators support 75% of food crops (FAO, 2025)
Cultural Services	Recreation, tourism, spiritual values, biocultural heritage	India’s ecotourism sector valued at \$24 billion
Supporting Services	Nutrient cycling, soil formation, primary production, oxygen	Underpin all other ecosystem services; soil microbiome supports 95% of terrestrial food production

India occupies just 2.4% of global land area, yet harbours roughly 8% of the world’s recorded biodiversity, including over 49,000 plant species and approximately 102,000 animal species (MoEFCC, 2025; IUCN, 2025). The country contains four of the world’s 36 recognised biodiversity hotspots like the Himalayas, the Western Ghats and Sri Lanka, the Indo-Burma region, and Sundaland (including the Nicobar Islands), each characterised by exceptional endemism and acute anthropogenic pressure (Table 2). As of 2025, forest and tree cover stood at approximately 24.62% of the national geographical area, and tiger numbers had recovered to an estimated 3,682 from 1,411 in 2006 (India State of Forest Report, 2025). Nevertheless, habitat loss, illegal wildlife trade, invasive alien species, pollution, and anthropogenic climate change the last linked to nearly 40% of animal extinctions globally (CBD, 2023) continue to drive biodiversity decline. Biopiracy, defined as the unauthorised appropriation of biological resources or associated traditional knowledge through patents and other intellectual-property instruments, remains a persistent and serious threat (Shiva, 1997; MoEFCC, 2021).

Table 2. Major causes of biodiversity loss in India.

Cause	Description	Severity (2025)	Impact
Habitat Destruction	Urbanisation, agriculture expansion, mining	Very High	~30% of original habitat degraded; Critically Endangered species
Climate Change	Temperature rise (+0.7°C since 1901), altered rainfall, sea-level rise	High - Escalating	Coral bleaching; species range shifts; Himalayan glacier retreat
Illegal Wildlife Trade	Poaching, smuggling, black market demand	High	Population collapse of key species; Rs 7,000+ crore annual illegal market
Invasive Alien Species	Non-native species displacing native biodiversity	High - Rising	Linked to 40% of animal extinctions globally (CBD, 2023)
Pollution	Industrial effluents, agricultural runoff, microplastics	Medium-High	Microplastics detected in 90% of Indian river ecosystems
Overexploitation	Unsustainable harvesting of biological resources	High	>35% medicinal plants under threat; marine ecosystem stress

India’s post-independence environmental legislation evolved incrementally. The Indian Forest Act, 1927 provided early statutory protection for forest resources; the Wildlife Protection Act, 1972 established the country’s protected-area system; the Forest Conservation Act, 1980 required central-government approval for the diversion of forest land; and the Environment (Protection) Act, 1986 set the overarching framework for environmental regulation. None of these instruments, however, addressed access to biological resources (2025) or the equitable sharing of benefits arising from their use, the regulatory vacuum that the Biological Diversity Act, 2002 was enacted to fill. This legislative architecture has been further reshaped in recent years by the Biological Diversity (Amendment) Act, 2023, the Biological Diversity Rules (2024), and the ABS Regulations (2025).

Against this backdrop, the present review pursues four objectives: first, it analyses India’s Biological Diversity Act, 2002, its structure and core provisions, situating it within the 2023 Amendment, the 2024 Rules, and the 2025 Regulations. Second, it evaluates how the Act has been operationalised over the past two decades, drawing on India’s first Nagoya Protocol Implementation Report



(2026). Third, it identifies the most consequential gaps in implementation. Finally, it offers evidence-based policy recommendations aligned with the Kunming-Montreal Global Biodiversity Framework (2022).

The scope of the review is bounded as follows. It examines India’s biodiversity governance through legal and policy analysis, drawing on primary and secondary sources published between 1990 and 2026. It covers the functioning of the NBA, SBBs, and BMCs; the operation of ABS rules; the status of PBR implementation; and brief comparative reference to other megadiverse jurisdictions. The principal limitations are reliance on secondary data, the possibility that some peer-reviewed work was not captured by the search strategy, and the difficulty of tracking policy developments that have evolved during the writing of this review.

## 2. Literature Review

Scholarship on biodiversity governance in India spans ecological, legal, and socio-economic perspectives. Kothari et al. (1995) questioned the exclusionary logic of protected-area management and argued for community-led conservation, while Gadgil and Guha (1995) offered a foundational political-ecology account of conflicts over India’s natural resources. Sahai (2003) provided one of the earliest critical reviews of the Biological Diversity Act, identifying structural weaknesses, and Bhutani and Kothari (2002) situated the Act within the broader landscape of international biodiversity governance. Building on this foundation, Kumar (2016) analysed Access and Benefit Sharing (ABS) provisions under the Act and revealed significant gaps between legislative intent and practical implementation, Nanda and Patra (2015) reviewed the National Biodiversity Authority’s institutional capacity and limitations, and Shrivastava (2018) critiqued the implications of the Amendment Bill for community rights. India’s first Nagoya Protocol Implementation Report (Down to Earth, 2026) has since offered the most comprehensive recent assessment of ABS outcomes, Biodiversity Management Committee (BMC) functionality, and benefit-sharing effectiveness.

