INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD
ISSN(O): 2455-0620 [Impact Factor: 9.47]
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value : 86.87
Volume - 11, Issue - 05, May - 2025

DOIs:10.2015/IJIRMF/202505020 --:-- Research Paper / Article / Review

Evaluation and Temporal Analysis of People's Biodiversity Register: A Case Study of Sukali Village, Yavatmal District

[1] **Sanket K. Dafe,** [2] **Shivani S. Shirbhate** [3] **Dr. Prashant A. Kadu,**
[1]Post Graduate Student, Civil Department, PRMIT&R, Badnera, Maharashtra, India.
[2]Post Graduate student, Civil Department, Walchand college of Engineering, Sangli, Maharashtra, India.
[3]Associate Professor, Civil Department, PRMIT&R, Badnera, Maharashtra, India.
Email – [1]sanket.dafe@gmail.com, [2]shivanishirbhate06@gmail.com, [3]pakadu@mitra.ac.in

Abstract: *This paper explores the critical role of the People's Biodiversity Register (PBR) in advancing sustainable environmental conservation, through a focused case study from Sukali Village, Yavatmal District. The study presents a two-year (2023–2024) temporal analysis of biodiversity data collected via a mobile application designed to digitally document local biological resources and traditional ecological knowledge. The primary objective was to evaluate, analyse, and present the collected data in a structured and meaningful format. By processing the exported Excel data, the study highlights change in species richness, abundance, and habitat types using visual tools such as pie charts and line graphs. This case study demonstrates the value of digital PBR data in enabling effective biodiversity monitoring and supporting data-driven decision-making in environmental planning.*

Key Words: *Assessment, Digital Biodiversity Tools, ePBR Monitoring, Temporal Pattern.*

1. INTRODUCTION:

The conservation of biodiversity is a foundational element of sustainable development, particularly in ecologically sensitive and rapidly developing regions. In India, the People's Biodiversity Register (PBR) serves as a decentralized, community-cantered tool to document local biological resources and associated traditional knowledge. Mandated under the Biological Diversity Act, 2002, the PBR aims to promote participatory conservation by recording species information, resource usage, and cultural linkages at the village level. Despite its conceptual significance, the practical utilization of PBR data in decision-making and planning processes remains limited, often due to inconsistencies in data formatting, accessibility, and interpretation.

This study focuses on the evaluation and temporal analysis of PBR data collected from Sukali Village, Yavatmal District, over a continuous two-year period (2023–2024). The data was captured using a mobile application developed to streamline digital biodiversity documentation and exported in structured Excel formats. Our research work was cantered not on data collection, but on the systematic analysis and presentation of this data to identify and monitor biodiversity trends. By applying data engineering techniques and using visual tools such as graphs and pie charts, we interpreted shifts in species richness, abundance, and habitat diversity across the two-year timeframe.The goal of this research is to demonstrate how structured evaluation and visualization of biodiversity data can enhance its utility for environmental planning and monitoring. This case study serves as a practical model for converting raw biodiversity records into actionable insights, paving the way for informed and ecologically conscious development practices.

2. LITERATURE REVIEW:

The People's Biodiversity Register (PBR) was conceptualized as a participatory documentation tool that enables local communities to record their biodiversity and traditional ecological knowledge. Gadgil (2000) emphasized that the PBR represents a bottom-up approach to conservation, helping decentralize environmental governance and empower local stakeholders. The foundational work by Gadgil, Rao, and Utkarsh (2000) further elaborated that integrating traditional knowledge with biodiversity documentation is crucial for ecological sustainability and cultural preservation.

Laladhas et al. (2013) recognized the importance of region-specific biodiversity education through PBRs, especially in helping communities connect with their environment and fostering conservation ethics. This role becomes more critical in rural and biodiversity-rich areas where developmental pressures pose risks to fragile ecosystems.

Similarly, Chavan and Mathur (2020) stressed the need for digital PBR systems, arguing that electronic formats enhance data credibility, transparency, and accessibility for scientific and planning purposes.

