Analysis on the Integration of Artificial Intelligence in Human–Elephant Conflict Mitigation Through the Legal Lens

Shahnaj Sultana

Research Scholar, The Assam Royal Global University, Email: shehnaj.sultana1111@gmail.com

Abstract

Human–Elephant Conflict (HEC) has emerged as a pressing conservation and governance challenge in India, particularly in Assam, where dense human settlements intersect ancient elephant corridors. The escalation of habitat fragmentation, deforestation, and encroachment has intensified encounters leading to recurring losses—over 700 human and 600 elephant deaths between 2015 and 2024 (MoEFCC, 2024). Traditional mitigation strategies such as trenches, electric fences, and compensation schemes have proved inadequate against the complex and dynamic nature of HEC. Judicially, after the National Green Tribunal (NGT) intervention through **OA No.174 of 2013 Rohit Choudhury -vs- Union of India & Otrs**. that Artificial Intelligence (AI) has surfaced as a promising tool for conflict mitigation, offering real-time monitoring, predictive analytics, and automated early warning systems.

This paper aims to understand the impact of AI on conflict mitigation and how it can transform HEC mitigation while remaining lawful, ethical, and locally legitimate. It specifically investigates the legal and policy frameworks governing AI deployment under India's environmental and technological laws—the Wildlife (Protection) Act, 1972; Forest (Conservation) Act, 1980; Environment (Protection) Act, 1986; Information Technology Act, 2000; and the Digital Personal Data Protection Act, 2023—alongside Assam's regional conservation policies. Employing a doctrinal legal methodology supplemented by case analyses especially at Kaziranga National Park and Tiger Reserve of AI-based interventions such as motion-sensor cameras, drone surveillance, and acoustic alert systems, the study evaluates the compatibility of emerging technologies with existing legal mandates. Findings highlight significant regulatory and ethical gaps, including the absence of explicit AI recognition in environmental law, data governance and liability ambiguities, and limited institutional readiness. The paper concludes that while AI offers transformative potential in real-time monitoring, predictive analytics, and early-warning systems, its success depends on robust legal safeguards, community participation, and interdepartmental coordination. It proposes a rights-based, multidisciplinary framework aligning ethical AI innovation with ecological integrity and constitutional principles, enabling coexistence-centered conservation in Assam and across India.

Keywords: Human–Elephant Conflict (HEC); Artificial Intelligence (AI); Wildlife Laws; Data Governance; Assam.

Introduction

Assam, home to approximately 5,700 Asian elephants (Elephas maximus), has emerged as a hotspot for Human–Elephant Conflict (HEC) due to rapid habitat fragmentation, urban expansion, and agricultural intensification.[1] Between 2015 and 2024, the state reported 764 human fatalities and 682 elephant deaths.[2] Traditional conflict mitigation measures, such as the erection of electric fences, construction of trenches, and use of firecrackers or community patrols, have shown limited effectiveness in addressing the evolving and often unpredictable patterns of elephant movement. These conventional methods, while useful in certain contexts, tend to be reactive, labour-intensive, and unsustainable over the long term.[3] In contrast, Artificial Intelligence (AI) technologies are increasingly being recognized as innovative and potentially transformative tools for conflict prevention and early response. AI-powered applications, including real-time sensor networks, geospatial tracking, predictive modelling, and automated warning systems, offer a proactive approach to mitigating HEC.[4] Technologies such as acoustic sensors, camera traps, and drone surveillance can detect low-frequency rumbles, monitor elephant movement, and issue community warnings within seconds.[5]

1.Menon, V. & Tiwari, Sandeep. (2019). Population status of Asian elephants Elephas maximus and key threats. International Zoo Yearbook. 53. 10.1111/izy.12247.

2.Ministry of Environment, Forest and Climate Change (MoEFCC) 2024, Annual Report 2023–24, Government of India, Ministry of Environment, Forest and Climate Change, New Delhi.

3. Anwaruddin Choudhury, "Status and conservation of the Asian Elephants Elephas maximus in north-eastern India," 29 Mammal Review 141–74 (1999).

4. Leandra Brickson et al., "Elephants and algorithms: a review of the current and future role of AI in elephant monitoring," 20 Journal of the Royal Society Interface 20230367 (2023).

5. Bandara, N.S. & Bandara, D.P. 2023, Elemantra: An end-to-end automated framework empowered with AI and IoT for tackling human-elephant conflict in elephant-range countries, arXiv preprint 2310.15012 (AI & IoT for elephant detection and early warning).

They not only facilitate timely detection of elephant movement but also enable targeted alerts to vulnerable communities, thereby reducing the likelihood of harmful encounters. Projects like Elephant Locator (ELOC) grids detect low-frequency rumbles up to 1 km (Cocks, 2023), and drone-based surveillance enables early visual identification.[6] Early data suggest a paradigm shift but also expose legal grey zones around aerial surveillance, data ownership and algorithmic liability. Yet, despite promising pilots, legal and policy structures remain outdated—drafted in a pre-digital era with no explicit recognition of AI technologies. These innovations also expose regulatory and ethical grey zones. Existing legal frameworks, notably the Wildlife (Protection) Act, 1972, Forest (Conservation) Act, 1980, and Information Technology Act, 2000, were conceived in a pre-digital era and lack provisions for AI integration. Moreover, emerging questions concerning data ownership, algorithmic liability, and community consent under the Digital Personal Data Protection Act, 2023 remain unresolved.
This paper situates these developments within the broader context of India's environmental governance, exploring how AI can sharpen HEC mitigation efforts while remaining lawful, ethical, and socially legitimate. By focusing on Assam—a state representing both ecological richness and conflict vulnerability—it seeks to examine the evolving intersection between conservation technology and environmental law.

Objectives of the study:
1. To understand and highlight the role and effectiveness of Artificial Intelligence-based technologies in mitigating Human-Elephant Conflict (HEC) in Assam.
2. To analyze the existing legal and policy frameworks regulating AI in environmental governance.
3. To propose a rights-based legal-policy framework for ethical AI integration in HEC mitigation.

Research Methodology
This research adopts a doctrinal methodology, which is primarily analytical and based on the systematic examination of legal texts, judicial decisions, policy documents, and academic literature.

6. Cocks, L. 2023, A New Elephant Monitoring System to Protect the Last Remaining Asian Elephants, Earth.Org, 29 June

The study involves an in-depth analysis of primary legal sources such as statutes, rules, regulations, and constitutional provisions relevant to wildlife conservation, environmental protection, and digital technology governance in India, with a specific emphasis
on their applicability in Assam. Key legislations including the Wildlife (Protection) Act, 1972, the Forest (Conservation) Act, 1980, the Environmental Protection Act, 1986, and the Information Technology Act, 2000 are closely examined to assess their adequacy in addressing the legal dimensions of AI-driven interventions in Human-Elephant Conflict (HEC) mitigation. The research also explores secondary sources such as government reports, policy briefs, scholarly articles, and case studies to understand the practical challenges and implementation gaps in deploying AI technologies in wildlife contexts. Judicial pronouncements from Indian Courts that touch upon issues of biodiversity, technological integration, and fundamental rights are analyzed to contextualize the legal discourse. The doctrinal approach enables the identification of normative inconsistencies, regulatory voids, and potential areas for legal reform. It also allows the development of a conceptual framework that balances technological innovation with ecological sustainability, ethical governance, and social justice.

