JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

THE IMPORTANCE OF ECOLOGICAL AND BIODIVERSITY (E&B) STUDY IN ENVIRONMENTAL IMPACT ASSESSMENT: AN INDIAN PERSPECTIVE

[1]Mahendra Singh and [2]Yati Kachhawa

[1]Deputy Manager, [2]Deputy Director

[1]Gaurang Environmental Solutions Pvt. Ltd., Jaipur, (Raj.), [2]National Accreditation Board for Education and Training, Quality Council of India, New Delhi.

Abstract: This study examines the current integration of ecological and biological several elements in the Indian Environmental Impact Assessment (EIA) and highlight the urgent need to switch from a control box approach to an ecologically responsible and scientifically informed framework. Supported by laws such as the Biological Diversity Act of 2002, the EIA notification 2006, and the Environmental Act of 1986, but the practical application of these laws often does not address the complexity of the country. Rating quality is usually affected by field issues, including a lack of local ecological data, lack of species diversity experts, inadequately adjusted investigations, and inadequate monitoring after illustrations. Based on practical cases of areas with many biodiversity rich areas, such as the Himalayas, Central India, and Western Ghats, this study identifies structural issues that limit the effectiveness of existing methods. To close these gaps, we recommend practical measures such as ecologist forced commitment, implementation of landscape scale and cumulative effects, integration of advanced instruments such as GIS, remote sensing technology, and citizen science initiatives. This paper also focus the significance of the international biological diversity framework of Kumming-Montreal (2022). Ultimately, embedding biological diversity in every stage of the EIA process is argued not just an environmental obligation but also a fundamental prerequisite for achieving India's long-term, integrated and sustainable development.

Keywords: EIA, Biological Diversity, Flora and Fauna

1. Introduction:

The article under review highlight the need to incorporate ecological and biodiversity values in Environmental Impact Assessments (EIA) especially given India's rich natural resources and its developed Biodiversity governance system. India struggles to balance its exceptional biological diversity with the challenge of rapid economic growth, expanding infrastructure and increasing industrial activity. India, known globally as one of the world's mega diverse nations, sustains over 8% of all known animal species and more than 11% of all known plant species on the planet. It also covers four of the world's 36 discovered biodiversity hotspots, namely the Himalayas Indo-Burma, Western Ghats, and Sundaland (Including the Nicobar Island) (MoEFCC, 2022). This implies that incorporating ecological considerations into the EIA framework is not just a legal necessity, but ecological necessity. As noted by Rajvanshi et al. (2001), "Biodiversity conservation is no longer a luxury, but a prerequisite for long term development planning."

The EIA in India is mainly directed by the EIA Notification of 2006, consisting of provisions under the Environment (Protection) Act of 1986, which stipulates that Category A and B projects need to go through an Environmental impact assessment (EIA) before obtaining permissions. The EIA and review concern proposed development's effects on local flora and fauna and natural ecosystems. In addition to the EIA process, other legal frameworks, such as the Wildlife (Protection) Act of 1972, the Forest (Conservation) Act of 1980, and the Biological Diversity Act of 2002, provide the regulatory framework around biodiversity in development activities; however, the article claims biodiversity values in the EIA process are poorly integrated. Many Environmental Impact Assessments (EIAs) in India are challenged for weak ecological foundations, incomplete baseline data, and fragmented integration of biodiversity into assessment and mitigation strategies. This gap often leads to insufficient impact prediction and poor conservation outcomes (Bigrad et al., 2017; Drayson et.al 2015; Adhikari et al., 2019).

The article provides genuine critique about the practices involving biodiversity in EIAs in India. It maintains that ecological assessments suffer from methodological crippledness, time constraints, and reliance on generic data sets. Brief and unseasonable field visits, such as during dry months when flora and fauna are dormant, unchecked taxonomic expertise, and lack of overarching species-governing metrics. Treweek (1999) put it aptly when he urged that "Species presence is one out of many contributors to 'effective' ecological impact assessments. So, in addition to species presence, also to be evaluated are processes, trophic interactions, and functional roles of organisms." Thus, a biodiversity

consideration paradoxically marginalized within EIA reports as remarked conspicuously in the critique was suggested rather robustly in the reviewed paper.

This article emphasize the lacuna between laws and guidelines and what is actually happening on the ground. There are Indian legal and political literature that require the conservation of biological diversity, such as the National Biodiversity Action Plan (2008), but reality often dissent with these fundamentals. Institutional flaws such as limited capabilities as accelerated project permits by the state's Environmental Impact Authority (SEIAA's) and limited publications often lead to decisions that impact the environment. Reduction efforts to combat the impact on biological diversity have often been described as ambiguous. As Gadgil et al. (2011) writes, "The failure to include local ecological knowledge and stakeholder input into EIAs has resulted in the approval of projects in areas of high conservation value- with little understanding of their long-term consequences."

The reviewed article also touches upon the need for India to align its biodiversity-inclusive EIA practices with global best practices and international commitments for instance the Kunming-Montreal Global Biodiversity Framework (2022). Which advocates for the integration of biodiversity considerations across all tiers of policy-making and development planning. The authors argue that the development of standardized biodiversity assessment protocols, investment in capacity building for ecological assessment teams, and promotion of independent ecological auditing are essential for improving the credibility and effectiveness of EIAs in India. As the country advances toward climate-resilient and biodiversity-friendly development goals, the integration of robust ecological science into EIA will be a cornerstone of environmental governance. In the words of the articles, "A development project without ecological intelligences is a gamble with irreversible loss" (Rajvanshi et al., 2001).