From a broader conservation perspective, Duffy et al. (2012) and Martens & Beumer (2015) highlighted the direct link between biodiversity health and human well-being, advocating for tools like PBRs to bridge ecological and societal needs. Faith (2018) cautioned against narrowing biodiversity assessments to ecosystem services alone and called for inclusive models that reflect nature's contributions to people, which PBRs are inherently designed to capture.

Recent technological integrations have enabled dynamic biodiversity assessments. Jaishankar et al. (2021) introduced frameworks like the Biodiversity Clock to support real-time monitoring, while Yang et al. (2021) proposed multidimensional approaches to biodiversity evaluation, reinforcing the relevance of temporal and spatial analyses. These perspectives align with the present study's aim to assess year-wise trends in biodiversity, thus contributing to a more nuanced understanding of ecological shifts at the village level.

Additionally, Groom et al. (2020) emphasized the importance of involving people in biodiversity data processes, noting that meaningful community participation strengthens conservation outcomes. This aligns with the shift toward community-led digital documentation, as demonstrated by mobile apps and electronic PBR formats. The digitization of biodiversity knowledge, as supported by Michel et al. (2021) through biodiversity knowledge graphs, provides scalable pathways for integrating grassroots data into national and global conservation frameworks.

Collectively, the literature underscores the importance of accessible, time-sensitive, and community-driven biodiversity data. While traditional PBRs laid the groundwork, their evolution into digital and analysable formats - such as those explored in this study - marks a critical transition toward making biodiversity knowledge actionable in planning and conservation.

3. OBJECTIVES:

This research aims to evaluate and demonstrate a simplified, structured approach to analysing and presenting biodiversity data collected through digital People's Biodiversity Registers (PBRs), with the goal of making such data actionable for environmental planning and sustainable infrastructure development.

The specific objectives are to:

- **Evaluate the quality and structure** of biodiversity data collected via a mobile-based digital PBR application in Sukali Village, Yavatmal District.
- **Conduct a temporal analysis** of biodiversity trends over a two-year period (2023–2024), focusing on species richness, abundance, and habitat diversity.
- **Develop user-friendly visualizations** (such as graphs and pie charts) to represent biodiversity conditions and changes in an accessible and policy-relevant manner.
- **Demonstrate a data engineering process** that transforms raw, community-contributed biodiversity data into meaningful insights for ecological monitoring.
- **Address inclusivity barriers** by proposing approaches that do not require technical expertise, enabling broader participation in biodiversity documentation and monitoring.

4. RESEARCH METHOD:

This study was conducted to analyse and evaluate biodiversity data collected using a mobile-based digital People's Biodiversity Register (PBR) application in Sukali Village, Yavatmal District. The objective was to demonstrate how digital tools can enhance the quality, usability, and accessibility of biodiversity data for monitoring and planning purposes.

4.1 Transition from Manual to Digital Documentation

To address the limitations of traditional paper-based PBRs - such as delays, data inconsistencies, and limited accessibility - a mobile application was adopted for field-level biodiversity data collection. This digital transformation was guided by the Maharashtra State Biodiversity Board and aligned with national goals for technology-driven, inclusive biodiversity governance. The app enabled real-time data recording, improved accuracy through geotagging and photo documentation, and streamlined the entire process of biodiversity data collection and monitoring.

4.2 Application Development and Features

The mobile application was developed with a user-centric approach, focusing on inclusivity and simplicity:

- **Government-Compliant Design**: The application was built in accordance with the specifications and standards set by the Maharashtra State Biodiversity Board.
- **Two-Tier Workflow**: The app structure was divided into intuitive categories for flora, fauna, water bodies, sacred groves, and habitat types, ensuring ease of data input.