Findings, Analysis And Discussions
1. HUMAN-ELEPHANT CONFLICT: CAUSES, IMPACT, AND CURRENT CHALLENGES:
Human-elephant conflict (HEC) is a multifaceted and escalating conservation issue that reflects the growing friction between expanding human populations and shrinking wildlife habitats. In the Indian context, and particularly in Assam, this conflict is rooted in complex socio-ecological dynamics. Historically, elephants have roamed freely across vast forested landscapes, guided by ancient migratory routes that span state and international boundaries.[7]
7. Hitendra Padalia et al., "Assessment of historical forest cover loss and fragmentation in Asian elephant ranges in India," 191 Environmental Monitoring and Assessment 1–13 (2019).
HEC in Assam is concentrated along 14 recognised corridors that link the protected areas of Kaziranga–Karbi Anglong, Manas, and Barnadi. Satellite telemetry shows that 82 % of conflict herds follow ancestral routes that now intersect National Highways 15 and 37.[8]

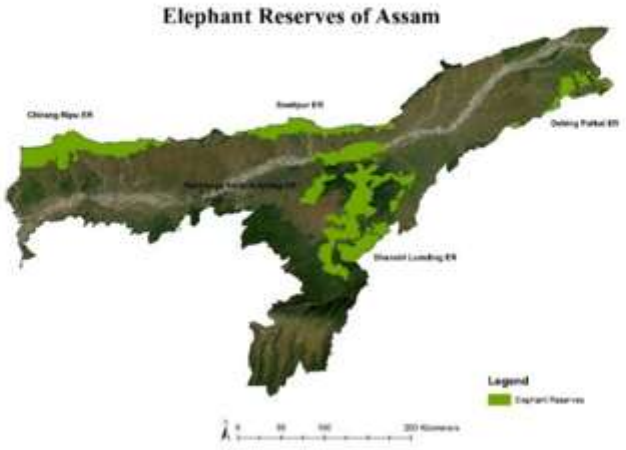

Fig 1: Elephant Population Estimation in Assam 2024, Assam Forest Dept.

However, in recent decades, these landscapes have been dramatically altered due to rapid urbanization, agricultural expansion, industrial development, and infrastructure projects such as highways, railways, and dams. As forests are fragmented and degraded, elephant habitats shrink and become increasingly isolated, forcing these wide-ranging animals to enter human-dominated areas in search of food and shelter.[9] In Assam, the situation is particularly acute due to the state's unique geography and ecological richness, which is now under pressure from unsustainable land-use patterns and demographic pressures. The Brahmaputra valley and the foothills of the eastern Himalayas, once dense with elephant-friendly vegetation, have witnessed a steady transformation into tea plantations, paddy fields, and settlements. Moreover, the seasonal flooding of the Brahmaputra River often compels elephants to move into elevated areas that are now occupied by human habitation, thereby increasing the frequency of encounters. As per Monsoon Damage report, in the 2023 monsoon, 42 % of Kaziranga lay under water for at least ten days, pushing elephants into adjoining tea estates.

8. Joshi, R. & Bist, S., "Elephant Corridors in India: A Review," Indian Forester, 139 (2013) 8–15.
9. Aditi Bansal, "Conservation Vs Development: The Legal Dilemma of Protecting Wildlife Corridors in India" SSRN Electronic Journal 5263169 (2025).

The resulting damage in Golaghat district alone totalled ₹11.3 crore.[10] These interactions often turn hostile, resulting in significant losses on both sides. Elephants, driven by hunger and habitat loss, raid crops and damage granaries and houses, while frightened villagers retaliate using fire, electric fences, and in some cases, even resort to lethal methods such as poisoning or electrocution.[11] Between 2010 and 2020, Assam reported hundreds of deaths on both sides, testament to the severity and persistence of the conflict.

The impact of HEC extends far beyond physical damages. For rural communities, especially small and marginal farmers, the loss of crops and property translates into economic insecurity, food scarcity, and emotional trauma. For elephants, recurring confrontations not only result in **mortality** but also disrupt their social structures, increase stress levels, and alter natural behaviour. The broader ecological implications include the weakening of forest health and the loss of biodiversity, as elephants, being keystone species, play a vital role in seed dispersal and maintaining ecological balance.[12] Furthermore, HEC erodes public support for wildlife conservation and breeds antagonism toward government efforts, particularly when compensation mechanisms are slow, inadequate, or inaccessible. This breakdown in community trust hampers both preventive and remedial measures, making conservation efforts more difficult to implement.

Despite numerous government initiatives and interventions by non-governmental organizations, strategies for mitigating Human-Elephant Conflict (HEC) in Assam have largely fallen short. Physical deterrents such as trenches, fences, and watchtowers are often breached or rendered ineffective over time, while community-based methods like patrolling groups and the use of traditional knowledge, though valuable, remain limited in scale and sustainability.

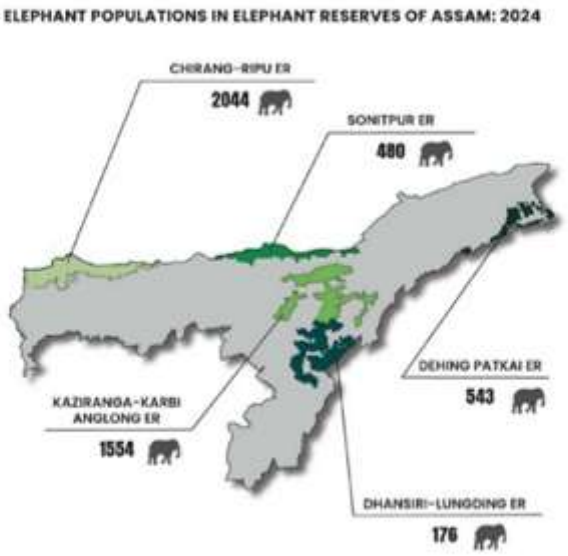

Fig2: Data collected from Assam Forest Dept.

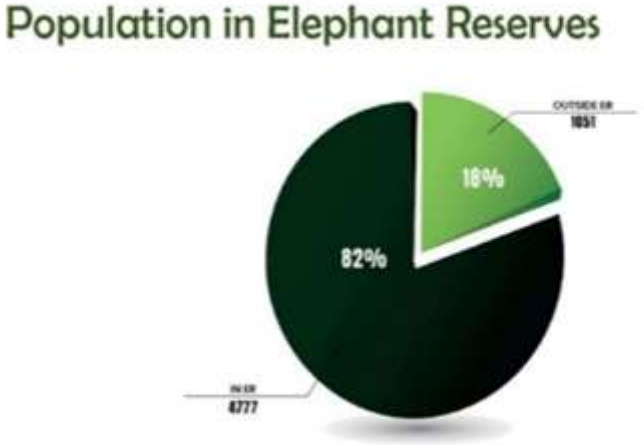

Fig3: Data collected from Assam Forest Dept.

10. Assam State Disaster Management Authority (ASDMA) 2024, Monsoon Damage Report 2023, Government of Assam, Assam State Disaster Management Authority, Guwahati.
11. Anwaruddin Choudhury, "Human–elephant conflicts in northeast India," 9 Human Dimensions of Wildlife 61–270 (2004).
12. Laura Chartier, Alexandra Zimmermann and Richard J. Ladle, "Habitat loss and human-elephant conflict in Assam, India: does a critical threshold exist?" 45 Oryx 528–33 (2011).

Compensation schemes, despite being present on paper, are frequently plagued by bureaucratic delays, corruption, and inconsistent valuation of losses, and the absence of real-time monitoring mechanisms hampers timely intervention, allowing conflicts that could otherwise be prevented to escalate, thereby, pointing to the need for real time, multi modal monitoring—an arena were.[13] AI excels sensors and artificial-intelligence-based pattern recognition—offers a transformative solution by detecting low-frequency rumbles from over 500 metres, with field trials in Sumatra and Borneo suggesting detection ranges could reliably exceed one kilometre once current machine-learning models trained on over 3,000 calls are fully deployed For Assam, where agrarian settlements abut elephant corridors, this leap from collar to soundscape represents a critical shift, as an ELOC grid can provide real-time alerts to forest rangers, village guards, and crop-insurance officers the moment any herd vocalises, transmitting notifications through a mobile dashboard that also serves as an evidence log for compensation claims. Such surveillance aligns with the Wildlife (Protection) Act, 1972's mandate to minimise animal distress and the

National Elephant Action Plan's emphasis on predictive conflict management, while simultaneously generating high-resolution data streams for AI-driven policy tools such as risk maps, dynamic corridor zoning, and adaptive insurance premia.

