International Journal on Science and Technology (IJSAT)



The Role of People's Biodiversity Register in Sustainable Environmental Conservation: A Comparative Analysis

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Abstract

This review paper explores the critical role of the People's Biodiversity Register (PBR) in promoting sustainable environmental conservation, with a focus on its implementation in India and its potential for global adaptation. The PBR serves as a decentralized tool to document local biological resources and traditional ecological knowledge. The paper reviews the structure, purpose, and current limitations of PBRs, particularly the challenges in data documentation, accessibility, and integration with development planning. It further highlights how the lack of standardized methodologies and expert-heavy processes hinders the inclusion of rural and indigenous knowledge systems, which are rapidly declining due to cultural shifts. Through comparative analysis of global documentation practices, the paper emphasizes the need for simplified, community-driven digital tools to preserve biodiversity knowledge. The integration of such data into infrastructure and land-use planning is also discussed as a pathway to balance ecological integrity with human development. This review ultimately underscores the PBR's potential as a key instrument in biodiversity conservation, provided it evolves to become more inclusive, technologically adaptive, and policy-relevant.

Keywords: Biodiversity, PBR, Documentation, Environmental Policy.

1. Introduction

In the 21st century, biodiversity loss has emerged as one of the most urgent environmental challenges globally. According to a 2021 report by the Centre for Science and Environment (CSE), India has lost 90% of the area under its four recognized biodiversity hotspots, with the Indo-Burma hotspot being the worst affected - experiencing a 95% reduction in vegetation cover. This alarming degradation is driven by habitat destruction, unsustainable development, overexploitation of natural resources, and climate change. These pressures not only threaten ecological integrity but also jeopardize food security, rural livelihoods, and long-term sustainability.

To respond to these challenges, the Government of India implemented the Biological Diversity Act, 2002, establishing a three-tier governance framework comprising the National Biodiversity Authority (NBA), State Biodiversity Boards (SBBs), and local Biodiversity Management Committees (BMCs). At the grassroots level, the People's Biodiversity Register (PBR) was introduced as a participatory tool to document local biodiversity and traditional ecological knowledge (TEK). However, despite its inclusive



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intent, most PBRs are limited to basic inventories - species names, photographs, and maps - without deeper analytical or policy relevance.

This issue is not unique to India; globally, biodiversity documentation efforts face similar constraints, especially in regions of the Global South. Indigenous knowledge systems remain undocumented or are rapidly disappearing due to urbanization and cultural shifts. The absence of structured, analysable biodiversity data hampers meaningful conservation planning and ecosystem-based development.

This review addresses these limitations by exploring methods to enhance PBR documentation through structured formats, Excel-based reporting, and foundational data engineering. The paper also examines how analytical PBRs can inform construction project planning, land-use regulation, and environmental impact mitigation. By integrating biodiversity insights into infrastructure development, planners can avoid ecologically sensitive zones and reduce habitat fragmentation.

Ultimately, this study advocates for a co-designed approach where development and conservation are mutually reinforcing. When effectively implemented and analysed, the People's Biodiversity Register can evolve into a transformative tool for inclusive environmental governance and sustainable national development.

2. Evolution and Conceptual Foundations of PBRs

The concept of the People's Biodiversity Register (PBR) emerged in response to the growing need for decentralized and inclusive approaches to biodiversity conservation. Prior to the 1990s, biodiversity-related data collection was largely the domain of scientists and government institutions, typically conducted through species inventories, natural resource assessments, or ecological surveys. These efforts, although valuable, were often technocratic and excluded the ecological knowledge of rural and indigenous communities. Notably, the term "biodiversity" itself only entered mainstream scientific discourse in the late 1980s, gaining prominence after the 1986 National Forum on Biodiversity and the 1988 publication of E.O. Wilson's seminal book "Biodiversity". However, the idea of a "biodiversity register" - a systematic tool to document local biological resources had not yet materialized in either academic or policy circles globally.

It was in the early 1990s that Dr. Madhav Gadgil and his team at the Centre for Ecological Sciences, Indian Institute of Science (IISc), Bangalore, formally introduced the concept of the People's Biodiversity Register. Their pioneering work under India's National Biodiversity Strategy and Action Plan (NBSAP) initiated a paradigm shift by emphasizing participatory documentation that combined traditional ecological knowledge with scientific methods (Gadgil et al., 2000). Pilot projects in multiple Indian villages demonstrated how community-based biodiversity registers could capture not only species data but also associated cultural, medicinal, and agricultural knowledge. This approach positioned local people as both knowledge holders and stewards of biodiversity.