International and thematic scholarship has further enriched this body of work. Laird (2002) provided a comprehensive global overview of ABS, Bavikatte and Robinson (2011) developed biocultural jurisprudence in the context of the Nagoya Protocol, and Suneetha and Pisupati (2009) documented Indian ABS cases that revealed systemic failures in benefit distribution; the ABS Regulations, 2025 now introduce sector-specific thresholds and Digital Sequence Information provisions. On People’s Biodiversity Registers (PBRs), Gadgil et al. (1993) pioneered the indigenous-knowledge concept informing PBR design, and Yadav and Singh (2020) documented inter-state variations in completion rates from 34% to 88% identifying capacity gaps as a primary constraint; the National Campaign for Updation and Verification of PBRs, launched in Goa, represents the most recent initiative to address PBR quality (NBA, 2025). On biopiracy and traditional knowledge, Shiva (1997, 2001) documented systematic appropriation of Indian traditional knowledge through the patent system using the Neem and Turmeric cases, Mgbeoji (2006) situated Indian cases within a global analysis of biopiracy, and Dutfield (2004) examined the relationship between intellectual property and biogenetic resources, with particular attention to India’s Traditional Knowledge Digital Library.

Notwithstanding this expanding literature, several research gaps remain. Empirical studies on BMC operational effectiveness are limited, scholarly analysis of the 2023 Amendment’s implications for community rights is still emerging, comparative legal analysis between India and other megadiverse nations is sparse, and the 2024 Rules and 2025 Regulations as operationalising instruments have yet to receive sustained scholarly attention. The present review addresses these gaps by synthesising statutory developments through 2026 with the empirical record on implementation (Table 3).

Table 3. Major previous studies related to biodiversity governance in India.

Author (Year)	Focus Area	Key Contribution	Research Gap
Kothari et al. (1995)	Community conservation	Emphasised local participation in biodiversity governance	Lack of formal legal framework
Shiva (1997)	Biopiracy & TK	Documented misappropriation of Indian genetic resources	Policy recommendations underexplored
Gadgil (1995)	PBR concept	Advocated grassroots documentation of biodiversity data	Implementation challenges not addressed
Nanda & Patra (2015)	NBA functioning	Reviewed NBA institutional capacity and limitations	State-level analysis missing
Yadav & Singh (2020)	PBR implementation	State-wise assessment of completion rates and quality	Post-2023 Amendment implications not covered
Down to Earth (2026)	Nagoya Protocol	India’s first Nagoya Report: 2,76,653 BMCs; Rs 216 crore ABS mobilised	BMC functionality in practice under-assessed

## 3. Methodology

This review adopts a qualitative, document-based research design that combines analytical and descriptive approaches to examine the legal architecture and implementation status of biodiversity governance in India. The qualitative orientation is appropriate given the multidimensional nature of biodiversity governance, which spans legal, institutional, ecological, and socio-economic domains. The evidence base draws on two categories of sources: primary sources comprise statutory instruments and treaty texts



the Biological Diversity Act, 2002; the Biological Diversity (Amendment) Act, 2023; the Biological Diversity Rules, 2024; the ABS Regulations, 2025; the Convention on Biological Diversity; the Nagoya Protocol; CITES; and the TRIPS Agreement together with NBA Annual Reports (2003–2024) and India’s first Nagoya Protocol Implementation Report (2026); secondary sources comprise peer-reviewed journal articles, government policy documents, reports from international organisations (IPBES, FAO, IUCN), publications from non-governmental organisations, and academic monographs. Three complementary methods were applied. First, a systematic literature review followed PRISMA-informed principles: a search across Google Scholar, LexisNexis, JSTOR, and PubMed using the terms biodiversity governance, Biological Diversity Act, Access and Benefit Sharing, People’s Biodiversity Registers, biopiracy, and Nagoya Protocol returned approximately 620 records published between 1990 and 2026; title and abstract screening reduced this to 284 records assessed for full-text eligibility, and after applying exclusion criteria and removing duplicates, 87 primary studies and policy documents were retained for analysis, with legal instruments and government reports examined in their entirety. Studies were eligible for inclusion if they addressed biodiversity governance, environmental law, or ABS mechanisms in India or in comparable megadiverse developing nations; were published in English in peer-reviewed journals or in credible grey literature; and appeared between 1990 and 2026; studies reporting purely ecological or taxonomic work without policy or governance relevance were excluded. Second, comparative legal analysis situated India’s framework alongside those of other megadiverse jurisdictions, principally Brazil and Australia. Third, policy analysis applied a gap-analysis lens, mapping statutory provisions against empirical implementation evidence to identify and categorise the deficits between legislative intent and outcomes (Figure 1).

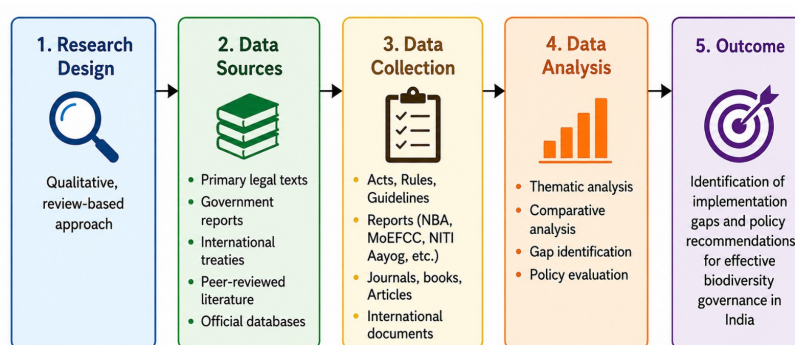


Figure 1. Research methodology flowchart (Source: Developed by Authors).

## 4. Thematic Analysis

### 4.1. Global Frameworks for Biodiversity Protection

#### 4.1.1. Convention on Biological Diversity (CBD): Origin and Objectives

The Convention on Biological Diversity, adopted at the 1992 United Nations Conference on environment and development in Rio de Janeiro, represents the most comprehensive multilateral agreement addressing biodiversity conservation (CBD, 1992) with 196 parties. The CBD established three principal objectives: conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of benefits arising from the utilisation of genetic resources.