Most importantly, this shift closes the loop between conservation science and community safety: by eliminating the logistical ceiling of recollar operations, the ELOC model enables managers to monitor entire reserves and surrounding farmlands, thereby reducing crop losses, preventing retaliatory killings, and preserving elephants' genetic connectivity. In transforming elephant monitoring from isolated veterinary records into an ecosystem-wide, AI-ready public good, the technology moves Assam a step closer to a coexistence-centred model of conservation.[14]

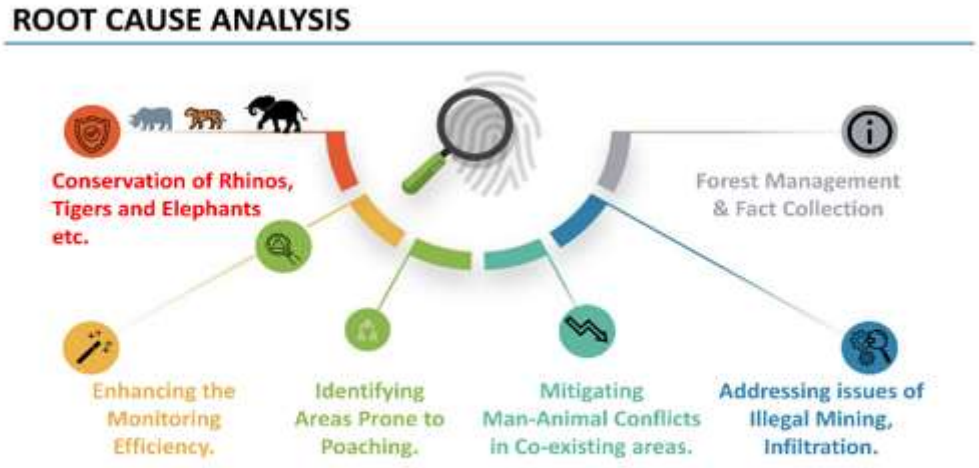

Figure – 4 e-Eye AI Based Wildlife Monitoring System

13. Tulishree Pradhan, Diya Sarkar and Chinmayee Nanda, "Transformative Solutions through AI and Digital Platforms in Human-Elephant Conflict Management," 9 RAIS Journal for Social Sciences 221–30 (2025).

14. Cocks, Tim, "A New Elephant Monitoring System to Protect the Last Remaining Asian Species," Earth.Org, (Jul. 20, 2023), available at https://earth.org/elephant-monitoring-system- protect-Asian-species/ (last visited Jul. 3, 2025).

2. ARTIFICIAL INTELLIGENCE IN WILDLIFE CONFLICT MITIGATION:

Artificial Intelligence (AI) has rapidly emerged as a transformative force in various sectors, and its application in environmental and wildlife conservation is gaining significant momentum. In the context of Human-Elephant Conflict (HEC) mitigation, AI offers the potential to move beyond conventional, reactive measures and introduce a proactive, data-driven approach to conflict prevention and management. AI systems, when integrated with other technologies such as the Internet of Things (IoT), satellite imaging, and geospatial analytics, can monitor animal movement patterns, predict risk zones, and issue early warnings to vulnerable communities.

Examples like Cornell's Elephant Listening Project adapted its 1 D CNN model to the lower frequency rumbles of Elephas maximus; deployed on solar powered edge devices near Sonitpur, flags herds two to three hours before they reach cropland, giving farmers time to move stored grain indoors.[15] Tri axial geophones at Nalbari tea estate identify footfall patterns; an SVM classifier separates elephants from buffalo with 87 % accuracy at 100 m. When paired with the acoustic grid the fusion model extends reliable detection to 2.1 km—even through dense Sal forests.[16]

Figure – 5 e-Eye AI Based Wildlife Monitoring System

15. Wrege, P. et al., "Acoustic Monitoring for Forest Elephants," Methods in Ecology and Evolution, 14 (2023) 311–325.
16. Devi, G. et al., "Seismic Signatures of Asian Elephants," Journal of Zoology, 327 (2024) 201–211)

This shifts from manual surveillance to automated, real-time systems had created new possibilities for minimizing both human and elephant casualties, preserving livelihoods, and fostering coexistence. One of the primary uses of AI in wildlife conflict mitigation is in tracking and analyzing movement patterns of elephants. Machine learning algorithms can be trained on vast datasets, comprising satellite imagery, GPS collar data, and environmental variables, to predict the probable routes elephants might take while moving through fragmented landscapes.

Figure – 6 e-Eye AI Based Wildlife Monitoring System, Geographical System

Such predictive models are particularly useful in areas like Assam, where elephant movement is highly influenced by seasonal changes, riverine landscapes, and human encroachments.[17] With sufficient historical and real-time data, these algorithms can detect anomalies, anticipate likely conflict zones, and initiate pre-emptive responses such as alerting forest officials or triggering community warning systems. This anticipatory capacity of AI fundamentally alters the equation: it enables a shift from reacting to conflict events after they occur to preventing them before they escalate. Another promising AI application lies in the use of computer vision and sensor-based surveillance systems. High-resolution camera traps equipped with AI-enabled image recognition can distinguish between different species, identify elephant herds, and assess their proximity to human settlements. These systems can be linked to centralized command centres or mobile apps that send automated warnings to forest departments and local communities.[18]

17. Tulishree Pradhan, Diya Sarkar and Chinmayee Nanda, "Transformative Solutions through AI and Digital Platforms in Human-Elephant Conflict Management," 9 RAIS Journal for Social Sciences 221–30 (2025).
18. Amrita University introduces innovative AI system to monitor wild elephant movements - Amma.org,"available at: https://amma.org/news/amrita-university-introduces-innovative-ai-system-to-monitor-wild-elephant-movements/ (last visited June 20, 2025).

In some parts of India, drone technology integrated with AI is being experimented with to monitor inaccessible forest areas, track elephant herds, and observe changes in vegetation patterns.[19] These tools not only enhance the capacity of forest personnel but also minimize the risks associated with manual patrolling in dangerous terrains. In addition to monitoring and prediction, AI is also being utilized to streamline and improve decision-making processes. For example, natural language processing (NLP) models can analyze reports from forest field staff, weather data, and social media feeds to provide a more comprehensive picture of emerging conflict situations. AI can also assist in optimizing resource allocation, for instance, by determining where to deploy limited patrolling teams or where to reinforce fences, based on real-time risk assessments. [20] Recent developments in artificial intelligence (AI) are reshaping the landscape of wildlife conservation and conflict management, offering critical insights for Human-Elephant Conflict (HEC) mitigation in Assam. Advances in AI-based wildlife recognition systems demonstrate how deep learning algorithms and computer vision tools can identify species from images, videos, and live camera feeds with high accuracy, while also providing ecological data on habitat, behavior, and conservation status. Such systems, originally designed to democratize biodiversity awareness, have direct applications in HEC contexts by automating the detection of elephants near settlements, generating real-time alerts, and creating reliable datasets for predictive analytics.[21] AI-driven predictive models can identify poaching hotspots, optimize ranger patrols, and enhance surveillance in vulnerable zones, while ecosystem-level models support reforestation planning and climate adaptation strategies. In the context of Assam, these innovations can be integrated into corridor zoning and conflict mitigation frameworks to preserve elephant movement routes, reduce retaliatory killings, and guide adaptive policy measures.[22]

19."Elephant Drone Behavior Tracking,"available at: https://colossalfoundation.org/project/non-invasive-elephant-monitoring-and-ai-enabled-behavior-movement-analytics/ (last visited June 20, 2025
20. S. Naveen et al., "ElephantGuardNet: A Comprehensive Solution for Elephant Conservation and Human-Elephant Conflict Reduction," 4th International Conference on Sentiment Analysis and Deep Learning, ICSADL 2025 - Proceedings 1470–7 (2025).
21. Palandurkar, V. R., Kulal, Ayush, Gholap, Aditya & Ingavale, Brijesh, "AI-Based Wildlife Recognition System," International Journal of Research Publication and Reviews, Vol. 5, Issue 4 (Apr. 2024) 1861–1867.
22. Oladele, Oluwaseyi Kolawole, "AI in Wildlife Conservation: Species Monitoring, Poaching Prevention, and Habitat Restoration" (March 2025) Research Gate.