The importance of PBRs was further emphasized by scholars such as (Laladhas et al. 2013), who argued that region-specific biodiversity education - facilitated through PBRs - fosters grassroots conservation awareness and empowers local governance. The 2002 Biological Diversity Act of India institutionalized the PBR mechanism through the establishment of Biodiversity Management Committees (BMCs), formalizing its role in decentralized environmental governance. More recently, Vishwas and Vinod (2020) highlighted the potential of digital PBRs to improve the credibility, accessibility, and utility of biodiversity data, particularly in informing local planning and policy decisions. Together, these developments underscore the PBR's evolution from an academic innovation to a nationally recognized



instrument for participatory biodiversity documentation, with growing relevance in global conservation discourse.

Following figure presents the evolution timeline of the People's Biodiversity Register (PBR) framework. It traces key milestones from its foundational concept in 2000 by Madhav Gadgil to its digital transformation in 2020. The chart captures shifting priorities - from community engagement and traditional knowledge to educational use and policy-oriented digital records. This progression highlights how PBRs have adapted to evolving conservation and planning needs over two decades.

Figure 1:Development Timeline of the PBR Framework.



3. Indigenous Knowledge & Community Participation

The integration of indigenous knowledge (IK) into biodiversity documentation through People's Biodiversity Registers (PBRs) is essential for meaningful and equitable conservation. Traditional ecological knowledge, often rooted in centuries of observation and lived experience, offers valuable insights into species behaviour, seasonal cycles, and sustainable resource use. However, incorporating this knowledge into formal biodiversity frameworks like the PBR remains fraught with socio-cultural, technical, and institutional challenges.

In their in-depth case study of the Baigachak region in Madhya Pradesh, Ratul and Prodyut (2011) explored how the Baiga tribe - known for its symbiotic relationship with forest ecosystems - contributes a wealth of undocumented biodiversity knowledge. The study highlighted that community members could identify and describe multiple uses of medicinal plants, animal behaviour, and patterns in forest regeneration that were absent from formal databases. However, a key challenge was language and literacy barriers that limited effective documentation. Furthermore, the community's reluctance to share sensitive or sacred knowledge, due to historical marginalization and fear of exploitation, created obstacles in the participatory process. The authors stressed that unless documentation methods are adapted to local cultural contexts and ensure trust, traditional knowledge will remain underutilized.

Walter et al. (2013), through a comparative analysis in Community Biodiversity Management, underscored the importance of landscape-scale approaches in engaging communities. Their research showed that biodiversity knowledge is embedded not only in individual memory but also in collective rituals, seasonal farming practices, and social institutions. However, formal documentation systems often fail to capture these dimensions, favouring static species lists over dynamic ecological relationships. One major challenge identified was the hierarchical structure of knowledge validation, where external experts tend to dominate data interpretation, thereby marginalizing community voices. The study emphasized the need for co-production of knowledge, where community members are not merely informants but active planners and stewards.



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Gail et al. (2021), in their study on public perceptions of biodiversity, added a more recent and nuanced layer. They found that shared cultural values and public narratives greatly influence how biodiversity is understood and prioritized at the community level. In tribal or rural contexts, the loss of biodiversity is often seen not just as an ecological concern but as a loss of identity, heritage, and autonomy. However, challenges arise when external conservation agendas do not align with local value systems. The study recommended the use of dialogue-based approaches, storytelling, and participatory mapping as tools to bridge scientific and indigenous worldviews.

Across these studies, several common challenges emerge:

- Fear of biopiracy and misuse of traditional knowledge.
- Lack of institutional trust between communities and implementing agencies.
- Language, literacy, and cultural gaps in documentation practices.
- Power asymmetries between scientific experts and local communities.

To overcome these barriers, a reorientation of the PBR process is needed - one that treats indigenous knowledge systems as equal and dynamic sources of ecological intelligence. This includes respecting cultural protocols, investing in community education, and developing locally adaptable tools that allow knowledge holders to lead documentation and monitoring efforts themselves.