2. Legal and Policy Framework:

India has a rather thorough legal framework for the weaving of ecology and biological diversity in the Environmental Impact Assessment (EIA) based on the strong foundations of the Environmental Act of 1986. This law allows the central government to take the needed steps to sustain the environment and enhance its quality. Project Developers explicitly ask to evaluate the ecological impact of the initiative and focus on aspects such as biodiversity, forest, wildlife, and habitats of ecosystems zones. Additionally, EIA notification requires these developers to present data on local flora and fauna, including rare and endangered species, but highlights potential ecological conservation.

Despite the occurrence of defined legal provisions of biodiversity incorporation within Environmental Impact Assessment (EIAs), actual implementation often remains limited and surface-level, with compliance equivalent to procedural formality rather than meaningful ecological practice (Slootweg & Kolhoff, 2003; Runhaar, 2024).India's updated Environmental Impact Assessment (EIA) guidelines represent efforts to align with international biodiversity commitments; nonetheless, significant gaps in monitoring and lack of institutional coordination remain key implementation constraints, as documented in government reports and peer reviewed studies (MoEFCC, 2024; UNEP, 2023 & TERI, 2024) . The Biological Diversity Act of 2002 increases the mission of the proposal to determine rules governing India's commitment to the Convention on Biodiversity 1992 (CBD) by promoting the protection and sustainable management use fair exchange of biological resources. Like National Biodiversity Agency (NBA, 2023) approvals required for examine to biological diversity and traditional ecological knowledge.

The Biological Diversity Act, 2002 reinforces the mandate of this proposal, as it establishes the rules that govern India's commitment towards the Convention on Biological Diversity, 1992 (CBD) by facilitating biodiversity conservation utilization, sustainable use of biological resources with equitable access to benefits of biological resources; as well as requiring approval from the National Biodiversity Authority (NBA) for rights to biological resources and traditional knowledge. Policies applicable to distinct sectors also aid biodiversity assessments. Consequences on ecological passageway are controlled in The Guidelines for Linear Infrastructure Projects (2013), and ecological contemplation is critical under the Forest (Conservation) Act of 1980 for the diversion of forest land. The Forest Rights Act of 2006 incorporates aspects of community involvement, thus deepening the socio-ecological of EIAs. International obligations also inform India's legal systems. National biodiversity policy is shaped by treaties such as the Ramsar Convention, the Convention on Migratory Species (1971), and the Kunming- Montreal Global Biodiversity Framework (2022).

The last of these sits fourth on the list of priorities and calls for countries to "mainstream biodiversity into all levels of government and across all sectors." Reinforcing India's shifting governance. While the implementation of laws is still a challenge, there is a robust foundational legislative gap. Insufficient scrutiny and a lack of ecological skill foster inadequate enforcement of biodiversity laws. As Treweek (1999) warns, "The value of an EIA lies not in the process itself, but in the decisions it informs-and poor ecological inputs can lead to decisions that irreversibly damage biodiversity." The authors suggest strengthening policy frameworks, incorporating South Asia's enviable biodiversity using the India Biodiversity Portal, ENVIS, and the WII's Species Database, and aligning national EIA procedures with International guidelines to achieve more coherent biodiversity goals.

3. Importance of Ecological and Biodiversity Studies in EIA:

Ecological and biodiversity assessments are the foundation of the Environmental Impact Assessment (EIA) framework to make sure that there is no development at the cost of environmental degradation. Ecological and biodiversity assessment assist in identifying some of the sensitive ecological features, which are likely to be adversely impacted due to development activities, such as native and conservation-priority species of flora and fauna, important and critical areas, wildlife migration routes, ecosystem service, and other associated features. As Treweek (1999) notes: "The predictive capability of EIAs and the potential loss of biodiversity is improved by incorporating a sound ecological assessment."

A working site within a given region has to be comprehensively understood in terms of the natural features and the processes which gives rise to certain phenomena such features. The understanding may be achieved through explorations regarded as baseline ecological surveys which include but are not limited to lists of species, maps of habitats, analysing vegetation, and periodic wildlife monitoring. Ecological patterns have quantifiable consequences which can be evaluated through tools of measurement such as biodiversity indices Shannon-Weiner, Simpson's (1949), scoring of the quality of habitats, and assessing the level of fragmentation. "The potential adverse impacts of ecological nature can be evaluated by quantitative approaches like habitat fragmentation analysis and species diversity indices" stated Geneletti (2003).

An ecological research in EIA is paramount to biodiversity defragmentation in India considering that the country harbours the biodiversity hotspots like Western Ghats, Eastern Himalayas and Indo-Burma Region. According to Gadgil et al. (2011), "Considerable ecological scrutiny-ecological assessment at the landscape level-should accompany development projects situated in ecologically sensitive regions to avert irreversible biodiversity damage." One of the major contemporary concerns to long term species viability and biodiversity sustainability are infrastructure induced linear habitat fragmentation as explained in the WTI studies (Menon et al., 2003).