- **Local Language Interface**: The UI supported vernacular languages and icon-based navigation to enable participation from semi-literate or non-technical users.
- **Data Capture Tools**: Integrated features included:
    - GPS-based geotagging for spatial accuracy
    - Instant photo upload with time-stamps
    - Dropdown menus, voice input, and guided fields to minimize manual typing
- **Offline Capability**: Users were able to collect data in areas with limited connectivity and sync it once online access was available.
- **Data Export and Monitoring**: The app allowed direct export of field data into structured Excel sheets in the PBR format, enabling real-time administrative oversight and simplified report generation.

4.3 Data Collection and Processing

The biodiversity data was collected during two consecutive years (2023 and 2024) through the mobile application. The structured Excel files exported from the app served as the basis for this study. The scope of this research was to:

- **Data Cleaning and Standardization**: Removing redundancies, correcting inconsistencies, and organizing data entries by category and observation date.
- **Temporal Comparison**: Comparative analysis was performed across two years to observe changes in species composition, abundance, and habitat status.
- **Visualization and Interpretation**: Data trends were illustrated using bar graphs, pie charts, and category-based distributions to highlight biodiversity shifts. These visuals were used to monitor ecological trends and to present the findings in a clear, policy-relevant manner.

5. RESULTS:

Based on the field-based documentation and categorization process carried out through the People's Biodiversity Register (PBR), key biodiversity elements were identified and recorded to represent the ecological and socio-cultural landscape of the study area. The focus of documentation included crops, trees, various types of plants, insects, local markets dependent on natural produce, soil and water sources, fruit-bearing trees, and both domestic and wild animals. Additionally, birds, medicinal plants, and flowering plants were also thoroughly observed due to their relevance to local ecological services and cultural practices. This comprehensive documentation enabled the identification of trends, vulnerabilities, and conservation priorities across multiple biological and human-interactive domains, highlighting the interconnectedness of agriculture, biodiversity, and community knowledge systems. As this was a pilot implementation, a simplified yet effective methodology was used to capture the condition of each biodiversity element. Field recorders were instructed to assess and input the condition of each species using a three-point scale, designed to reflect the general health or prevalence of the species:

- 1 – Flourishing (Healthy, Abundant, or Stable)
- 2 – Sustaining (Declining, Rare, or Affected)
- 3 – Endangered (Degraded, Disappearing, or Threatened)

These categories were selected for their ease of understanding and to enable rapid assessments by trained local data collectors.

In addition to condition status, the recorders also captured other relevant informative details, including:

- Local and scientific names (where available)
- Habitat type (e.g., farm, forest edge, water body)
- Use or significance (medicinal, cultural, economic)
- Geotagged locations and photographs (where possible)

These entries were compiled digitally in a structured Excel format, allowing for easier sorting, visualization, and interpretation. The categorical classification and condition-based tagging allowed the research team to:

- Quantify the distribution of biodiversity elements across the village
- Identify elements showing signs of stress or decline
- Establish a baseline for future temporal monitoring

This simplified condition classification served as an initial step toward long-term monitoring, offering a practical and community-friendly method for tracking biodiversity trends. The approach demonstrates how even non-experts can contribute valuable ecological insights that can be visualized and analysed systematically. The results highlight the potential of digital PBRs to generate actionable local biodiversity data that can support conservation planning and integration with infrastructure development.

INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD
ISSN(O): 2455-0620 [Impact Factor: 9.47]
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value : 86.87
Volume - 11, Issue - 05, May - 2025

6. ANALYSIS :

The following section outlines the methodology adopted for visual representation of biodiversity conditions. Through systematic colour coding, scale assignment, and graphical plotting, we translated qualitative field data into meaningful visual insights.

6.1 Colour Coding and Scale Assignment

To enhance clarity and enable visual comparison, each condition was mapped to a specific colour and numerical scale. This dual encoding allowed both human-readable and data-driven interpretations.