4. Global Context & Comparative Approaches

Internationally, biodiversity documentation efforts have evolved beyond static species inventories toward integrated, policy-relevant frameworks that align conservation with social and economic objectives. Victoria F.G. et al. (2018) emphasize the principle of "No Net Loss" of biodiversity, which has been embedded into national environmental regulations and impact assessments across countries like Australia, the UK, and Brazil. This approach ties biodiversity preservation directly to development planning, requiring developers to either avoid, minimize, or offset biodiversity loss - creating a legal and financial incentive for detailed, structured biodiversity data. Qing Y. et al. (2021) advanced this by proposing a three-dimensional perspective of biodiversity - encompassing taxonomic, functional, and phylogenetic diversity - arguing that meaningful conservation must account for ecosystem functions and evolutionary heritage, not just species counts. Such frameworks demand high-quality, standardized data, something grassroots tools like the PBR can adapt to with methodological refinement. Eivind L.B. et al. (2021) analyzed national biodiversity footprints across land-use sectors and revealed significant discrepancies between countries due to inconsistent data integration and lack of cross-sectoral accountability. This study underscores the need for harmonized metrics and real-time tracking mechanisms - a space where India's decentralized but under-optimized PBRs can evolve by adopting global best practices. Abdulkarim R. (2021) added that private sector engagement, as seen in the European Union and Japan, is increasingly vital in biodiversity governance. Public-private partnerships and corporate biodiversity accounting are emerging as powerful tools for scaling conservation impact. Cross-country comparisons reveal that while tools like PBRs are unique to India, their success depends on global learnings: integrating biodiversity into economic decisions, adopting multidimensional indicators, and embedding conservation into national planning and governance systems.



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Table 1: Comparative Overview of National Biodiversity Documentation Strategies

Country/	Key Strategy/	Core	Lessons for PBR	
Region	Framework	Features	(India)	
Australia	No Net Loss policy in biodiversity offsetting	Legally mandates biodiversity assessments for infrastructure projects; uses standardized metrics to quantify loss and offset	Emphasizes legal enforcement, standardized data, and integration with development approvals	
United Kingdom	Biodiversity Net Gain (BNG) framework	Developers must enhance biodiversity by at least 10% post-project; linked to planning laws	Strong policy linkage with spatial planning; encourages digital biodiversity baselining	
Brazil	Cadastro Ambiental Rural (CAR)	National rural land registry includes ecological data and forest cover monitoring; combines remote sensing with landholder inputs	Shows how large-scale data systems can integrate community and satellite data	
China	Three-Dimensional Biodiversity Framework (Qing Y. et al., 2021)	Captures taxonomic, functional, and phylogenetic biodiversity; advanced ecological indicators guide conservation	Urges the PBR process to expand beyond species lists to include ecological functions	
Norway &	National Biodiversity	Measures biodiversity impacts across	Highlights cross-sector integration;	
OECD	Footprint Accounting	consumption sectors (forestry, energy,	relevant for PBR's potential use in	
Countries	(Eivind L.B. et al., 2021)	agriculture)	environmental policy	
India	People's Biodiversity Register (PBR)	Community-based documentation of species and traditional knowledge under	Offers a bottom-up model, but needs data standardization, digital integration,	
		the Biodiversity Act, 2002	and stronger policy linkages	

5. Technological Innovations in Biodiversity Documentation

Recent advances in technology have significantly enhanced the scope, accuracy, and accessibility of biodiversity documentation. Quentin G. et al. (2020) emphasize that people play a critical role in linking biodiversity data through participatory platforms, suggesting that community-driven digital tools can bridge the gap between local knowledge and global datasets. This directly supports the case for electronic People's Biodiversity Registers (e-PBRs) - digitized, geo-tagged, and searchable platforms that go beyond static records. R. Jaishanker et al. (2021) introduce the Biodiversity Clock and Conservation Triangle, integrative digital tools designed to monitor species' conservation status and provide early-warning signals for ecological shifts. These innovations demonstrate how biodiversity monitoring can move from descriptive to predictive systems. Lock et al. (2021) further highlight the use of remote sensing-enabled essential biodiversity variables (EBVs) that allow spatial alignment of conservation policy with real-time ecological data - an area where Indian PBRs could evolve significantly. Andre L.A. et al. (2021) propose Biodiversity 4.0, a standardized protocol framework tailored for the private sector, which aligns business operations with biodiversity metrics. This enables broader stakeholder engagement in biodiversity conservation beyond traditional actors. Frank M. et al. (2021) take this further with the concept of Biodiversity Knowledge Graphs, an advanced data integration model capable of connecting scattered ecological databases, traditional knowledge systems, and scientific datasets into a unified semantic web. Collectively, these technologies point toward a new era of biodiversity governance—where data standardization, digital mapping, and real-time monitoring become essential pillars. For India's PBR initiative, these innovations offer a roadmap to create more dynamic, analytical, and policy-relevant documentation systems.