Most significantly, in the specific domain of elephant monitoring, AI-enabled systems are emerging as transformative tools. As Brickson et al. (2023) demonstrate, AI is revolutionizing elephant conservation by replacing labour-intensive traditional monitoring methods with advanced technologies such as camera traps (e.g., Mbaza AI), UAV-based aerial surveys, and automated image recognition. These systems are increasingly used in Assam-like contexts to track elephant movements, issue early warnings for crop raids, and identify repeat "conflict elephants" through deep learning models that analyse tusks, ears, and body contours. AI-driven Automated Behavior Analysis (ABA) further enhances the ability to detect stress or aggression, while Passive Acoustic Monitoring (PAM) using infrasonic rumbles and seismic signals provides detection capacity even in dense forested habitats.

Yet, the deployment of these technologies must be anchored in robust legal and policy frameworks, as India's current conservation laws—including the Wildlife (Protection) Act, 1972, and the Forest (Conservation) Act, 1980—do not explicitly recognize AI-generated data or regulate its ethical use. Recognition of AI-based evidence in corridor management, compensation assessments, and enforcement mechanisms, combined with region-specific datasets, interdisciplinary collaboration, and ethical safeguards, is therefore essential to realize the full potential of these tools.[23]

Figure-7 Thermal imaging Camera Footage of Panbari Elephant Corridor from K.N.P to Karbi Anglong

23. Brickson, Leandra, Zhang, Libby, Vollrath, Fritz, Douglas-Hamilton, Iain & Titus, Alexander J., "Elephants and Algorithms: A Review of the Current and Future Role of AI in Elephant Monitoring," Journal of the Royal Society Interface, Vol. 20, No. 206, 2023, pp. 1–17, available at: https://doi.org/10.1098/rsif.2023.0367.

3. LEGAL AND POLICY FRAMEWORK GOVERNING HEC AND AI IN INDIA:

Addressing Human-Elephant Conflict (HEC) through technological interventions such as Artificial Intelligence (AI) requires a strong and supportive legal and policy framework. In India, wildlife conservation and environmental protection are governed by a series of national legislations and policies that aim to protect biodiversity, manage forest resources, and regulate human activities that impact ecological balance. However, these laws were primarily enacted in a pre-digital era and do not explicitly contemplate the use of advanced technologies like AI in conservation efforts. As a result, the legal landscape remains fragmented and underprepared to guide the ethical, effective, and accountable deployment of AI tools in HEC mitigation. Let us explore the key legal instruments and policy initiatives relevant to wildlife protection and AI integration, while identifying gaps and opportunities for reform.

AT A GLANCE:

Legal Provisions vis-à-vis AI Integration in Indian Environmental & Data Laws

Statute	Key Legal Provisions	Nature of Regulation	Current AI Relevance	Gaps / Constraints	Scope for AI Integration
Wildlife (Protection) Act, 1972	• Sections 9, 11, 12 (prohibition, exceptions) • Sections 33, 35 (National Parks) • Sections 38V, 38X (Tiger Reserves) • Schedules I–VI	Species protection, habitat conservation, enforcement-focused	AI used indirectly for wildlife monitoring, anti-poaching surveillance, corridor mapping	• No recognition of digital tools or AI • No data governance framework for wildlife data •Discretionary enforcement	• AI-based camera traps & drones for monitoring • Predictive analytics for Human–Wildlife Conflict • Smart patrolling systems • AI-assisted population estimation
Forest (Conservation) Act, 1980	• Section 2 (prior Central approval for diversion) • Forest (Conservation) Rules, 2022	Land-use regulation, administrative approval regime	AI used externally in project appraisal, satellite imagery	• No statutory basis for AI-assisted clearances • Opaque decision-making	• AI-based land-use change detection • Automated forest diversion risk scoring • Decision-support tools for clearance scrutiny

Statute	Key Legal Provisions	Nature of Regulation	Current AI Relevance	Gaps / Constraints	Scope for AI Integration
Environment (Protection) Act, 1986	• Section 3 (wide rule-making powers) • Section 5 (directions) • EIA Notification, 2006	Umbrella environmental regulation, executive-driven	Strong potential for AI via delegated legislation	• No express AI safeguards • Weak transparency • Algorithmic bias risk	• AI-driven EIAs • Pollution forecasting models • Real-time environmental compliance monitoring • Climate risk modelling
Information Technology Act, 2000	• Section 43A (data protection negligence) • Section 66 (computer-related offences) • Section 72A (breach of confidentiality) • Intermediary Guidelines Rules, 2021	Cyber law, liability and digital governance	Indirectly regulates AI systems handling data	• No AI-specific standards • Limited accountability for automated decisions	• Liability framework for AI misuse •Cybersecurity standards for AI tools in governance • Regulating AI platforms as intermediaries
Digital Personal Data Protection Act, 2023	• Sections 4–7 (consent & legitimate use) • Section 8 (data fiduciary obligations) • Section 10 (children's data) • Section 17 (exemptions)	Rights-based personal data governance	Directly impacts AI systems using personal data	• Broad state exemptions • No algorithmic transparency right • No automated decision safeguards	• Ethical AI governance • Regulating AI-driven surveillance • Privacy safeguards for AI in conservation & disaster management

- **WILDLIFE (PROTECTION) ACT, 1972:**

The Wildlife (Protection) Act, 1972 is the cornerstone of India's legal regime for the protection of wildlife and their habitats. It provides for the creation of protected areas, regulates hunting, and lays down penalties for wildlife crimes. Elephants are listed in Schedule I of the Act, granting them the highest level of protection under Indian law. The Act prohibits the killing, poaching, or capturing of wild elephants and empowers the State and Central governments to take measures for their conservation. Section 9 of the Act specifically makes it illegal to hunt any wild animal listed in Schedule I, and this includes acts of retaliation by humans in conflict situations. In this context, the Act places a legal obligation on the state to ensure the safety and preservation of elephant populations, which also implies a duty to prevent the escalation of human-elephant conflict through proactive measures. However, the law was drafted at a time when the threats to wildlife from technological and urban developments were relatively limited, and therefore it lacks specific provisions to address conflicts arising from changing land-use patterns and emerging technologies.[24]

While the Act empowers authorities to declare national parks, sanctuaries, and conservation reserves, it does not provide a clear legal mandate or framework for the integration of AI and modern technology in wildlife management. Forest officers are granted considerable discretion in managing protected areas, but their powers are rooted in traditional enforcement tools rather than technologically enhanced systems. The absence of express statutory provisions on digital surveillance, AI-based monitoring, or real-time alert systems under the Act has created ambiguity about the legality and scope of such interventions. There is also a lack of detailed policy guidance on how AI can be ethically and legally aligned with the Act's conservation goals.[25] Without formal recognition or regulation of AI tools under this law, their deployment in HEC mitigation often takes place in a grey zone, guided more by administrative improvisation than statutory clarity.