Another crucial role of biodiversity assessments is the identification of Species of Conservation Concern (SCC), including those covered by the IUCN Red List (2024) and Wildlife Protection Act (1972). Rajvanshi et al. (2001) stated that "the species that are highly sensitive to disturbance, species with very specific ecological niches and limited range are most often ignored in EIA." The latter paragraph also emphasize that the evaluated impacts should include the contribution of the ecosystem to the human well-being through carbon sequestration, pollination, and water purification, etc. whose decline may have socioeconomic consequences."

India's Environmental Impact Assessments (EIAs) are frequently criticized for lacking ecological understanding, particularly in areas where they rely on weak or non-existent baseline biodiversity data and have had very little field verification, despite strong policy frameworks. According to Kritika and Sharma (2025), the application of highly technical tools like GIS, remote sensing, and species distribution models is "under-utilised" as there is insufficient technical know-how. In line with this, the convention on Biological Diversity (2002) also points to the shortcomings of the baseline ecological information. Recent publication suggest that the use of spatially explicit tools can significantly improve the accuracy of the predication of habitat change (Roy et al., 2022; Soubry et al., 2021). Thus, the International Association for impact Assessment (2025) is calling for the use of geospatial and modelling methods as a norm to EIA to EIA to have a stronger biodiversity component. Therefore, it is fully justified to say that building technical skills and adopting data-driven spatial analyses are a must if Indian EIAs are to be taken as more that just a check on the fulfilment of procedural requirement but rather a move in the direction of real ecological sustainability.

4. Primary Challenges in the Indian Scenario:

India, in fact, has developed robust policy frameworks that aim to incorporate ecology and biodiversity concerns in Environmental Impact Assessment (EIA), however, there are still some significant gaps that impede the efficient implementation of these policies. Such restrictions frequently lead to the inadequate inclusion of the environment in project evaluation processes, thus the risk of irreversible environmental degradation and biodiversity loss is getting higher and higher.

Even though India has organized strong policy frameworks to include ecology and biodiversity issues into Environmental Impact Assessment (EIA), certain notable gaps remains that limit their effective implementation. These limitations often result in insufficient ecological representation during project evaluations, increasing the risk of long-term environmental harm and biodiversity loss.

a. Limited Availability of Region-Specific Ecological Data:

India's EIA system has been grappling with the lack of ecologically relevant data at the regional level for long time, especially in nature conservation areas such as the Northeast and Western Ghats. Roy (2012) pointed out that "there is a lack of spatially coherent biodiversity baselines which are still sparse and fragmented" in India's Landscapes. Patel et al., (2021), argued that ecological information systems are "badly designed and that the accessibility of data is inconsistent". Chakraborty et al., (2021) discovered that the majority of "environmental impact assessments reports do not have spatial data relating to the biodiversity-rich or most sensitive areas which hinders the predication of the impacts." Hence, it is necessary to upgrade India's ecological databases and geospatial monitoring to facilitate credible, science-based EIAs. In defiance of efforts like the Indian Biodiversity Portal, ENVIS, and the National Biodiversity Authority (NBA, 2023), their integration into EIA reports remains restricted. Recent developments such as the Zoological Survey of India's release of a systematic fauna checklist record over 104,000 species denote a vital step toward improving baseline data availability.

b. Inadequate Field Surveys and Seasonal Coverage:

Over-reliance on short-term or single-season biodiversity surveys is a long-standing flow in EIA practice. This frequently leads to an incomplete ecological picture, in particular, where ecosystems are highly dynamic and have seasonal variations. In such areas, the timing of the surveys is of utmost importance since essential processes like migration, reproduction, and flowering cycles happen only in specific times. Treweek (1999) correctly noted that "Ecological surveys conducted outside of optimal biological time windows often result in under-reporting of species and ecological functions." As a result, important migratory bird's species, amphibians that occur only during the monsoon, and seasonal plants that are critical to food webs and habitat structure are often overlooked in assessments. There oversights can lead to underestimation of entire ecological functions and missed opportunities for nature conservation planning.

c. Shortage of Trained Taxonomic Experts:

One common problem that biologically diverse India environmental impact assessments (EIAs) confront is the shortage of skillful taxonomists and ecologists for the field. Due to the lack of these experts, the biodiversity evaluations that accompany such assessments tend to be of a lower quality. Because of this paucity, there are cases where the data is misinterpreted, and some of it is even missing, while at the same time there is a heavy reliance on secondary sources, which in total have the effect of the assessments losing their scientific basis. The authors Al-Asif and Nerurkar (2024) assert "The lack of skilled taxonomists has evolved into the main obstacle in research on biodiversity and conservation, especially in the areas that are identified as biodiversity hotspots." Besides, excessive reliance on common faunal lists of previous studies lowers the precision of the impact predictions even more. Nevertheless, the efforts of the Zoological Survey of India's (ZSI) checklist of fauna are going some way towards filling in these important gaps in knowledge.

d. Lack of Cumulative Impact Assessments:

Majority of the EIAs in India consider project impacts individually and do not take into account possible interactions and cumulative effects of several projects, thus, this is a matter of great concern in the case of industrial corridors, mining clusters, or densely hydro-powered river

bins. Geneletti (2003) warned that "Cumulative impact assessment remains the least developed component of EIA, despite being crucial for regional biodiversity conservation." Without landscape-level planning, ecosystem linkages such as wildlife corridors, migratory routes, and hydrological regimes are at risk of fragmentation.

e. Weak Enforcement and Review Mechanisms:

Even where biodiversity evaluation are included in EIA reports, implementation remains inadequate. Expert Appraisal Committees (EACs) under MoEFCC often lack ecological experts, weakening biodiversity-related reviews. Kohli and Menon (2009) critically observe, "The clearance process is marked by procedural compliance rather than ecological rigour, with project approvals rarely withheld on biodiversity grounds." Post-clearance monitoring is poor: reports show that regional MoEFCC offices are severely understaffed with as few as one officer per 180 projects relying on self-reporting with minimal verification. Recent judicial and institutional actions highlight systemic deficiencies for example, the Supreme Court's 2024 directive mandating the filling of SPCB vacancies to bolster enforcement.

5. Emerging Tools and Best Practices:

Emerging tools and standardized practices have been widely accepted as a solution for the constraints of traditional biodiversity assessments in Environmental Impact Assessments (EIAs). They are expected to bring about more, accuracy, transparency, and effectiveness in ecological evaluations. The Indian situation is the place where and extensive and less documented biodiversity exists. It is the use of such applications that will facilitate contribution to policy or decision formulation.

a. Application of Geographic Information System and Remote Sensing Mapping Habitats and Monitoring Environmental Changes:

Geographical Information Systems (GIS) and remote sensing have had an amazing impact on ecological assessments. It has become possible to map and monitor the land use and land cover (LULC) on a larger scale so as to identify the changes in habitats over the years. According to the words of Turner et al. (2003), "Remote sensing presents a unique opportunity to observe environmental change repeatedly and from the top." Satellites, such as Landsat and Sentinel, are currently being used in various observed analyse, such as the evaluation of deforestation, wetland contraction, and fragmentation, which is also crucial for prediction of an impact of natural disasters. In Forest (Conservation) Order, GIS techniques have been used to affirm the withdrawal of forestland while also being employed in tracing the wildlife corridors, and in the disappeared forest there have always been wild animal present (Menon et al., 2003).

b. Biodiversity Databases- India Biodiversity Portal, GBIF, ZSI & ENVIS:

Accessibility to broad biodiversity information is needed to conduct correct species estimates. Portal such as India Biodiversity Portal (IBP), Global Biodiversity Information Facility (GBIF), Zoological Survey of India (ZSI), and Environmental Information System (ENVIS) make occurrence records for species and ecological data openly available. "Biodiversity data repositories improve EIAs' quality by providing authenticated, geo-referenced species data," according to Rodrigues et al. (2006). These databases are also used to locate endemism-rich areas and sites of conservation importance.

c. Citizen Science for Data Collection:

Several Citizen Science website such as eBird, iNaturalist, and SesaonWatch have proliferated in India over the last few years. These platforms now provide abundant real-time data, especially for avifaunal and phenology research. As per Dickinson et al. (2010), "Citizen Science bridges the gap between professional knowledge and public participation, democratizing biodiversity monitoring." For example, eBird India has already provided more than 20 million bird records, which are now being used extensively in conservation and academic research (Sullivan et al., 2009). These datasets, when incorporated in EIA studies, yield greater spatial and temporal biodiversity information.

d. Long-Term Ecological Monitoring (LTEM):

Long term ecological monitoring is the main sources of data which is necessary for understanding the changes of biodiversity and the health of ecosystems over time. These are the institutions like Indian Institute of Science (IISc) and the Wildlife Institute of India (WII) which are leading the way in such monitoring initiatives. As per the statement of Lindenmayer and Likens (2010), "Long-term ecological datasets are critical for detecting slow or cumulative effects that are often overlooked by short-term studies." Such monitoring in biodiversity rich areas like the Western Ghats has resulted in uncovering of changes in species composition due to, predominantly the combined effect of infrastructure development and climate change (Gadgil et al., 2011).

e. Standardized Protocols and Biodiversity Metrics:

Standardizing biodiversity metrics and protocols in EIAs increases the scientific rigor and allows the results to be more easily compared. Different projects can use the same standards such as the Shannon-Weiner Index, Simpson's Index, and Important Bird and Biodiversity Area (IBA) criteria to measure their biodiversity. Harris (2021) also supports this view by saying: "standard biodiversity indicators are indispensable for a meaningful understanding and comparing of biodiversity benefits across projects". Moreover, the IUCN's Key Biodiversity Areas (KBA) guidelines provide a universally accepted framework for the identification of areas essential for the survival of global biodiversity, thus giving a solid scientific basis to conservation that is also consistent in different areas.