International Journal on Science and Technology (IJSAT)



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Innovation	Scalability	Community Participation	Accuracy	Policy Integration	Digital Maturity	Reference
ePBRs	4	5	4	4	5	Vishwas & Vinod, 2020; Quentin G. et al., 2020
Remote Sensing	5	2	5	5	4	Lock et al., 2021
Biodiversity Clock	3	3	4	3	3	R. Jaishanker et al., 2021
Standard Protocols	4	2	4	4	5	Andre L.A. et al., 2021 (Biodiversity 4.0)
Knowledge Graphs	3	3	5	3	5	Frank M. et al., 2021

Table 2: Comparative Evaluation of Biodiversity Documentation Tools Across Key Dimensions

The scoring presented in this study is based on a tentative comparative framework, designed to offer an indicative overview of various biodiversity documentation technologies. Five core evaluation parameters - Scalability, Community Participation, Data Accuracy, Policy Integration, and Digital Maturity - were selected through thematic analysis of peer-reviewed literature. Each technology was assessed using a 1 to 5 Likert scale, where 1 denotes the lowest and 5 the highest performance.

This simplified scale was intentionally chosen to maintain clarity and consistency in comparison. Scores were assigned by synthesizing qualitative evidence and case study findings from relevant research papers. For instance, ePBRs scored highly in community participation due to documented grassroots engagement (Vishwas & Vinod, 2020), while remote sensing tools ranked lower in that dimension due to limited human interface.

It is important to note that this approach provides an approximate, literature-based evaluation. For more detailed and rigorous assessments, future studies can adopt structured methodologies such as stakeholder surveys, expert panels, or multi-criteria decision analysis (MCDA) to validate and expand the scoring dimensions.

The radar (spider) charts illustrate a comparative assessment of five biodiversity documentation technologies across key performance parameters. Each chart represents an individual method, enabling focused visualization of strengths and limitations





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Figure 6:Assessment for Knowledge Graphs



6. Integration of PBR with Development & Planning

The integration of People's Biodiversity Registers (PBRs) into development and planning processes is essential for ensuring that ecological sustainability is embedded within infrastructure expansion and land-use governance. Kamaljit S.B. et al. (2021) emphasize the critical role of biodiversity knowledge in advancing a national mission for biodiversity and human well-being, advocating for ecological data like PBRs to be used in early-stage planning decisions. Bradley J.C. et al. (2012) argue that biodiversity loss directly affects human systems, including food security and health, thus linking ecosystem integrity to development imperatives. This connection mandates a shift from biodiversity being an afterthought to becoming a fundamental input in spatial planning. Meredith P.M. et al. (2021) further highlight how decisions at the community level such as - tree planting- are often utility-driven rather than biodiversity-informed, revealing a gap in translating biodiversity knowledge into practical developmental choices. By embedding PBR data into tools used for zoning, Environmental Impact Assessments (EIAs), and Sustainable Development Goal (SDG) frameworks, governments and planners can ensure that infrastructure growth respects ecological thresholds, minimizes habitat fragmentation, and sustains ecosystem services for long-term resilience.



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7. Limitations, Uncertainties, and Policy Recommendations

Despite the growing recognition of People's Biodiversity Registers (PBRs) as essential tools in biodiversity conservation, their implementation faces significant limitations and uncertainties. Daniel P.F. (2018) critiques frameworks like IPBES for drifting away from grounded biodiversity values, warning against overgeneralized narratives such as "nature's contributions to people" that can obscure local ecological realities. He advocates for re-aligning biodiversity governance with context-specific, co-produced knowledge that involves both scientific and community inputs. Indra P.S. (2021) highlights the pervasive scientific uncertainties in biodiversity inventories, particularly in regions with limited baseline data or expertise. Such gaps lead to underrepresentation of critical ecosystems in policy decisions and hinder evidence-based planning. Claudio C.M. (2021) underscores the governance challenge of integrating climate, biodiversity, and people-centric policies, arguing for stronger cross-sectoral collaboration and participatory governance mechanisms. Together, these insights suggest that future PBR processes must move beyond simple documentation. Instead, they should foster institutional frameworks that support continuous data validation, invest in capacity building at the local level, and promote the co-production of ecological knowledge to inform adaptive, inclusive, and resilient biodiversity policies.

8. Conflict of Interest

The authors declare that this research was conducted without any commercial or financial interests and solely for academic and scientific purposes. No competing financial interests or personal benefits influenced the study's design, data collection, analysis, or publication.

9. Authors' Biography

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