#### 4.1.2. Nagoya Protocol on Access and Benefit Sharing (ABS)

The Nagoya Protocol, adopted in 2010 and entered into force in 2014, operationalised the CBD’s third objective by establishing a legally binding ABS framework. It requires Prior Informed Consent from the providing country and benefit sharing on Mutually Agreed Terms. India’s first Nagoya Protocol Implementation Report (2026) revealed that between 2017 and 2025, Rs 216.31 crore was mobilised through NBA approvals, with Rs 139.69 crore disbursed to communities, farmers, and traditional knowledge holders.

#### 4.1.3. CITES: Trade Regulation of Endangered Species

The Convention on International Trade in Endangered Species (1973) regulates international trade in approximately 38,000 species through a permit system. India is a CITES signatory, integrating its provisions through the Wildlife Protection Act, 1972.

#### 4.1.4. TRIPS Agreement and Its Conflict with Biodiversity Protection

The TRIPS Agreement (1994) creates inherent tensions with biodiversity governance by permitting patents on biological materials without mandatory disclosure of origin or proof of ABS compliance. India has consistently advocated in WTO forums for amendments requiring disclosure of origin and evidence of PIC and ABS compliance.



#### 4.1.5. United Nations Sustainable Development Goals (SDGs) and Biodiversity

SDG 15 (Life on Land) and SDG 14 (Life Below Water) directly address biodiversity conservation. India’s biodiversity governance commitments are increasingly integrated with its broader SDG implementation framework and the Kunming-Montreal GBF (2022).

#### 4.1.6. India's International Biodiversity Commitments

India has ratified all major international biodiversity agreements, including the CBD, Nagoya Protocol, Cartagena Protocol on Biosafety, and CITES. India’s commitments under the Kunming-Montreal Global Biodiversity Framework (2022) include the 30×30 target, against which India’s current protected area coverage of approximately 5% of land represents a significant implementation challenge. The Union Minister of Environment has affirmed that the 30×30 target will be “comfortably achieved” by 2030 (Table 4 and Figure 2).

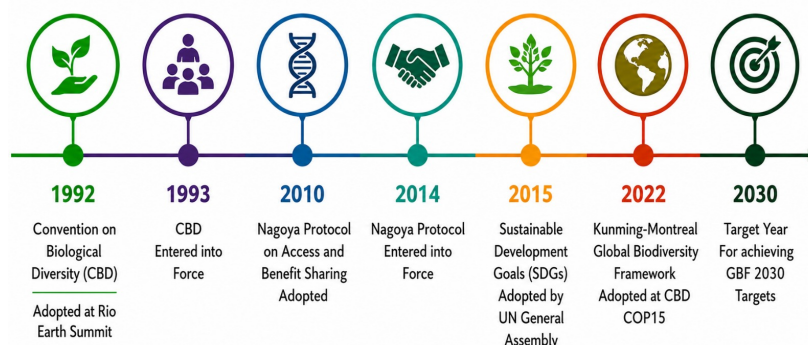


Figure 2. Timeline of International Biodiversity Agreements (1973–2026).

Table 4. Major international biodiversity agreements and objectives.

Agreement	Year	Place Adopted	Objectives / 2026 Status
CBD	1992	Rio de Janeiro	Conservation, sustainable use, equitable benefit sharing; 196 parties
Nagoya Protocol	2010 (in force 2014)	Nagoya, Japan	ABS from genetic resources; India’s first implementation report 2026
CITES	1973	Washington DC	International trade regulation of ~38,000 species
Cartagena Protocol	2000	Montreal, Canada	Safe handling of living modified organisms
Bonn Guidelines	2002	Bonn, Germany	Voluntary ABS guidelines preceding Nagoya Protocol
Kunming-Montreal GBF	2022	Montreal, Canada	23 targets for 2030; 30×30; \$200 billion/year finance target

#### 4.2. Biodiversity Laws in India: Pre-2002 Legal Framework

Table 5 presents a comparative overview of the major environmental and forest-related laws in India prior to the enactment of the Biological Diversity Act, 2002. The table highlights the primary focus, scope, and limitations of key legislations, including the Indian Forest Act (1927), Wildlife Protection Act (1972), Forest Conservation Act (1980), and Environment Protection Act (1986). Although these laws contributed significantly to environmental conservation, they lacked comprehensive provisions for biodiversity management, access and benefit-sharing (ABS), and community participation, thereby necessitating a dedicated legal framework for biodiversity conservation in India.

Table 5. Comparison of environmental laws before 2002.

Law	Primary Focus	Scope	Limitations
Indian Forest Act, 1927	Forest protection	Limited to state forest land	Excluded private lands; no biodiversity or ABS focus
Wildlife Protection Act, 1972	Wildlife and habitat	Protected areas and sanctuaries	No ABS mechanism; limited community role
Forest Conservation Act, 1980	Forest diversion control	Central government approval needed	No biodiversity assessment requirement
Environment Protection Act, 1986	Broad environmental protection	All environmental media	Biodiversity not explicitly covered



### 4.3. Biological Diversity Act, 2002: An Overview

#### 4.3.1. Historical Background and Legislative Journey

The legislative journey of the BDA spanned nearly a decade, reflecting the complexity of reconciling diverse stakeholder interests. India’s active participation in CBD negotiations from 1989 and its signature at the 1992 Rio Summit created a domestic legislative imperative. The BDA was passed in 2002 and notified in 2003, informed by recognition that India’s sovereign rights over biological resources were being undermined by unchecked biopiracy and the absence of dedicated ABS mechanisms (Bhutani & Kothari, 2002). The Biological Diversity (Amendment) Act, 2023, the Biological Diversity Rules, 2024, and ABS Regulations 2025 represent the most recent evolution of this legislative framework.