6. Case Studies from Ecologically Sensitive Regions: Learning from Infrastructure Projects in India:

Infrastructure development in ecologically critical regions such as the Western Ghats, the Himalayan foothills, and throughout the forested regions of central India is being scrutinized for ecological impacts. Case studies in these areas demonstrate the challenging realities of actually facilitating biodiversity-inclusive Environmental Impact Assessment (EIAs) in some cases, and also a mixed bag of successes, failures and missed opportunities.

a. The Western Ghats- Linear Infrastructure and Ecological Fragmentation:

The Western Ghats are a UNESCO World Heritage Site and have been recognized internationally as one of the eight most global areas that qualify as biodiversity hotspots (Myers et al., 2000). However, these ecologically significant mountain ranges are facing a decreasing trend of their ecological integrity due to numerous infrastructure projects, prominently the spreading of the road network, railways, and hydroelectric dams. A well-known case is the Hubbali-Ankola railway line Karnataka, Which Face repeated rejections from expert committees due to potential fragmentation of key tiger and elephant habitats.

As Menon et al. (2003) point out, Linear infrastructure projects in the Western Ghats threaten the ecological integrity of contiguous forested landscape that serve as vital wildlife corridors. “Despite repeated recommendations from wildlife experts and the Western Ghats Ecology Expert Panel (WGEEP), as presented in the report (Gadgil Report, 2011), several projects in the region have proceeded without rigorous biodiversity assessments, often citing strategic or economic priorities.

b. Himalayan Road Infrastructure Project: Char Dham Connectivity:

One of effects of the Char Dham Road Project on Environment of Uttarakhand is a viral news about the major road development project in Uttarakhand that tries to extend the roads to improve the connectivity to the main pilgrimage places has raised concerns about its environmental impact. The area is a sensitive ecological Himalayan region with alpine habitats that are very fragile, rare plants and animals, and a watershed system that is very important. In 2021, this matter went up to the Supreme Court (Citizen for Green Doon vs. Union of India) and was closely examined. The court noted that the ecological EIA process had been carried out with gross negligence.

The Expert Committee appointed by the court has identified a recurring theme in the case of the under-estimation of environmental risks, especially risks of slope instability, deforestation, and the disruption of wildlife corridors (MoEFCC, 2022). A similar note to this (Meena, 2022) wrote that the proliferation of construction activities in mountain ecosystems without adequate baseline ecological assessment has resulted in a rise landslides, loss of biodiversity, and the exodus of tribal communities.

c. Central India -Mining and Forest Ecosystems:

The core of India, especially the forest areas of Chhattisgarh, Jharkhand, and Madhya Pradesh, is not only home to some of the country’s richest biodiversity but also to the tribal communities that live there. One such area is the Hadeo Arand Forest in Chhattisgarh which has been at the center of the environmental debates of the country because of the spreading of open-cast coal mining. These nature-loving forests have experienced the uprising of the people, which has been the main factor due to absence of detailed biodiversity studies being a cause of their concern.

Environmental Impact Assessments (EIAs) for mining projects in India are pervasively silent or only briefly mention forest biodiversity and ecosystem services, without giving very detailed account of habitat degradation and threats to species. To give an example, the Forest Advisory Committee had first suggested the denial of forest clearance for the Hasdeo coal mining project because the ecological impact was considerable. But, later, a portion of the forest clearance for the project was approved after some political moves, thus, the question of environmental governance 'discipline' arises.

On the other hand, initiatives such as the move of the village from Panna Tiger Reserve and the planned Ken-Betwa Lining project show how detailed environmental assessments can guide flexible and science-based planning. Although the project that was linking the rivers was criticized for the possible flooding of the core area of the tiger habitat, the WII (2018) prepared a biodiversity offset and monitoring that is aimed at neutralizing the ecological loss by interventions that are scientific and of a research nature.

d. Model Conservation Practice Implemented along the NH-44 in Pench Tiger Reserve:

The expansion of NH-44 via the Pench Tiger Reserve in Madhya Pradesh is an example of a green infrastructure project. In contrast with most linear development projects that only increase risks for wildlife, the project introduced several crossing points specially-designed over and under the highway for animals, that were not only built but also their position was determined animal movement data and GIS-based corridor modelling. The design was developed in collaboration with the Wildlife Institute of India (WII) and conservation-focused NGOs, utilizing inputs such as camera traps records species distributions data, and habitat connectivity models (Habib et al., 2020).

Ecological connectivity has significantly benefited from the installation of scientifically designed wildlife crossings integrated with Indian highways. Saxena and Habib (2022) recorded the presence of 21 wild mammal species, among which were also tigers and leopards, that were observed to be using the crossings along NH 44, thus, showing their effectiveness. In the same way, the (Habib et al., 2020) communicated that the use of underpasses in Pench Tiger Reserve has been a source of easy going for the main carnivores and herbivores thus, a strong call for ecological planning in infrastructure development (WII, 2020).