- Flourishing:
  - Colour: Green, Scale Value: 3, Meaning: Healthy condition, thriving population
- Sustaining:
  - Colour: Yellow, Scale Value: 2, Meaning: Stable but showing signs of stress
- Endangered:
  - Colour: Red, Scale Value: 1, Meaning: Immediate attention required due to declining condition

Table 1: Colour code and scale value used for graphical presentation

Condition	Colour Code	Scale Value
Flourishing	Green	3
Sustaining	Yellow/Orange	2
Endangered	Red	1

6.2 Bar Chart Preparation

Bar charts were constructed to assess the individual status of elements over time. These graphs allowed direct comparison across different years by plotting:

- X-axis: Biodiversity elements (e.g., types of crops, animals)
- Y-axis: Condition scale values (1, 2, 3)
- Colour coding: Each bar was shaded based on the assigned status (Red, Yellow, or Green)

This visualization approach provided a straightforward mechanism to detect changes or trends in individual biodiversity elements.

6.3 Pie Chart Construction

To analyse the overall distribution of biodiversity conditions within each year, pie charts were created. This step involved:

- Counting the number of elements in each condition category
- Calculating category-wise percentages using the formula: Percentage = $\left(\frac{Category\ Count}{Total\ Elements\ Count}\right) \times 100$
- Plotting pie charts for 2023 and 2024 side by side to compare shifts
- Using consistent colour codes for visual coherence

The pie charts provided a high-level snapshot of ecosystem health across years, enabling macro-level interpretation.

6.4 Observations from Graphical Analysis

The visual tools enabled both detailed and aggregate-level insights. Key observations included:

- Bar Charts: Highlighted how specific elements improved, declined, or remained constant over time.
- Pie Charts: Offered a clear picture of biodiversity distribution in a given year.
- Trend Analysis: Helped detect patterns, such as improvement in crop conditions or stagnation in biproducts.

These observations informed conclusions about the broader ecological trajectory of the village.

6.5 Biodiversity Distribution Bar Chart & Trend Line

A final visual layer was added through a stacked bar chart and a trend line, which depicted the cumulative biodiversity status across the 12 elements.

- The stacked bar chart illustrated the total count of elements in each category (Flourishing, Sustaining, Endangered) across years.
- A trend line was superimposed to indicate the direction of biodiversity change over time.

Interpretation of the trend line:

- Upward trend → Suggests positive outcomes and potential ecosystem recovery
- Downward trend → Indicates ecological stress, requiring conservation intervention

This integrated graphical system provided both quantitative rigor and intuitive visual storytelling, forming a strong basis for strategic planning and biodiversity conservation.

7. SAMPLE ASSESEMENT:

To demonstrate the application of our analysis methodology, we present a sample assessment of a key biodiversity element: "Crop Products", for the years 2023 and 2024. This category was selected because, unlike other elements which showed minimal year-on-year variation, crop products exhibited significant changes over the two-year period. These variations are likely influenced by seasonal conditions, agricultural practices, and post-harvest handling, making crop products an effective indicator of environmental and human-driven impacts.

Field-level data was collected for selected crop products and by-products associated with primary crop cultivation. These were categorized under three defined indicators - Flourishing, Sustaining, and Endangered - based on their availability, ecological utility, and local dependence. Volunteers classified the status of each product by considering its quantity, usage patterns, and seasonal consistency.