24. Ministry of Environment, Forest and Climate Change (MoEFCC) 2017, National Wildlife Action Plan (2017–2031), Government of India, New Delhi.

25. Deepali Singh and Aadarsh Sharma, "Implementation of the Wildlife Protection Act, 1972: A Focus on the Protection of Elephants" SSRN Electronic Journal 4976716 (2024).

- **FOREST (CONSERVATION) ACT, 1980:**

The Forest (Conservation) Act, 1980 was enacted with the primary aim of preventing the indiscriminate diversion of forest land for non-forest purposes. It mandates prior approval from the Central Government before any forest land is used for activities such as mining, industrial projects, or infrastructure development. This law plays a crucial role in HEC mitigation because the destruction and fragmentation of forests directly contribute to the displacement of elephants and the subsequent escalation of conflict. The Act, therefore, serves as a legal barrier against the unregulated clearance of elephant habitats, indirectly supporting conservation. However, despite its protective intent, the law has faced criticism for allowing repeated "exemptions" and for being inadequately enforced in ecologically sensitive regions like Assam. [26] Many forest clearance approvals have been granted without adequate ecological assessments, often ignoring elephant corridors and movement routes. Out of the 212 forest clearance proposals from Assam processed between 2014 and 2023, 62 % lacked corridor impact assessments.[27]

While the Act does not directly deal with AI or wildlife conflict, it has significant implications for the use of technology in monitoring and managing forest landscapes. Satellite-based forest monitoring, GIS tools, and AI-driven deforestation alerts could, theoretically, be used to strengthen compliance with this law. Yet, the Forest (Conservation) Act remains silent on such digital innovations. There are no enabling provisions for data integration, real-time forest surveillance, or predictive modelling that could guide conservation-oriented forest governance. The rigidity of the Act's framework, which was designed to resist deforestation, may inadvertently hinder proactive, tech-enabled forest management practices if not interpreted progressively. To effectively integrate AI into forest conservation and HEC mitigation, there is a need for harmonizing this Act with newer digital governance norms that recognize the role of AI in ecological decision-making and landscape planning.

26. "Critical Analysis of The Forest (Conservation) Amendment Bill, 2023 LinkedIn," available at: https://www.linkedin.com/pulse/critical-analysis-forest-conservation-amendment-bill-2023-q3h7c/ (last visited June 20, 2025).

27. Ministry of Environment, Forest and Climate Change (MoEFCC) Forest Clearance Database, Government of India, PARIVESH / Online Forest Clearance Portal, data for Assam Forest clearance proposals 2014–2023, accessed 1 Jun 2025.

- **ENVIRONMENTAL PROTECTION ACT, 1986:**

Environmental Protection Act (EPA), 1986 is an umbrella legislation enacted in the aftermath of the Bhopal Gas Tragedy, giving the central government sweeping powers to protect and improve the environment. The Act allows the government to set environmental standards, regulate industrial activities, and take emergency measures to prevent ecological damage. One of its strengths lies in its flexibility, Section 3 of the Act allows the Central Government to take "all such measures as it deems necessary" for environmental protection, which provides legal latitude to incorporate modern technologies like AI into conservation practices.[28] Under this provision, the government could issue notifications or formulate schemes to institutionalize AI-based monitoring systems for wildlife conservation, including HEC mitigation. Unfortunately, such potential remains underutilized due to lack of clear regulatory guidance and political will.

The EPA's enforcement mechanisms, such as the Environment (Protection) Rules, 1986, do not explicitly reference or accommodate AI-based data collection and analytics. Moreover, environmental impact assessments (EIAs), which are mandated under the EPA for certain development projects, often overlook the implications of habitat fragmentation for migratory species like elephants. This disconnection between legal intent and ecological complexity weakens the EPA's ability to prevent or mitigate HEC. If AI tools were embedded into EIA protocols, for example, using predictive models to assess the impact of proposed highways on elephant movement, the Act's implementation could become more ecologically sound. To realize this vision, the EPA must evolve beyond its post-industrial roots and embrace digital conservation strategies through appropriate legislative or administrative amendments that explicitly recognize the value and risks of AI in environmental governance.

28. The Environment (Protection) Act, 1986 (India), ss 3, 6, 8, 25; Shastri, S.C. 2014, Environmental Law, 6th edn, Eastern Book Company, Lucknow, ch 7; Ministry of Environment and Forests (MoEF) 1986, Statement of Objects and Reasons, The Environment (Protection) Bill, 1986, Government of India, New Delhi.

- **INFORMATION TECHNOLOGY ACT, 2000 (RELEVANT PROVISIONS):**

The Information Technology Act, 2000 (IT Act) was primarily enacted to address issues related to cybercrime, digital communication, and electronic commerce. While its original scope was not designed to regulate ecological or conservation technologies, certain provisions of the Act have growing relevance as AI becomes a tool of governance, including in environmental and wildlife contexts. For instance, Section 66 and its sub-clauses deal with computer-related offences and unauthorized access to data, which are pertinent when AI-driven systems rely on sensitive data related to geographical locations, community demographics, or real-time surveillance feeds.[29] The Act also provides legal recognition to electronic records and digital signatures, thereby offering a basic framework for legitimizing data generated through AI-based HEC monitoring systems.

However, the IT Act does not provide any substantive framework for regulating AI itself. As AI is used to process environmental and biological data, often involving sensitive locations or endangered species, questions arise about the storage, transmission, and usage of such data. If drone footage or GPS-tracking data of elephants

is leaked, misused, or manipulated, it could endanger both the species and local communities. Presently, there are no binding guidelines under the IT Act that set standards for AI accountability, explainability, or ethical use in environmental applications. Moreover, while AI can assist authorities in HEC mitigation, the absence of legal clarity under the IT Act regarding state responsibility, technological failures, and redress mechanisms limits its safe and effective deployment in conservation. This legal vacuum necessitates the formulation of sector-specific guidelines or amendments to the IT Act that acknowledge the interdisciplinary nature of AI applications beyond commerce and cybersecurity.

29. The Information Technology Act, 2000 (India), ss 2, 43, 65, 66, 66B–66F; Singh, P. 2020, Information Technology Law and Practice, 2nd edn, LexisNexis, New Delhi, chs 3 & 7; Bhatia, G. 2020, 'Surveillance, privacy and the rule of law in India', NUJS Law Review 13(3): 1–27.

- **DIGITAL PERSONAL DATA PROTECTION ACT, 2023 (DPDP ACT) AND ETHICAL CONCERNS:**

As AI systems increasingly rely on large datasets, including satellite imagery, GPS tracking, community input, and behavioural analytics, data governance becomes central to their legal and ethical acceptability. India currently lacks a dedicated, enforceable data protection framework, although the Digital Personal Data Protection Act, 2023 (DPDP Act) is a step toward remedying this gap.[30] In the context of HEC mitigation, the use of data collected from rural communities, forest areas, and surveillance equipment raises pressing questions about consent, data ownership, and the rights of local populations. For instance, if a community is constantly monitored through camera traps and drones, there must be transparency about what data is collected, how it is stored, who accesses it, and for what purpose. Ethical deployment of AI requires mechanisms to prevent surveillance abuse and to ensure that local communities are not reduced to mere data points in conservation algorithms.

Further, AI systems trained on incomplete or unrepresentative data may misidentify risks or disproportionately prioritize certain areas while neglecting others. [31] There is also the risk of undermining traditional ecological knowledge and community-led conservation practices by placing undue reliance on machine-generated insights. In such a context, data ethics must be integrated into the broader legal framework governing wildlife and environmental governance. This includes creating clear accountability chains for algorithmic decisions, mandating transparency in the design and deployment of AI models and ensuring participatory mechanisms where affected communities can question or contest the outputs of such systems. Without a rights-based data protection regime, the promise of AI in HEC mitigation could unintentionally perpetuate new forms of ecological injustice.