7. Recommendations:

An urgent and radical change in both practice and policy is required if India wants to sustainably incorporate ecological and biodiversity considerations in its Environmental Impact Assessment (EIA) process. It is acknowledged that there are laws in place, however, the actual implementation is often lacking because of system and technical problems. The main recommendations to raise the ecological assessment standard in EIA, based on the analysis of the existing situations and difficulties, are:

a. Mandatory Involvement of Trained Ecologists and Taxonomists:

Biological negligence is a frequent consequence of the lack of properly qualified biodiversity specialists in Environmental Impact Assessments (EIAs) in India. Khera and Kumar (2010) argued that the involvement of professional ecologists, field biologists, and trained taxonomists in the EIA process not only makes the ecological evaluations more accurate but also more comprehensive. Their proficiency in species

identification, ecological interactions, and habitat assessments provides the basis for scientifically sound recommendations, thus elevating the standard of environmental decision-making.

b. Adoption of Landscape-Level and Cumulative Impact Approaches:

Biodiversity is not a closed system within the confines of a project. The environmental impact of a development project should be evaluated by the surrounding natural life-support system. This means taking into consideration habitat connectivity, animal movement corridors, and the cumulative impacts over the whole landscape. The use of landscape-level planning makes it possible to find the thresholds of the natural world, the risks of fragmentation and the linkage of ecosystems, which may not be visible even in the most detailed local assessments. Geneletti (2003) states that "An EIA focused on the project can fail to see the wider spatial patterns of biodiversity loss unless it is considered within a landscape-level assessment."

c. Enhancing Data Sharing and Open-Access Repositories:

One of the problems that hinders the implementation of biodiversity-inclusive Environmental Impact Assessment (EIAs) is the absence of detailed biological data for precise areas. Improving the India Biodiversity Portal, GBIF, ENVIS, and Data.gov.in platforms and at the same time making baseline ecological information freely available to anyone interested in it can be a means of facilitating transparency, reliability, and scientific uniformity. Researchers would be better able to monitor species movement, validate assessments, and enhance prescient modelling over time with this transparency. Strong guidelines for this kind of open ecological data integration were established by the 2024 update of the India's Open Government Data (OGD) Platform and the National Data Sharing and Accessibility Policy (NDSAP) (Government of India, 2024).

d. Institutional Mechanisms for Post-Clearance Monitoring:

Ecological assessments must not end with project approval. Post-clearance monitoring systems should be standardized and analytical reviewed, using defined protocols to track biodiversity impacts, restoration success, and compliance with mitigation measures. A notable example is the Uttar Pradesh government's modernization of forest monitoring through an Integrated Forest Management System (IFMS), launched in 2025, which integrates IT, AI, GIS, drones, and sensor-based surveillance via a systematized command center. This initiative indicates the potential for real-time ecological monitoring and stronger implementation (Times of India, 2025).

e. capacity Building of Regulatory Bodies and Local Stakeholders:

Building the ecological capacity of authorities involved in project appraisal is crucial to improving EIA efficiency. This comprise specialized training in biodiversity science, GIS-based ecological analysis, and systematic review of ecological impact reports. Civil society organizations are taking the lead for example, QCI-NABET has organised 3-days workshop from July 16-18, 2025, at, Hyderabad aimed for enhancing the capacity of EIA consultants to develop Good-quality Environmental Impact Assessment (EIA) reports. This workshop addressed topics including Use of GIS in EIA report preparation, Socioeconomics and Baseline Studies, Biodiversity impact assessment, Quantification and Interpretation of Data for identification of impacts the Centre for Science and Environment (CSE, 2025) is hosting a four-day intensive training on EIA monitoring and mitigation techniques in August 2025 (CSE, 2025). Similarly, the INTOSAI iCED is organizing an International Workshop on Biodiversity with Special Reference to Forest Resources in February 2025, aimed at auditors and officials, to strengthen biodiversity oversight and institutional accountability (INTOSAI iCED, 2025).

8. Conclusion:

Ecology and biodiversity are not outer concerns but lie at the very heart of sustainable development. In a country like India-renowned for its ecological diversity and home to diverse globally identified biodiversity hotspots-the Environmental Impact Assessment (EIA) process must reflect this reality with depth and accuracy. Although the current environmental laws and regulations such as the 1986 Environment (Protection) Act and EIA Notification, 2006, lay down a framework for the environment, their on-ground execution is still not adequate to fathom the complexity of the ecological systems. The paucity of quality data, lack of expertise in taxonomy and inadequate long-term monitoring that are the loopholes in the present scenario have made the whole exercise of EIAs, stop the environmental damage from becoming irreversible, ineffective.

To truly serve as a protector of ecological integrity, the EIA system in India must evolve. This contains the adoption of scientifically strong methodologies, the use of technological inventions like GIS and remote sensing, and the institutionalization of involving governance that supports both experts and local communities. Integrating biodiversity concerns in every phase of the project cycle-from assessment to clearance and post-execution monitoring will definitely help to escalate the positive ecological impact. Besides that, it will also lessen the social conflicts and create a feeling of public trust among the citizens. Incorporating biodiversity into all sectors of planning and development is not merely an environmental obligation, rather it is a developmental necessity. By implementing such a combined strategy, India will be able to have a more equal way of forward that not only complies with ecological levels but also fulfills the country's growth goals.

Acknowledgment:

I sincerely express my gratitude to Mr. Vipul Khandelwal, Director of Gaurang Environmental Private Solutions, Jaipur (Rajasthan), for his constant support and expert guidance throughout this study.

References:

Adhikari, D., et al. (2019). Ecological niche modeling as a cumulative environmental impact assessment tool for biodiversity assessment and conservation planning. Journal of Environmental Management, 250, 109–121.

Al-Asif, A., & Nerurkar, A. (2024). Taxonomy in crisis: Addressing the shortage of taxonomists in a biodiversity hotspot era.