Table 2: Raw Data collected

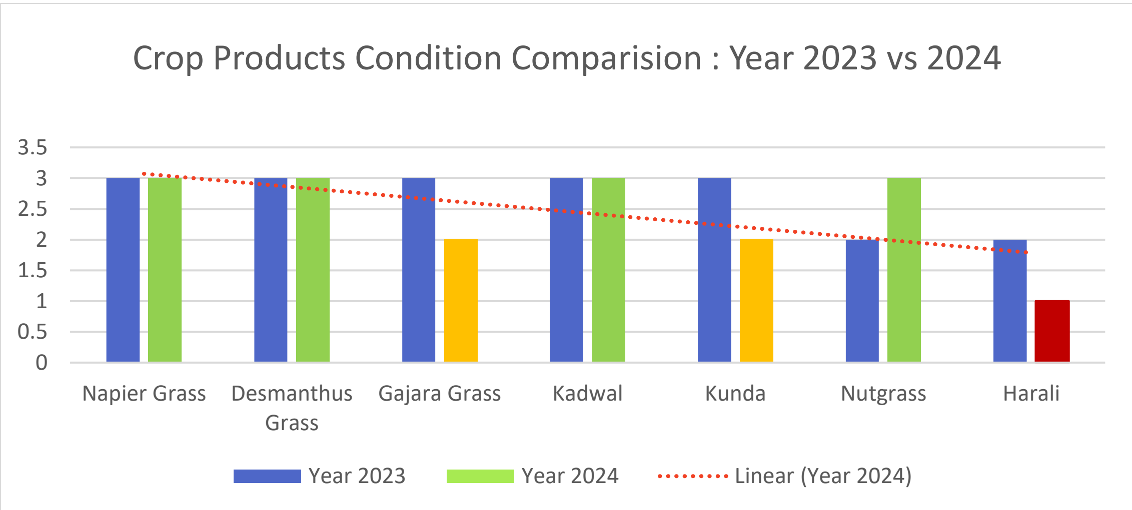
Crop Products	Year 2023	Year 2024
Napier Grass	Flourishing	Flourishing
Desmanthus Grass	Flourishing	Flourishing
Gajara Grass	Flourishing	Sustaining
Kadwal	Flourishing	Flourishing
Kunda	Flourishing	Sustaining
Nutgrass	Sustaining	Flourishing
Harali	Sustaining	Endangered

Table 3: Colour code and scale applied data

Crop Products	Year 2023	Year 2024
Napier Grass	3	3
Desmanthus Grass	3	3
Gajara Grass	3	2
Kadwal	3	3
Kunda	3	2
Nutgrass	2	3
Harali	2	1

This raw data was structured and presented in Table 2, showing the comparative condition of various crop products for 2023 and 2024. We then applied a Colour Coding and Numerical Scale system (Ref Table 1) to translate qualitative observations into quantitative insights. The results are displayed in Table 3, providing a color-coded and scaled dataset ready for graphical interpretation.

Figure 1: Yearly Status Comparison for Crop Products



From Table 3, we generated above Bar Chart with the X-axis representing individual crop products and the Y-axis denoting their scale values. The color-coded bars clearly highlight performance shifts between the two years. This visual tool helps identify which crop products have been adversely affected or have shown recovery, offering important clues about underlying agricultural or environmental changes. A noticeable decline is observed in most species in 2024, with the trend line indicating a downward trajectory. This suggests a deterioration in fruit tree health, potentially due to climatic, agricultural, or ecological stress factors. The red trend line for 2024 highlights the overall negative shift in biodiversity status.

Subsequently, we prepared Table 4 by counting the number of elements in each category (Flourishing, Sustaining, Endangered) for both years.

Table 4:Color Coded and Scaled Data for Proportional Distribution of Crop Product

Condition of Crop Product	Year 2023	Year 2024
Flourishing	5	4
Sustaining	2	2
Endangered	0	1

These figures were used to construct Pie Charts (Figure 2), representing the percentage distribution of crop product statuses in 2023 and 2024.