4. JUDICIAL CONTRIBUTION TO TECHNOLOGY-DRIVEN CONSERVATION:

The origin lies in the case OA No. 174 of 2013, Rohit Choudhary vs. Union of India & Ors., first heard before the NGT on 9th October, 2013. However, it was on the 5th of February, 2015, that the NGT passed the directive to the State of Assam

30. The Digital Personal Data Protection Act, 2023 (India), Act No. 22 of 2023, enacted 11 August 2023; Digital Personal Data Protection Act, 2023 overview, Parliament of India/Wikipedia (accessed 2025).
31. Reva Schwartz et al., "Towards a Standard for Identifying and Managing Bias in Artificial Intelligence," NIST Special Publication 1270.

The State Government shall ensure fixation of sensor-operated automatic barriers at the animal corridors—i.e., the points where, as per survey undertaken the animals cross the highway to reach the other side of the forest area. The key beneficiaries are Environment and Forest Department, Government of Assam, Transport Department, Government of Assam, Public Works Department, Government of Assam, Police Department, Government of Assam. Indian constitutional jurisprudence provides a normative foundation for integrating Artificial Intelligence into Human–Elephant Conflict mitigation while simultaneously imposing ethical and legal constraints on its deployment. In Animal Welfare Board of India v. A. Nagaraja (2014), the Supreme Court expanded the scope of Article 21 by recognising animal dignity and intrinsic worth, holding that animals are entitled to live with honour and without unnecessary human-inflicted suffering.[32] This interpretation directly supports non-intrusive AI-based monitoring tools—such as thermal sensors, passive acoustic surveillance, and predictive analytics—as legally preferable alternatives to physically invasive methods like capture, translocation, or aggressive deterrence traditionally used in elephant management. From a legal lens, AI thus emerges not merely as a technological aid but as a constitutionally compatible mechanism that aligns wildlife governance with eco-centric constitutionalism. Further, in T**.N. Godavarman Thirumulpad v. Union of India (2012),** the Court reaffirmed the State's continuing obligation to maintain ecological balance and adopt evolving scientific approaches for forest and wildlife conservation. [33] Read purposively, this judicial mandate implies a positive duty on the State to incorporate modern, data-driven tools—including AI-enabled early warning systems and corridor mapping—to prevent habitat fragmentation and mitigate conflict-induced mortality of elephants. Finally, the Supreme Court's recognition of the right to privacy as a fundamental right in People's Union for Civil Liberties v. Union of India (2017) introduces a critical rights-based dimension to AI deployment in conflict landscapes.[34]

32. Animal Welfare Board of India v. A. Nagaraja, (2014) 7 SCC 547 (Supreme Court of India).
33. T.N. Godavarman Thirumulpad v. Union of India, (2012) 3 SCC 277 (Supreme Court of India).

34. People's Union for Civil Liberties (PUCL) v. Union of India, (2017) 10 SCC 1 (Supreme Court of India).

As AI surveillance in HEC mitigation often involves community-level data collection through camera traps, drones, and mobile-based alert systems, the judgment underscores the necessity of informed consent, data minimisation, and purpose limitation, particularly in tribal and forest-fringe areas. Collectively, these decisions demonstrate that Indian courts have implicitly laid down a constitutional framework within which AI can be responsibly integrated into HEC mitigation—one that balances animal welfare, ecological sustainability, and human privacy—thereby reinforcing the urgent need for targeted legal and policy reform governing AI use in wildlife conservation.

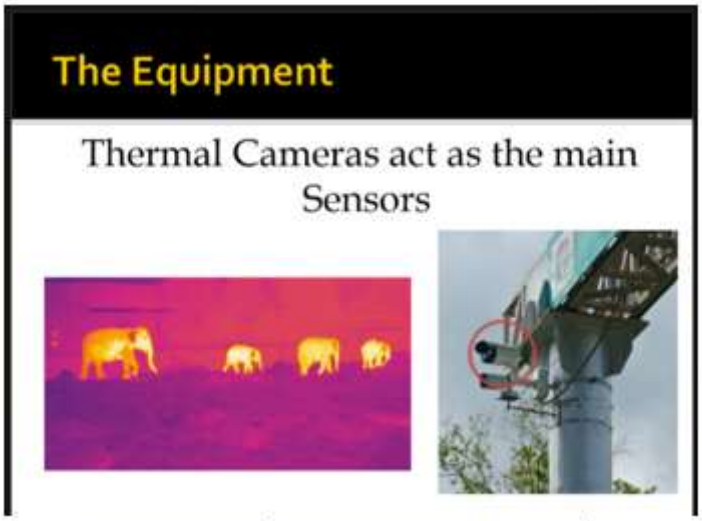

Figure-8 Animal Sensor Project, K.N.P and T.R

5. CASE STUDY ANALYSIS:

Assam, with its diverse landscapes and substantial population of Asian elephants, has emerged as both a hotspot of human-elephant conflict (HEC) and a testing ground for innovative mitigation strategies, including those based on Artificial Intelligence (AI). The deployment of AI-enabled technologies in certain districts has offered promising insights into how real-time data, machine learning algorithms, and community alerts can be harnessed to reduce conflict. However, the practical implementation of these technologies has encountered a range of legal, administrative, and infrastructural challenges that must be addressed to ensure scalability and sustainability.

One notable case is that of Kaziranga National Park, a UNESCO World Heritage Site renowned for its rich biodiversity, including elephants. In and around the park's periphery, AI-based camera traps and geofencing systems have been introduced in collaboration with tech-based NGOs and academic institutions. These systems use motion sensors and real-time video analytics to detect elephant movement and send alerts to forest guards and nearby villagers via SMS and app-based notifications. This has significantly reduced the response time of forest personnel and has helped local residents take precautionary steps, such as avoiding known elephant paths at night or safeguarding food storage. [35]

Figure-9 Animal Sensor Project, K.N.P and T.R

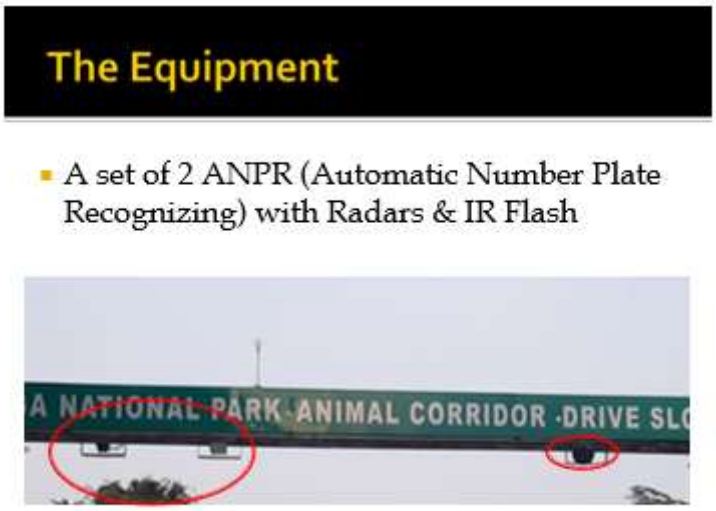

Figure-10 Animal Sensor Project, K.N.P and T.R

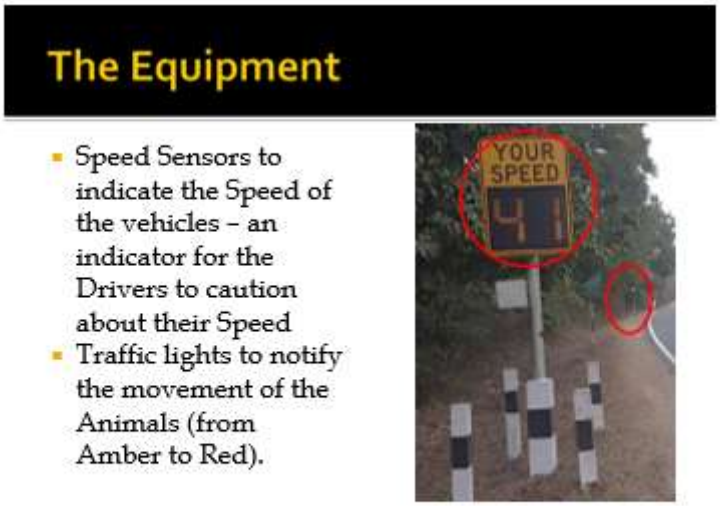

Figure-11 Animal Sensor Project, K.N.P and T.R

ADVANTAGES

- Data about the movement of the wildlife is being recorded.
- Wildlife accidents in the corridor area are also being recorded and used for levying penalties.
- Vehicle movement data is being collected
- Police have used it on numerous occasions for their investigations.