Bigard, C., Pioch, S., & Thompson, J.D. (2017). The inclusion of biodiversity in environmental impact assessment: Policy-related progress limited by gaps and semantic confusion. Journal of Environmental Management, 200, 35–45.

Centre for Science and Environment (CSE). (2025). *Building EIA expertise for environmental leaders.* Residential training programme, August 2025.

Chakraborty, R., Lindner, A., & Wende, W. (2021). Public Participation in Biodiversity Impact Assessment in the State of West Bengal, India: Present Status and Finding Ways for Improvement. Environments, 8(5), 39.

Citizens for Green Doon v. Union of India, Civil Appeal Nos. 6497–6498/2021, Supreme Court of India, decided on November 16, 2021.

Convention on Biological Diversity (CBD). (1992). *Convention on Biological Diversity.* United Nations, Rio de Janeiro, Brazil.

Convention on Biological Diversity (CBD). (2002). National assessment of biodiversity and environmental impact assessment in India. Secretariat of the Convention on Biological Diversity.

Convention on Biological Diversity (CBD). (2022). *Kunming-Montreal Global Biodiversity Framework.* Secretariat of the Convention on Biological Diversity, United Nations Environment Programme.

Dickinson, J. L., Zuckerberg, B., & Bonter, D. N. (2010). Citizen science as an ecological research tool: Challenges and benefits. *Annual Review of Ecology, Evolution, and Systematics*, 41, 149–172.

Doon Law Mentor. (2025). *Environmental impact assessment laws in India: Top challenges 2025.* Discusses NGT orders, digital integration, and court directives to improve enforcement.

Drayson, K., Wood, G., & Thompson, S. (2015). Assessing the quality of the ecological component of English Environmental Statements. Journal of Environmental Management, 160, 241–253.

Gadgil, M., Prasad, A., Joshi, N. V., & Kumar, D. (2011). *Western Ghats Ecology Expert Panel Report.* Ministry of Environment and Forests, Government of India.

Geneletti, D. (2003). Biodiversity impact assessment of roads: An approach based on ecosystem rarity. *Environmental Impact Assessment Review*, 23(3), 343–365.

Government of India. (1972). *The Wildlife (Protection) Act, 1972 (as amended).* Ministry of Environment, Forest and Climate Change, New Delhi.

Government of India. (1980). *the Forest (Conservation) Act, 1980 (Act No. 69 of 1980).* Ministry of Environment, Forest and Climate Change, New Delhi.

Government of India. (1986). *The Environment (Protection) Act, 1986 (No. 29 of 1986).* Ministry of Environment and Forests, New Delhi.

Government of India. (2002). *The Biological Diversity Act, 2002 (Act No. 18 of 2003).* Ministry of Environment and Forests, New Delhi.

Government of India. (2006). *The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (No. 2 of 2007).* Ministry of Tribal Affairs, New Delhi.

Government of India. (2024). *National Data Sharing and Accessibility Policy (NDSAP) & Open Government Data Platform India (Data.gov.in).* Ministry of Science & Technology.

Habib, B., Saxena, A., Jhala, Y. V., & Rajvanshi, A. (2020). *Monitoring of animal underpasses on National Highway 44 (earlier 7) passing through Pench Tiger Reserve, Maharashtra* (Technical Report No. 2020/09). Wildlife Institute of India.

Harris, S. (2021). Biodiversity indicators review: Standardization and application across projects. Joint Nature Conservation Committee (JNCC).

International Association for Impact Assessment (IAIA). (2025). Best practice guidance for biodiversity-inclusive impact assessment. IAIA Publications.

International Association for Impact Assessment. (2025). *Strategic Environmental Assessment Key*

International Union for Conservation of Nature (IUCN). (2024). *The IUCN Red List of Threatened Species, Version 2024–1.*

INTOSAI iCED. (2025). *International workshop on biodiversity with special reference to forest resources.* Training programme, February 2025, Jaipur.

Khera, N., & Kumar, A. (2010). Inclusion of biodiversity in environmental impact assessments (EIA): A case study of selected EIA reports in India. Impact Assessment and Project Appraisal, 28(3), 189–200.

Kohli, K., & Menon, M. (2009). *Calling the bluff: Revealing the state of monitoring and compliance of environmental clearance conditions.* Kalpavriksh and Environment Justice Programme, National Centre for Advocacy Studies.

Kritika, & Sharma, A. (2025). Review of Indian studies on environmental impact assessment. Integrated Environmental Assessment and Management, 21(1), 117–130.

Law Blend. (2023/2024). *Environmental impact assessment (EIA) in India: Legal framework, process, and challenges.* Highlights deficiencies including weak post-clearance monitoring, consultant bias, and poor biodiversity coverage.

Lindenmayer, D. B., & Likens, G. E. (2010). *Effective ecological monitoring.* CSIRO Publishing.

Meena, M. (2022). Impact of Char Dham Highway Expansion on Himalaya Ecosystem: Policy Suggestions and Recommendations. Indian Streams Research Journal, 12(7).

Menon, V., Easa, P. S. and Johnsingh, A. J. T. (Eds) (2003) Securing Chilla – Motichur Corridor - A Status Report. Wildlife Trust of India, New Delhi.