#### 4.3.2. Three-Tier Institutional Structure

The BDA’s three-tier institutional structure represents a pioneering model of decentralised biodiversity governance, distributing regulatory authority across national, state, and local levels. This architecture reflects the principle of subsidiarity placing governance decisions as close as possible to the communities most dependent on biodiversity. The NBA (2024) provides overarching regulatory authority and international interface; SBBs translate national policy into state-level implementation contexts; and BMCs ground the governance framework in the specific ecological and cultural knowledge of local communities. As of September 2025, India has constituted 2,76,653 BMCs nationally (NBA, 2025), representing the largest network of community-level biodiversity governance institutions in the world. The effectiveness of this structure, however, is contingent on functional coordination across all three tiers, adequate resource allocation, and meaningful community participation conditions that remain partially unmet, as detailed in the implementation gap analysis below (Figure 3 and Table 6).

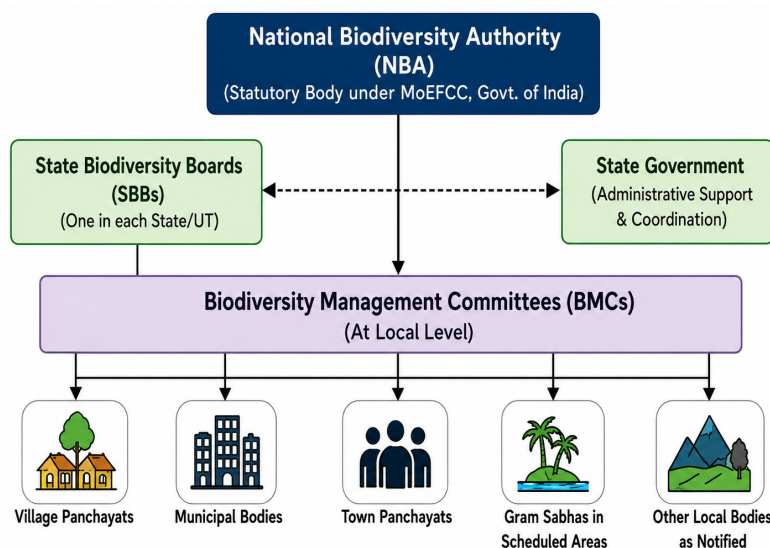


Figure 3. Institutional structure under Biological Diversity Act, 2002.

Table 6. Major features of Biological Diversity Act, 2002.

Feature	Description (Updated 2025-26)
Three-Tier Structure	NBA at national, SBBs at state, BMCs at local level; 2,76,653 BMCs as of September 2025 (NBA, 2025)
Access Regulation	Prior Informed Consent (PIC) and Mutually Agreed Terms (MAT); online applications under Biological Diversity Rules, 2024
Benefit Sharing	Rs 216.31 crore mobilised 2017–2025; Rs 139.69 crore disbursed to communities (Down to Earth, 2026)
People’s Biodiversity Registers	2,72,648 PBRs documented nationwide; digitization mandate under BD Rules, 2024 (NBA, 2025)
IPR Protection	NBA approval required before filing IPR claims; e-forms under 2023 Amendment operationalised
ABS Regulations 2025	Sector-specific thresholds; 5–20% for high-value species (red sanders, agarwood, sandalwood); DSI provisions included
Penalty Provisions	Adjudicated by officer not below Joint Secretary rank; appeals to NGT under BD Rules, 2024



#### 4.4. National Biodiversity Authority (NBA): Structure and Functions

The NBA was constituted in 2003 as a statutory, autonomous body under the BDA, headquartered in Chennai. Its core functions encompass regulation of access to biological resources and associated traditional knowledge, negotiation and operationalization of ABS agreements, advising the Central Government on biodiversity policy, and maintaining a publicly accessible National Biodiversity Register. Critically, no person or organisation may apply for intellectual property rights on research involving biological resources obtained from India without prior NBA approval. Under the Biological Diversity Rules, 2024, the NBA received 41 declarations in Form 10 related to utilisation of foreign biological resources (Table 7).

Table 7. Functions and Powers of NBA.

Functions of NBA	Powers of NBA
Regulate access to biological resources by foreign entities	Grant approval for filing IPR on biological resources
Negotiate and operationalize ABS agreements	Maintain National Biodiversity Fund
Advise Central Government on biodiversity matters	Compile biodiversity inventories
Review environmental impact assessments	Coordinate with State Biodiversity Boards
Protect traditional knowledge from biopiracy	Impose penalty on violators of the Act

#### 4.5. State Biodiversity Boards (SBBs): Role and Functioning

SBBs have been established in 29 states, serving as the primary interface between national policy and local implementation (Table 8). State-wise performance analysis reveals significant inter-state variations. While Kerala and Tamil Nadu demonstrate relatively robust performance in managing biological diversity, several State Biodiversity Boards (SBBs) in the central and northeastern regions remain largely dysfunctional due to a severe lack of operational resources (NBA, 2024).

Table 8. State-wise status of biodiversity boards and BMCs (updated September 2025).