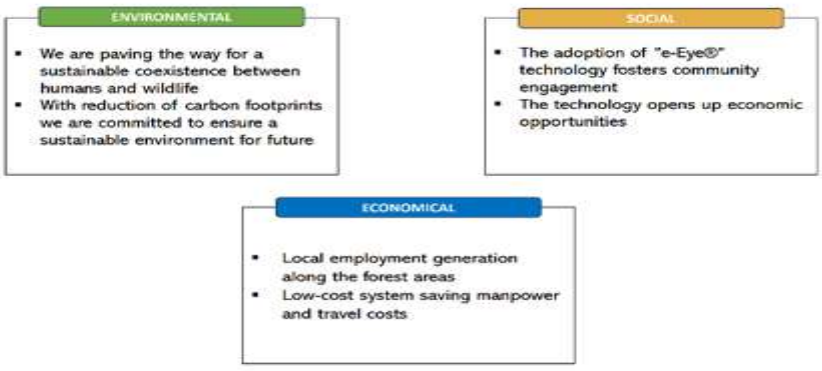

Figure-12 e-Eye AI Based Wildlife Monitoring System

35. Pallabi Chakraborty et al., "Camera trap-based monitoring of a key wildlife corridor reveals opportunities and challenges for large mammal conservation in Assam, India," 62 Tropical Ecology 186–96 (2021).

However, the initiative remains largely in pilot form due to administrative and financial limitations. There is no formal mandate or budgetary allocation from the Assam state government for AI integration in protected area management, and such initiatives often rely on short-term grants or private partnerships, which limits their long-term viability.

In Sonitpur district, which has historically reported high levels of HEC due to encroachment on elephant corridors, a more community-integrated model has been explored. Here, AI-assisted early warning systems using GPS collars fitted on elephant herds have been combined with local knowledge systems.[36] The movement of collared elephants is monitored through satellite tracking, and predictive models generate alerts when herds approach human settlements. These alerts are relayed to community volunteers and forest guards through a centralized dashboard and SMS-based networks. While this model has helped reduce surprise encounters and crop damage, its effectiveness has been hindered by weak legal backing for data sharing and insufficient regulation on the ethical use of location-based surveillance. The absence of clear rules regarding data ownership, cross-agency coordination, and funding allocation means that such projects depend heavily on the discretion of local forest officers and external collaborators, which can lead to inconsistent outcomes across regions.

Figure 13- The Sentinel: Elephant Radio Collar Movement In Sonitpur District

36. Radio collar use to track elephant movement in Sonitpur district, available at: https://www.sentinelassam.com/north-east-india-news/assam-news/radio-collar-use-to-track-elephant-movement-in-sonitpur-district-563632 (last visited June 20, 2025).

Another important example is Bonai district, where terrain and human habitation patterns have made conflict mitigation particularly difficult. In 2021, the district administration, in partnership with a private AI startup, initiated a pilot project to use drone-mounted infrared cameras and AI-based object recognition systems to detect elephant movement during nighttime. The drones captured images from the air, analyzed them in real time, and issued voice alerts through sirens installed in nearby villages.[37]

While the project showed strong initial results in reducing night-time encounters, it quickly ran into legal and operational hurdles. Drone usage in wildlife zones falls under the purview of the Directorate General of Civil Aviation (DGCA), and special clearances are required under the Indian Aircraft Rules, which many local officials were unaware of. Furthermore, the Wildlife (Protection) Act, 1972, does not currently provide a framework for the regular use of aerial surveillance for conservation purposes, leading to regulatory ambiguity. As a result, the pilot was temporarily halted pending further legal review, highlighting the urgent need for harmonization between wildlife law and civil aviation norms.

Across these case studies, a common pattern emerges. While AI offers immense potential to transform HEC mitigation, its field-level implementation is often ad hoc and policy-deficient. Legal enablers, such as the broad discretionary powers of forest officers under the Wildlife (Protection) Act, 1972 and the flexible interpretation of environmental laws, do allow for some innovation. However, these same discretionary powers also become barriers when there is no consistent state-level policy on AI usage in conservation, resulting in legal uncertainty. Administrative bottlenecks, such as lack of trained personnel, poor digital infrastructure, and inadequate inter-departmental coordination, further weaken the deployment of AI tools. Additionally, the lack of community sensitization and participation in the design and execution of these technologies often leads to mistrust or misuse, limiting their impact.

37. "AI cameras, thermal imaging new tools for Bonai to curb man-elephant conflict," available at https://www.newindianexpress.com/states/odisha/2025/Jan/20/ai-cameras-thermal-imaging-new-tools-for-bonai-to-curb-man-elephant-conflict-3 (last visited June 20, 2025).

These case studies illustrate both the possibilities and pitfalls of AI-led HEC mitigation in Assam. While technological solutions have demonstrated measurable success in reducing conflict incidents, their longevity and effectiveness are contingent upon strong legalframeworks, institutional clarity, sustained funding, and inclusive governance. As Assam continues to face the dual challenge of protecting its elephants and securing the lives and livelihoods of its people, a structured, legally supported, and ethically guided approach to AI adoption is imperative.

6. CHALLENGES

Despite its potential, the integration of AI in wildlife conflict mitigation is not without challenges. The deployment of such technology in remote, ecologically sensitive areas like Assam requires vigorous digital infrastructure, reliable electricity, and trained personnel, all of which may be in short supply. Moreover, AI systems are only as effective as the data they are trained on. Inadequate or biased data can lead to inaccurate predictions and even unintended consequences, such as sending false alarms or overlooking emerging hotspots. Furthermore, the cost of AI-based interventions, both in terms of financial investment and maintenance, remains a concern for many developing regions. [38] There is also the danger of overreliance on technology at the expense of traditional knowledge systems and community engagement, which have long played a vital role in local conservation efforts.

Ethical and legal considerations add another layer of complexity. Questions related to data ownership, consent, algorithmic transparency, and accountability need to be addressed before large-scale deployment. For example, who is responsible if an AI system fails to issue a timely warning, resulting in loss of life or property? What safeguards are in place to prevent surveillance technologies from infringing on the privacy of forest-dwelling communities?

38. "The Elephant in the Room: AI's Challenge with Data Quality and Self-Training," available at https://www.ninetwothree.co/blog/the-elephant-in-the-room-ais-challenge-with-data-quality-and-self-training (last visited June 20, 2025).

These concerns underscore the necessity of embedding AI within a well-defined regulatory and ethical framework that respects both environmental and human rights. AI holds immense promise for revolutionizing HEC mitigation strategies through real-time monitoring, predictive analytics, and intelligent decision-making tools. However, its successful application requires a nuanced approach that balances technological innovation with ecological sensitivity, community involvement, and legal safeguards. Especially in biodiverse and conflict-prone states like Assam, the fusion of AI and conservation must be guided by interdisciplinary collaboration and a commitment to sustainable coexistence between humans and wildlife. There is also a noticeable gap in interdepartmental coordination among forest, revenue, and disaster management authorities, leading to fragmented and reactionary responses.