Figure 2: Yearly Condition Proportion Distribution for Crop Products

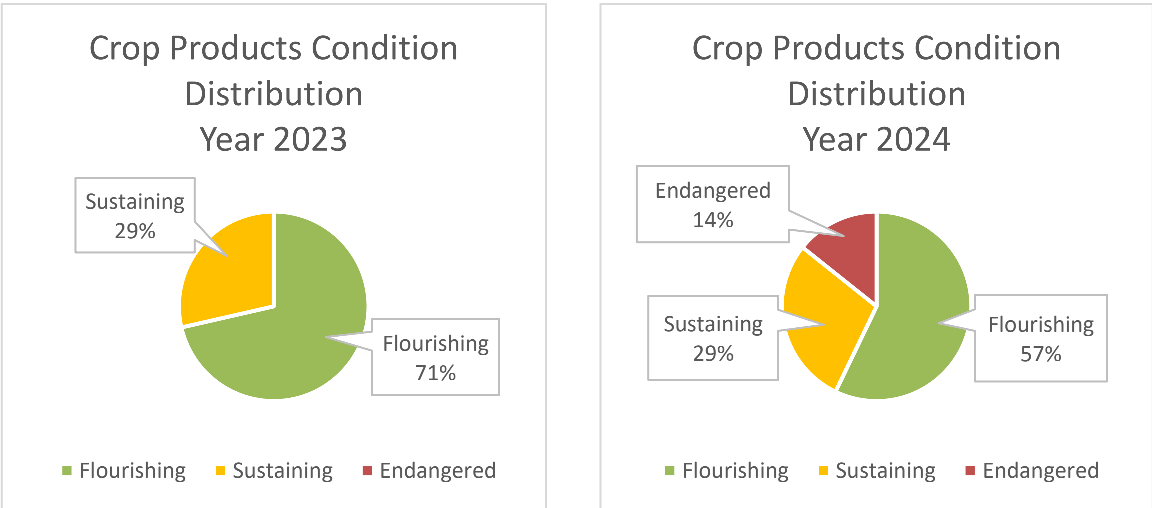


Figure 2 presents a comparative pie chart showing the condition distribution of crop products for the years 2023 and 2024. In 2023, a majority (71%) of the crop products were categorized as flourishing, with the remaining 29% sustaining and no elements marked endangered. However, in 2024, the proportion of flourishing crop products declined to 57%, while the sustaining category remained unchanged at 29%, and a new 14% portion of crop products shifted into the endangered category. This shift indicates a visible decline in the overall health of crop-related biodiversity, suggesting emerging environmental stress or agricultural practice impacts.

8. CONCLUSIONS:

The analysis of biodiversity status through the People's Biodiversity Register (PBR) highlights its strong potential as a ground-level ecological monitoring tool. By comparing data from Sukali Village over 2023 and 2024, it becomes evident that PBR can detect temporal shifts - such as the decline of flourishing crop products and the rise of endangered ones - that are often missed by traditional Environmental Impact Assessments (EIA), which tend to rely on assumptions. Therefore, integrating PBR with EIA in infrastructure and development projects will lead to more informed and sustainable planning.

Key conclusions include:

- PBR provides real-time, location-specific biodiversity data, improving accuracy over assumption-based models like EIA.
- Visible biodiversity changes across years (2023–2024) highlight the impact of human activities and seasonal agricultural shifts.
- Incorporating PBR into national project planning can help prioritize ecological corridors and reduce habitat fragmentation.
- Development planning should respect and integrate existing biodiversity networks, giving them the same importance as industrial and transport corridors to ensure ecological balance.
- Current limitations of PBR include limited public awareness, inconsistent implementation, and need for skilled facilitators.

9. LIMITATIONS:

The People's Biodiversity Register (PBR), though conceptually powerful, faces several limitations at the ground level primarily because it is still in its developmental stage. One of the key challenges is the lack of awareness and understanding among local communities about the purpose and importance of the PBR, which leads to low participation and inconsistent data collection. Additionally, the absence of proper training and capacity-building programs for those involved results in inaccurate or incomplete documentation, particularly in species identification and classification. Institutional support is often weak, with Biodiversity Management Committees (BMCs) either inactive or lacking the resources to effectively maintain and update the register. Financial constraints and limited access to technology further hinder the digitization and standardization of data. Moreover, since the PBR has not yet been fully integrated into mainstream environmental governance frameworks like the Environmental Impact Assessment (EIA), its findings are often overlooked during project planning and approval. Overall, these limitations stem from a combination of insufficient awareness, infrastructural gaps, lack of policy enforcement, and the early-stage nature of the initiative, underscoring the need for focused investment and strategic strengthening of the PBR framework.