State	BMCs (September 2025)	PBRs Prepared	Key Performance Indicators
Uttar Pradesh	59,407	Ongoing	Largest BMC network nationally; awareness and effectiveness gaps persist
Maharashtra	28,649	Significant	Active ABS models; Dapur village received Rs 68 lakh under ABS (2025)
Madhya Pradesh	23,557	~34% (7,800 of 23,557)	Large GP network; significant capacity gap
Tamil Nadu	13,614	66% (8,230 of 12,525)	Strong BMC formation; some quality inconsistencies
Rajasthan	11,882	~41% (4,100 of 9,882)	Funding constraints; incomplete PBRs
Kerala	1,200	88% (912 of 1,034)	Highest quality; digitised records; strong community participation
Karnataka	6,554	~80% (4,800 of 6,022)	Good progress; strong NGO collaboration

#### 4.6. Biodiversity Management Committees (BMCs): Grassroots Conservation

BMCs represent the most innovative element of the BDA’s institutional architecture, mandated at every gram panchayat, municipality, and cantonment board (Table 9). Their primary responsibility is preparation and regular updating of People’s Biodiversity Registers. As of September 2025, 2,76,653 BMCs have been constituted nationally comprising 2,71,954 in states and 4,699 in union territories (NBA, 2025). However, India’s first Nagoya Protocol implementation report (2026) directly questions their functional effectiveness: BMC mandates were not meaningfully operationalised until after 2016, following NGT intervention, and industries frequently fail to pay benefit-sharing fees to BMCs (Down to Earth, 2026).

Table 9. Functions of biodiversity management committees.

Function	Description
Preparation of People’s Biodiversity Registers	Document all biological resources and associated traditional knowledge at local level
Conservation of Local Biodiversity	Identify and protect locally significant species, habitats, and ecosystems
Regulation of Commercial Access	Grant or deny permission for commercial access to biological resources in their jurisdiction
Benefit Sharing Implementation	Ensure equitable distribution of benefits among local communities
Awareness Generation	Organise capacity-building programmes for community members
Liaison with SBBs	Coordinate with State Biodiversity Boards for implementation support

#### 4.7. Access and Benefit Sharing (ABS)

The ABS framework established under the BDA directly operationalises the CBD’s third objective (Figure 4 and Table 10). The framework distinguishes three regulatory tracks: foreigners and foreign companies require NBA approval; Indian citizens and



companies for commercial purposes require SBB approval; and local communities accessing resources for subsistence are generally exempt. Between 2017 and 2025, Rs 216.31 crore was mobilised through NBA approvals, with Rs 139.69 crore disbursed to beneficiaries. An additional Rs 51.96 crore was generated through SBB approvals. Nearly 395 approvals also included non-monetary benefits such as capacity building, technology transfer, and collaborative research (Down to Earth, 2026). The ABS Regulations, 2025 introduce sector-specific thresholds of 5–20% or more for high-value species including red sanders, agarwood, and sandalwood, alongside provisions for Digital Sequence Information.

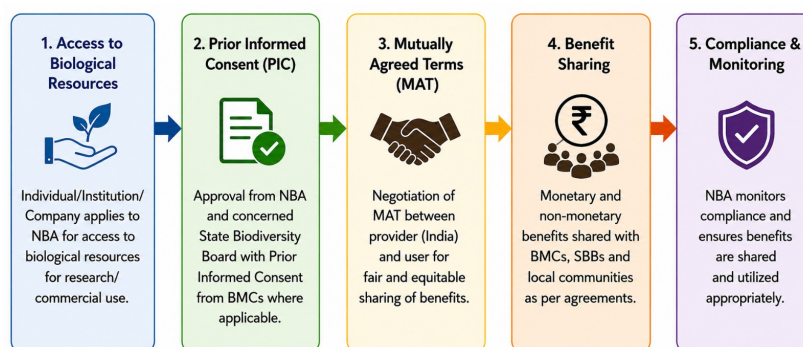


Figure 4. Access and benefit sharing framework in India.

Table 10. Types of benefits under ABS system.

Benefit Type	Examples	2025 Status and Significance
Monetary Benefits	Royalties, fees, milestone payments, research funding contributions	Rs 216.31 crore total mobilised 2017–2025; sector-specific thresholds under ABS Regulations 2025
Non-Monetary Benefits	Technology transfer, capacity building, joint research and training	395 approvals included non-monetary benefits; 2,56,393 individuals trained in 3,724 workshops (2017–2025)
Intellectual Benefits	Co-authorship, recognition of traditional knowledge holders	DSI provisions included in ABS Regulations 2025
In-Kind Benefits	Conservation infrastructure, equipment, product revenue shares	Dapur village, Maharashtra: Rs 68 lakh received under ABS mechanism (2025)

#### 4.8. People's Biodiversity Registers (PBRs)

PBRs represent a pioneering instrument for grassroots documentation of traditional ecological knowledge, conceived as both a conservation tool and a mechanism for establishing prior art against biopiracy. As of 2025, India has documented 2,72,648 PBRs across states and union territories (NBA, 2025). The Biological Diversity Rules (2024) mandated digitisation and introduced quality control requirements. The National Campaign for Updating and Verification of PBRs, launched in Goa, represents a significant recent undertaking. However, completion rates vary dramatically from 34% in Madhya Pradesh to 88% in Kerala and quality deficiencies including inaccurate documentation, outdated information, and poor digitisation persist (Table 11).

Table 11. Status of PBR preparation across Indian states.

State	Total GPs / Villages	PBRs Prepared (2025)	Challenges
Kerala	1,034	912 (88%)	High accuracy; digitisation ongoing under 2024 Rules
Karnataka	6,022	~4,800 (80%)	Good; NGO-supported; national campaign beneficiary
Tamil Nadu	12,525	8,230 (66%)	Ongoing; some quality inconsistencies
West Bengal	3,354	~2,100 (63%)	Moderate; language barriers persist
Rajasthan	11,882	~4,100 (41%)	Poor database management; funding constraints
Madhya Pradesh	23,557	~7,800 (34%)	Very incomplete; significant capacity gap
Total (National)	~2,72,648	2,72,648 (various rates)	Digitisation mandate under BD Rules, 2024; quality & updating remain challenges



## 4.9. Biopiracy and India's Legal Response

Biopiracy, defined as the unauthorised appropriation of biological resources or associated traditional knowledge, typically through the patent system, without adequate benefit sharing has been a central concern driving India's biodiversity governance agenda (Shiva, 1997). India's experience with high-profile cases in the 1990s and 2000s provided the political momentum for the BDA's enactment. The Neem and Turmeric patent cases (1990s-2000s) were landmark legal battles where India successfully challenged US and European patents on traditional knowledge, preventing "biopiracy". India proved that both neem's fungicidal properties and turmeric's wound-healing capabilities were known and practiced for centuries, making them ineligible for patents (Table 12).