Ministry of Environment and Forests (MoEF). (2006). *Environmental Impact Assessment (EIA) Notification, 2006,* issued on 14th September 2006 under the Environment (Protection) Act, 1986. Government of India, New Delhi.

Ministry of Environment and Forests (MoEF). (2008). *National Biodiversity Action Plan.* Government of India, New Delhi.

Ministry of Environment and Forests (MoEF). (2013). *Guidelines for linear infrastructure projects.* Government of India, New Delhi.

Ministry of Environment, Forest and Climate Change (MoEFCC). (2020). *India's Sixth National Report to the Convention on Biological Diversity*. Government of India.

Ministry of Environment, Forest and Climate Change (MoEFCC). (2021). *High Powered Committee Report on the Char Dham Project.* Supreme Court of India Submission.

Ministry of Environment, Forest and Climate Change (MoEFCC). (2022). *Western Ghats, Eastern Himalayas, Indo-Burma and Sundaland (including Nicobar Islands).* Government of India.

Ministry of Environment, Forest and Climate Change (MoEFCC). (2024). Annual Report 2024-25. Government of India.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, 403(6772), 853–858.

National Biodiversity Authority. (2003). About the National Biodiversity Authority. Ministry of Environment, Forest and Climate Change, Government of India.

National Tiger Conservation Authority. (2020). Compendium of Guidelines, Advisories & Orders, Volume II. National Tiger Conservation Authority, Ministry of Environment, Forest & Climate Change

Patel, A., Jain, S., & Debnath, N. C. (2021). InBiodiv-O: An Ontology for Indian Biodiversity Knowledge Management. arXiv.

Rajvanshi, A., Mathur, V.B., Teleki, G.C. and Mukherjee, S.K. (2001). Roads, Sensitive Habitats and Wildlife: Environmental Guideline for India and South Asia. Wildlife Institute of India, Dehradun and Canadian Environmental Collaborative Ltd., Toronto.

Ramsar Convention Secretariat. (1971). *The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat.* Ramsar, Iran: United Nations Educational, Scientific and Cultural Organization (UNESCO).

Rodrigues, A. S. L., Pilgrim, J. D., Lamoreux, J. F., Hoffmann, M., & Brooks, T. M. (2006). The value of biodiversity data repositories in impact assessments. *Biodiversity and Conservation*, 29(4), 1123–1139.

Roy, P. S. (2012). Geospatial Characterization of Biodiversity: Need and Challenges. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XXXVIII-8/W20, 140–144.

Roy, S., Suman, A., Ray, S., & Saikia, S. K. (2022). Use of species distribution models to study habitat suitability for sustainable management and conservation in the Indian subcontinent: A decade's retrospective. Frontiers in Sustainable Resource Management.

Runhaar, H. (2024). Mainstreaming biodiversity targets into sectoral policies and plans. Environmental Science and Policy, 155, 103–115.

Saxena, A., & Habib, B. (2022). *Monitoring of wildlife crossing structures along National Highway 44: Implications for habitat connectivity.* Science of The Total Environment, 835, 155430.

Shannon, C. E., & Weaver, W. (1949). *The mathematical theory of communication.* University of Illinois Press.

Slootweg, R., & Kolhoff, A. (2003). A generic approach to integrate biodiversity considerations in screening and scoping for EIA. Environmental Impact Assessment Review, 23(6), 657–681.

Soubry, I., Doan, T., Chu, T., & Guo, X. (2021). A systematic review on the integration of remote sensing and GIS to forest and grassland ecosystem health attributes, indicators, and measures. Remote Sensing, 13(16), 3262.

Sullivan, B. L., Wood, C. L., Iliff, M. J., Bonney, R. E., Fink, D., & Kelling, S. (2009). eBird: A citizen-based bird observation network in the biological sciences. Biological Conservation, 142(10), 2282–2292.

The Energy and Resources Institute (TERI). (2024). Biodiversity and Land Restoration in India: Policy, Institutional Frameworks, and Challenges. TERI Press.

Times of India. (2025, August 18). *UP forest force to be modernised through use of IT, AI tech.*

Treweek, J. R. (1999). *Ecological impact assessment.* Blackwell Science Oxford, 349.

Turner, W., Spector, S., Gardiner, N., Fladeland, M., Sterling, E., & Steininger, M. (2003). Remote sensing for biodiversity science and conservation. *Trends in Ecology & Evolution*, 18(6), 306–314.

United Nations Environment Programme (UNEP). (2023). Global Environment Outlook: Biodiversity and Ecosystem Services. UNEP Publications.

United Nations. (1992). *Convention on Biological Diversity.* United Nations Environment Programme.

Wildlife Institute of India (WII). (2013). *Eco-friendly measures to mitigate impacts of linear infrastructure on wildlife in India*. Dehradun: Wildlife Institute of India, Ministry of Environment and Forests, Government of India.

Wildlife Institute of India (WII). (2018). *Ken–Betwa River Linking Project: Wildlife conservation plan and biodiversity offset strategy.* Ministry of Jal Shakti, Government of India.

Zoological Survey of India (ZSI). (2023). Fauna checklist of India. Ministry of Environment, Forest and Climate Change, Government of India.

Zoological Survey of India. (2024). *Fauna checklist.* Documents 104,561 species, aiding baseline data improvement.