1. Lack of Awareness and Community Engagement
   - Many community members are unaware of the purpose or importance of the PBR.
   - Participation is often limited to a few informed individuals or local leaders, rather than broad community involvement.
   - There's a lack of clarity on how the documented data will be used, reducing motivation.
2. Inadequate Training and Capacity Building
   - Field data collectors often lack sufficient ecological knowledge or training.
   - Inconsistent data collection methods result in poor quality or incomplete entries.
   - Identification of species is frequently incorrect or oversimplified (e.g., local names without scientific validation).
3. Data Standardization and Integration Issues
   - Data is often not digitized or standardized, making comparison and analysis difficult.
   - Lack of integration with larger biodiversity databases or planning frameworks.
   - Updates to the register are rare or non-existent, making the data outdated.
4. Institutional and Administrative Gaps
   - Biodiversity Management Committees (BMCs) responsible for PBRs are often inactive or underfunded.
   - Poor coordination between the State Biodiversity Board, local bodies, and other departments.
   - No strict regulatory push to use PBRs in development project assessments.
5. Financial and Logistical Constraints
   - Budget allocations for PBR preparation and monitoring are insufficient.
   - Technological tools like GPS mapping, mobile-based data entry, or biodiversity apps are rarely used.
   - No dedicated personnel to ensure continuous monitoring and updating.
6. Political and Industrial Pressures
   - Local ecological data is sometimes ignored when it conflicts with commercial or infrastructure interests.
   - PBR findings are rarely considered binding in EIA processes or land-use decisions.
7. Language and Accessibility Barriers
   - The scientific or administrative format of PBRs may not be easily understandable to the local population.
   - Multilingual and community-friendly versions are rarely made available.

10. RECOMMENDATIONS:

Based on the temporal analysis and findings from the People's Biodiversity Register (PBR) in Sukali Village, it is strongly recommended that PBR be institutionalized as an essential component alongside the Environmental Impact Assessment (EIA) in the planning and execution of infrastructure and development projects. While EIA offers predictive insights, often based on modelled assumptions, PBR provides grounded, community-sourced, and temporally verifiable data on actual biodiversity trends and changes. This makes PBR a more responsive and context-sensitive tool for assessing ecological impacts. In particular, PBR enables the monitoring of real-time biodiversity changes - capturing how human interference, construction activities, or policy interventions directly influence the ecological balance. This is crucial in identifying not just environmental degradation, but also areas where restoration or conservation efforts may be needed.

Furthermore, national-scale project planning - such as for industrial corridors, Special Economic Zones (SEZs), urban expansion, and regional connectivity - must also account for ecological connectivity. Just as transport or industrial linkages are considered vital for economic growth, biodiversity linkages across landscapes are essential for ecological health and resilience. The fragmentation of biodiversity hotspots leads to increased human-wildlife interactions, ecosystem instability, and conflicts, which can be mitigated by integrated ecological planning.

Key recommendations include:

- Mandate the inclusion of updated PBRs in EIA documentation for all major infrastructure and development projects.
- Integrate biodiversity corridors and hotspot mapping through PBR data into national and regional planning frameworks.
- Develop advanced digital versions of PBRs to enable real-time updates and spatial-temporal analyses.
- Encourage participatory biodiversity documentation to empower communities and enhance ground-level environmental governance.
- Promote coexistence between human settlements and nature by minimizing ecological fragmentation and maintaining ecological buffers and corridors.