## 4.10. Biological Diversity Amendment Act, 2023

The Biological Diversity (Amendment) Act, 2023 introduced several significant legislative reforms to the original BDA framework. Most notably, registered practitioners of codified traditional medicine systems including Ayurveda, Unani, and Siddha were exempted from Access and Benefit Sharing obligations when utilising biological resources for non-commercial purposes, a provision intended to reduce regulatory burden on traditional healers. The Amendment also expanded the categories of exempted entities, decriminalised certain offences by replacing imprisonment with monetary penalties, and restructured the composition of the National Biodiversity Authority to enhance state government representation. The Biological Diversity Rules, 2024, which superseded the Biological Diversity Rules of 2004, operationalised these amendments by mandating online application portals, prescribing time-bound procedures for regulatory approvals, and introducing standardised compliance protocols across states. Subsequently, the Access and Benefit Sharing Regulations, 2025 established sector-specific benefit-sharing thresholds, incorporated provisions for Digital Sequence Information, and introduced enhanced protections for high-value species including red sanders, agarwood, and sandalwood. These legislative developments have attracted critical scholarly and civil society scrutiny. Critics argue that the broadened exemptions may create regulatory loopholes susceptible to commercial misappropriation, while the shift from criminal to civil penalties is perceived as diminishing the deterrent effect of enforcement mechanisms. The long-term implications of these reforms for community biodiversity rights and the integrity of the ABS framework remain subjects of ongoing academic and policy debate (Table 13).

Table 12. Important biopiracy cases and legal outcomes.

Case	Period	Entity Involved	Legal Outcome
Neem Patent	1994–2000	W.R. Grace & Co. (USA) and USDA	Patent revoked by EPO after legal challenge by India and NGOs
Turmeric Patent	1995–1997	University of Mississippi Medical Center	Patent cancelled by USPTO citing ancient Indian texts
Basmati Rice	1997–2002	RiceTec Inc. (USA)	Partial revocation; India's GI tag for Basmati strengthened
Bitter Gourd	2002–2006	Japanese Corporation	Patent opposed; traditional use documented as prior art
Hoodia (comparable)	2003	South African Corporation	ABS agreement negotiated as corrective measure

Table 13. Comparison between Original Act, 2023 Amendment, and 2024-25 Rules.

Aspect	Original BDA 2002	Amendment Act 2023	BD Rules 2024 / ABS Regulations 2025
ABS Scope	All commercial users require prior approval	AYUSH practitioners and codified medicine users exempted	Online portal; time-bound procedures; sector-specific thresholds
Community Rights	Strong recognition of community biodiversity rights	Rights potentially diluted by expanded exemptions	BMC roles strengthened in benefit-sharing negotiation (2024 Rules)
Penalties	Strict criminal penalties (up to 5 years)	Shift towards compounding of offences	Adjudication by Joint Secretary; appeals to NGT
NBA Composition	Scientific experts dominant	Increased government representation	E-forms for IPR applications; digital transparency
ABS Mechanism	Mandatory for all commercial exploitation	Reduced mandatory scope for some sectors	5–20%+ for high-value species; DSI provisions included

## 5. Discussion

### 5.1. Implementation Gaps in the Biological Diversity Act, 2002

Despite its normatively comprehensive architecture, the BDA has faced persistent and systemic implementation challenges over its two-decade lifespan. India's first Nagoya Protocol implementation report (2026) and academic assessments reveal ten significant implementation gaps (Figure 5 and Table 14).



**Gap 1: Weak Institutional Capacity of NBA and SBBs:** The NBA and SBBs have chronically suffered from insufficient staffing, limited technical expertise, and inadequate administrative infrastructure. Several SBBs exist in name but lack the financial resources, technical capacity, and political support necessary for effective functioning (Nanda & Patra, 2015).

**Gap 2: Poor Awareness Among Local Communities and Farmers:** Surveys have consistently documented extremely low levels of awareness about the BDA, its rights provisions, and ABS mechanisms among farming communities, forest-dependent populations, and indigenous groups. Between 2017 and 2025, only 2,56,393 individuals were trained through 3,724 workshops a fraction of those requiring awareness (Down to Earth, 2026).

**Gap 3: Incomplete and Outdated People’s Biodiversity Registers:** PBR completion rates range from 34% in Madhya Pradesh to 88% in Kerala. Beyond incompleteness, existing PBRs suffer from quality deficiencies including inaccurate documentation, outdated information, and poor digitisation. The 2024 Rules mandated digitisation, but implementation remains uneven (Yadav & Singh, 2020; NBA, 2025).

**Gap 4: Inadequate Funding and Budget Allocation:** The National Biodiversity Fund and state funds continue to receive allocations grossly inadequate relative to implementation requirements. India’s biodiversity budget remains far below the Kunming-Montreal GBF’s international finance target of \$30 billion per year for developing countries by 2030 (MoEFCC, 2021).

**Gap 5: Overlapping Jurisdictions with Other Environmental Laws:** The BDA coexists with a complex web of overlapping legislation the Forest Rights Act, Wildlife Protection Act, Environment Protection Act, Plant Variety Protection Act creating jurisdictional ambiguities and governance vacuums (Cullet, 2005).

**Gap 6: Lack of Coordination Between NBA, SBBs and BMCs:** Coordination across the three-tier structure remains weak. BMCs often lack awareness of SBB guidelines; SBBs lack resources to provide technical support to BMCs; and NBA-SBB-BMC data flows are fragmented, impeding integrated biodiversity governance.

**Gap 7: Ineffective Enforcement and Penalty Mechanisms:** Despite BDA provisions for penalties including imprisonment of up to five years, enforcement actions have been remarkably rare. The 2023 Amendment’s shift toward compounding of offences further diminishes the deterrent effect. Industries frequently fail to pay benefit-sharing fees without facing consequences (Down to Earth, 2026).

**Gap 8: Limited Coverage of Marine and Coastal Biodiversity:** India’s marine and coastal ecosystems remain inadequately addressed by the BDA. The Kunming-Montreal 30×30 target explicitly requires 30% marine area protection by 2030; India’s current coverage falls far short, particularly for deep-sea habitats and beyond the territorial sea.

**Gap 9: Exclusion of Certain Biological Resources from Act’s Purview:** Certain categories including microorganisms in their natural state, certain agricultural varieties, and resources accessed through ex-situ collections remain in legal grey areas. The Act’s definitional architecture has not kept pace with advances in biotechnology, synthetic biology, and Digital Sequence Information (Kumar, 2016).

**Gap 10: Insufficient Integration with Forest and Agricultural Policies:** The BDA operates largely in isolation from India’s forest policy, agricultural biodiversity governance, and climate adaptation frameworks. Achieving the Kunming-Montreal GBF targets requires integration of biodiversity governance across all sectoral policies.

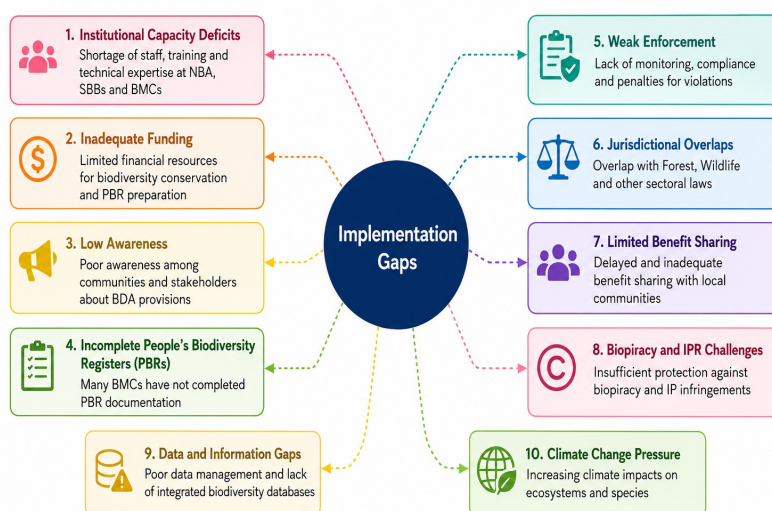


Figure 5. Major implementation gaps in biodiversity governance.



## 5.2. Comparative Analysis: India versus Other Countries

**Table 15** provides a comparative analysis of biodiversity governance frameworks in India, Brazil, and Australia. The comparison focuses on key aspects including access and benefit-sharing (ABS) mechanisms, community rights, biopiracy prevention, funding arrangements, enforcement capacity, and marine biodiversity conservation. While India has made notable progress through ABS regulations, Traditional Knowledge Digital Library (TKDL), and strengthened biodiversity rules, challenges remain in enforcement effectiveness and marine biodiversity protection. In contrast, Brazil and Australia demonstrate stronger institutional enforcement mechanisms and more comprehensive biodiversity management systems, offering valuable lessons for enhancing India’s biodiversity governance framework.

## 5.3. Role of the Judiciary in Biodiversity Protection in India

The Indian judiciary particularly the Supreme Court, various High Courts, and the National Green Tribunal (established 2010) has played an increasingly important role through environmental public interest litigation. The Supreme Court’s expansive interpretation of Article 21 to encompass the right to a healthy environment has created constitutional foundations for biodiversity protection beyond the BDA. Several landmark decisions illustrate the judiciary’s critical role in enforcing biodiversity governance. In *T.N. Godavarman Thirumulpad v. Union of India* (1995, ongoing), the Supreme Court issued a series of orders fundamentally restructuring forest governance in India, effectively extending protections to all forest lands regardless of ownership and requiring prior approval for any non-forest use establishing a precedent for judicial oversight of ecosystem conservation that complemented the BDA’s objectives. In *Vellore Citizens Welfare Forum v. Union of India* (1996), the Supreme Court constitutionalised the precautionary principle and the polluter-pays principle as integral components of Indian environmental law, providing a judicially enforceable framework directly applicable to biodiversity harm. In *Intellectual Forum, Tirupathi v. State of A.P.* (2006), the Supreme Court affirmed the public trust doctrine over natural resources, holding that the State holds biological and natural resources in trust for present and future generations a ruling with significant implications for biodiversity governance accountability. Critically, BMC mandates were only operationalised after 2016 following NGT intervention on a petition by Chandra Bhal Singh, highlighting the judiciary’s essential role in compelling implementation of statutory obligations (Down to Earth, 2026). The NGT has adjudicated numerous additional cases involving biodiversity-related grievances, including challenges to environmental clearances granted without adequate biodiversity impact assessment, and has increasingly required demonstration of BDA compliance as a condition for industrial approvals.

Table 14. Key implementation challenges Under Biodiversity Act (2002).