REFERENCES:

Journal Papers:

1. Gadgil, Madhao. (2000). *People's Biodiversity Register: Lesson Learnt*. Environment Development and Sustainability, 2(1), 123–132.
2. Gadgil, Madhav, P.R. Sheshagiri Rao, & G. Utkarsh. (2000). *New meanings for old knowledge: The people's biodiversity register program*. Traditional Ecological Knowledge, 155–164.
3. Duffy, J. E., Gonzalez, A., & Venail, P. (2012). *Biodiversity loss and its impact on humanity*. Nature, 486(7401), 59–67.
4. Laladhas, K. P., Baijulal, B., & Oommen, V. (2013). *Region-specific biodiversity education: The role of people's biodiversity register*. Current Science, 104(11), 1479–1481.
5. Martens, P., & Beumer, C. (2015). *Biodiversity keeps people healthy*. Health of People, Places and Planet, 2(1), 21–25.
6. Griffiths, V. F., Bull, J. W., & Baker, J. (2018). *No net loss for people and biodiversity*. Conservation Biology, 32(3), 534–543.
7. Faith, Daniel P. (2018). *Avoiding paradigm drifts in IPBES*. Ecology and Society, 23(1), 12.
8. Groom, Quentin, Anton Guntsch, & Pieter Huybrechts. (2020). *People are essential to linking biodiversity data*. Database: The Journal of Biological Databases and Curation, baaa063.
9. Chavan, V., & Mathur, V. B. B. (2020). *Developing electronic peoples' biodiversity registers*. Economic and Political Weekly, 55(34), 38–45.
10. Subedi, I. P. (2020/2021). *Scientific uncertainty and biodiversity inventory*. Nepal Journal of Science and Technology, 20(1), 135–144.
11. Bawa, Kamaljit S., Asmita Sengupta, & Vishwas Chavan. (2021). *Securing biodiversity, securing our future*. Biological Conservation, 253, 108937.
12. Bjelle, E. L., Kuipers, K., & Wood, R. (2021). *Trends in national biodiversity footprints of land use*. Ecological Economics, 179, 106870.
13. Chiatante, G., Pellitteri, D., & Torretta, E. (2021). *Indicators of biodiversity in an intensively cultivated landscape*. Ecological Indicators, 121, 107109.
14. Flora, T., Kovacs, B., Bidlo, A., & Dima, B. (2021). *Environmental drivers of forest biodiversity*. Science of the Total Environment, 768, 144999.
15. Jaishankar, R. et al. (2021). *Biodiversity clock and Conservation triangle*. Environmental and Sustainability Indicators, 13, 100107.
16. Lock, M.C. et al. (2021). *Alignment of conservation policies with remote sensing biodiversity variables*. Ecological Indicators, 121, 107165.
17. Martin, M. P., Woodbury, D. J., & Doroski, D. A. (2021). *People plant trees for utility*. Biological Conservation, 254, 108965.
18. Yang, Q., Liu, G., & Casazza, M. (2021). *Three dimensions of biodiversity*. Ecological Indicators, 121, 107170.
19. Austen, G. E., & Dallimer, M. (2021). *Exploring shared public perspectives on biodiversity*. People and Nature, 3(1), 63–73.
20. Rashed, A. (2021). *The role of the private sector in SDG implementation*. Environment, Development and Sustainability, 23(1), 732–748.

Proceedings Papers:

1. Michel, Frank, Antonia Ettorre, & Catherine Faron. (2021). *Biodiversity knowledge graphs: Time to move up a gear!* Conference Abstract, 14281.
2. Maretti, C. C. (2021). *Climate change, biodiversity and environmental governance*. Symposium on Biodiversity, Ecology and Conservation, Brasília, Brazil.

Books:

De Boef, W. S., & Hanazaki, N. (2013). *People, biodiversity and landscapes: Introduction*. In *Community Biodiversity Management* (pp. 1–18). Routledge.

Web References:

- https://msbb.mahaforest.gov.in
- http://biodiversityofmaharashtra.blogspot.com/2015/03/biodiversity-in-maharashtra.html
- https://ijrbat.in/upload_papers/01062022031614E21_R20%20Jumale%20R.K.pdf
- https://www.scribd.com/document/494389250/Biodiversity-of-Maharastra-PDF