Challenge	2025-26 Status	Recommended Solution
Institutional Weakness	NBA/SBBs understaffed; non-functional in several states	Mandatory capacity benchmarks; biodiversity expert recruitment
BMC Functionality	2,76,653 BMCs formed but functional effectiveness questioned (Nagoya Report, 2026)	Performance-linked funding; third-party audits; training scale-up
Incomplete PBRs	34–88% completion; digitisation underway under 2024 Rules	Mandatory digitisation targets; national PBR quality dashboard
Funding Shortfall	Budget far below GBF’s \$30 billion/year target	Dedicated biodiversity fund; ABS revenue channelled to communities
Jurisdictional Overlap	Conflicts with Forest Act, Wildlife Act, EPA, FRA	Integrated biodiversity governance framework; inter-ministerial coordination
Enforcement Gap	Prosecution rates negligibly low; 2023 Amendment reduced deterrence	Dedicated biodiversity enforcement cells; NGT fast-track mechanisms
Marine Exclusion	30×30 target demands urgent action; current coverage ~5% of land	Extend BDA jurisdiction to EEZ; national marine biodiversity action plan
ABS Leakage	Industries fail to pay benefit-sharing fees (SBB reports, 2025)	Mandatory supply-chain traceability under ABS Regulations 2025



Table 15. Comparative analysis of biodiversity laws.

Aspect	India (2026)	Brazil	Australia
ABS Mechanism	Mandatory PIC/MAT; ABS Regulations 2025; Rs 216 crore mobilised 2017–2025	Robust SINAC system; strong federal enforcement	Strong regulatory compliance under EPBC Act
Community Rights	2,76,653 BMCs; functional effectiveness questioned; strengthened under 2024 Rules	Quilombola and Indigenous recognition	ILUA agreements with Aboriginal communities
Biopiracy Prevention	TKDL; NBA approval for IPR; 41 Form-10 declarations in 2024–25	Genetic heritage register	Access and Benefit Sharing Act 2002
Funding Mechanism	National Biodiversity Fund; ABS Regulations 2025 special species provisions	FUNDO Nacional do Meio Ambiente	Environmental Restoration Fund
Enforcement	Historically weak; 2024 Rules improve adjudication; prosecution rates remain low	Federal enforcement agencies active	Strong compliance monitoring
Marine Biodiversity	Limited coverage; 30×30 target requires urgent action	Amazon basin focus	Comprehensive marine protection under EPBC Act

#### 5.4. Policy Implications and Future Challenges

The compounding pressures of climate change and biodiversity loss are intensifying faster than current governance frameworks can absorb. Climate-driven range shifts are displacing species and, with them, the place-based traditional knowledge systems co-evolved with those species. India’s Himalayan ecosystems are losing glacier mass, while its coastal ecosystems face rising sea levels and recurrent coral bleaching. A future-ready biodiversity governance framework must incorporate climate-adaptive provisions, including assisted species migration, climate-refugia management, and formal recognition of displaced traditional knowledge.

Although community engagement is statutorily mandated under the BDA, implementation evidence suggests that participatory processes frequently remain procedural formalities rather than substantive exercises in co-governance. Meaningful co-management requires not merely the formal establishment of BMCs, but the provision of adequate funding, technical capacity, and genuine devolution of decision-making authority to community institutions. At the highest policy levels, it is imperative to systematically integrate biodiversity governance with India’s SDG commitments and the Kunming-Montreal GBF, particularly the 30×30 target, given that India’s current protected area coverage of approximately 5% of land area represents a substantial shortfall relative to this commitment. Achieving the 30×30 target by 2030, as affirmed by the Union Minister of Environment (ORF, 2024), will necessitate a comprehensive national plan incorporating specific area-based milestones, dedicated funding commitments, and robust inter-ministerial coordination mechanisms.

#### 6. Conclusion

This comprehensive review has examined the Biological Diversity Act, 2002 as India’s primary biodiversity governance instrument, evaluating two decades of implementation in light of the Biological Diversity (Amendment) Act, 2023, the Biological Diversity Rules, 2024, the ABS Regulations, 2025, and India’s first Nagoya Protocol Implementation Report (2026). India’s biodiversity governance has produced measurable outcomes: 2,76,653 BMCs constituted, 2,72,648 PBRs documented, Rs 216.31 crore mobilised through ABS approvals (2017–2025), and 2,56,393 individuals trained. Yet ten critical implementation gaps persist spanning institutional capacity deficits, inadequate funding, incomplete PBRs, weak enforcement, ABS leakage, and marine exclusion. The 2023 Amendment’s broadened exemptions risk undermining community rights gains. The path forward requires substantial strengthening across all three institutional tiers; dedicated funding aligned with Kunming-Montreal GBF targets; mandatory PBR digitisation and quality standards; robust enforcement mechanisms; extension of jurisdiction to marine and EEZ areas; and meaningful community capacity investment. India’s extraordinary biodiversity heritage 8% of global species across 2.4% of land area and the rights of the communities that have conserved it demand a revitalised governance framework commensurate with India’s global commitments and the urgency of the biodiversity crisis.

#### Author Contributions

Anshul: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing; Archit Kapil: Data curation, Methodology, Visualization, Writing – original draft, Writing – review & editing; Vansh Gupta: Data curation, Methodology, Writing – review & editing; Sandeep Kumar Barwal: Supervision, Writing – review & editing; Harsh Singh: Supervision, Writing – review & editing.

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## Declarations

**Conflicts of Interest:** The author(s) declare no conflict of interest

**Institutional/Ethical Approval:** This study did not involve human or animal subjects, and no institutional or ethical approval was required.

**Data Availability/Sharing:** The datasets used and analysed during the current study will be made available from the corresponding author upon a reasonable request.

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