7. RECOMMENDATIONS:

Key Points:

1. Legal Reform: Amend WLPA & FCA for AI clauses.
2. Assam State Policy: need of a Dedicated "Technology in Wildlife Conflict Management Policy."
3. Ethical Oversight: Establishment of AI Ethics Board.
4. Institutional Mechanism: Creation of Wildlife–AI Integration Cell.
5. Capacity Building: Continuous training for forest guards and local youth.
6. Funding: Leverage Corporate Social Responsibility (CSR) and Public-Private Partnership (PPP) models.
7. Community Participation: Citizen science apps for alerts and data validation.

The integration of Artificial Intelligence (AI) into Human-Elephant Conflict (HEC) mitigation strategies in Assam holds significant promise, but its success depends on the establishment of a comprehensive legal, institutional, and ethical framework that supports innovation while safeguarding ecological balance and community interests. As demonstrated by various pilot projects and case studies across Assam, AI-based tools such as GPS tracking, drone surveillance, real-time alerts, and predictive analytics have the potential to reduce conflict incidents, minimize crop and property damage, and even save lives—both human and elephant. However, these interventions remain largely experimental and localized due to the absence of structured policy support and legal recognition. To ensure scalability and long-term success, a set of targeted reforms and collaborative mechanisms must be pursued.

First and foremost, there is a need for explicit legal recognition of AI-based conservation technologies within India's environmental and wildlife protection statutes. The Wildlife (Protection) Act, 1972, and the Forest (Conservation) Act, 1980, should be amended or supplemented with detailed guidelines that recognize the role of AI, remote sensing, and digital data in monitoring wildlife and managing conflicts. These amendments must include provisions for the ethical collection and use of data, standards for AI system transparency, and liability clauses for technological failures. Additionally, the Environmental Protection Act, 1986, can be leveraged to issue

notifications under Section 3 that authorize and regulate the use of AI in ecological risk mitigation. Such statutory backing will not only clarify the legal status of AI-based tools but also empower forest departments and other stakeholders to integrate these technologies without fear of regulatory overreach or administrative resistance.

Second, state-specific policy frameworks tailored to regional ecological and socio-cultural contexts must be developed. Assam should consider formulating a dedicated policy on "Technology in Wildlife Conflict Management," which outlines strategic priorities, funding models, capacity-building initiatives, and implementation timelines. This policy should be co-developed by key departments such as Environment and Forests, Science and Technology, and Revenue and Disaster Management, in consultation with local communities, conservationists, legal experts, and AI developers. Importantly, the policy must adopt a participatory governance model that integrates local knowledge systems and community feedback into the design and functioning of AI tools. Without public trust and involvement, even the most sophisticated technology may fail to generate positive outcomes on the ground.

Third, a robust institutional mechanism for interdepartmental coordination and data governance should be established. At present, the fragmented nature of administrative responsibilities and lack of centralized data infrastructure lead to duplication, delays, and inefficiency. The government of Assam could establish a multi-agency task force or nodal body, such as a "Wildlife-AI Integration Cell," to oversee technology procurement, data management, project evaluation, and compliance monitoring. This body should also develop a shared digital platform for data exchange between the forest department, research institutions, and technology partners. Importantly, any such mechanism must adhere to ethical standards on data privacy and consent, especially when technologies like camera traps and drones are used in inhabited or tribal areas.

Fourth, capacity-building and training of frontline staff and local communities is essential to operationalize AI-based systems effectively. Many forest guards and community volunteers lack exposure to digital technologies, which creates a gap between system deployment and actual usage. The state should invest in continuous training programs, translated into local languages, that explain how AI systems work, what their limitations are, and how communities can benefit from them. Involving educational institutions such as IIT Guwahati, Assam Agricultural University, or wildlife research centres could provide much-needed technical expertise and create a sustainable ecosystem of innovation.

Fifth, funding and public-private partnerships (PPPs) must be encouraged to scale AI innovations beyond pilot projects. The high cost of AI infrastructure, including satellite services, sensor networks, and drone fleets, can be offset by leveraging CSR funds, international conservation grants, and public-private partnerships. Clear legal contracts must be developed to govern such partnerships, delineating responsibilities, data rights, and profit-sharing norms where applicable. PPPs can also bring much-needed agility, innovation, and domain expertise that government departments may lack.

Lastly, ethical oversight and regulatory safeguards must be institutionalized to ensure that AI tools serve public and environmental interests without causing unintended harm. An independent ethics board or advisory committee could be constituted to vet AI-based HEC projects before deployment, especially those involving surveillance or sensitive data collection. This body should include ecologists, legal scholars, data scientists, and community representatives. It must ensure compliance with national data protection laws, assess environmental risks of technological interventions, and prevent the marginalization of vulnerable groups. Ultimately, AI should complement—not replace—traditional knowledge, embedding technology within constitutional values of ecological balance, dignity, and justice.

Conclusion

The intensifying Human-Elephant Conflict (HEC) in Assam represents a complex interplay of ecological degradation, unplanned development, and fragmented conservation strategies. Traditional approaches to conflict mitigation, while valuable in certain contexts, have proven inadequate in addressing the scale, frequency, and unpredictability of these encounters. In this context, Artificial Intelligence (AI) emerges as a powerful tool capable of transforming how we monitor, predict, and respond to wildlife movements, offering real-time, data-driven solutions that can significantly reduce human and elephant casualties. However, the use of such advanced technologies in conservation must be grounded in a sound legal and policy framework that ensures ethical deployment, safeguards the rights of affected communities, and maintains ecological integrity. Beyond conflict-specific applications, broader advances in AI-based wildlife recognition offer valuable insights for enhancing Human-Elephant Conflict (HEC) mitigation strategies. Recent innovations in computer vision and deep learning, such as the YOLOv8-powered wildlife recognition platforms, demonstrate how species can be accurately identified from images, videos, and live camera feeds, providing detailed ecological information on habitat, behavior, and conservation status in real time.[39] These technologies, originally designed to democratize wildlife observation and engage communities in biodiversity awareness, have direct applicability in HEC-prone landscapes like Assam. Integrating such recognition systems with AI-driven conflict monitoring tools could enable automated identification of elephants near settlements, support real-time alerts, and generate reliable datasets for predictive analytics.

By linking species recognition with legal frameworks such as the Wildlife (Protection) Act, 1972, and state-specific conflict management schemes, the approach can bridge conservation monitoring with community safety, ensuring both compliance with environmental law and participatory conflict mitigation. Recent advancements in AI-driven wildlife conservation provide important lessons for strengthening Human-Elephant Conflict (HEC) mitigation in Assam. AI is increasingly used in species monitoring through computer vision, machine learning,

and remote sensing, enabling real-time identification and tracking of endangered species via camera traps, drones, and predictive models. These systems not only automate data collection but also help anticipate poaching hotspots and optimize anti-poaching patrols, while simultaneously supporting habitat restoration through ecosystem health monitoring, reforestation planning, and climate impact prediction.

39. N Nagaraj, 'Automated Approach for Wildlife Detection and Tracking Using YOLOv8 Deep Learning Algorithm' (2025) 2 Discover Electronics Art 107.

Applying these innovations to HEC management, AI can enhance existing predictive models of elephant movement by integrating environmental data with poaching risk assessments, thereby reducing both retaliatory killings and illegal hunting pressures. Moreover, habitat restoration insights from AI-based ecosystem modelling can guide corridor zoning and landscape planning in Assam, ensuring ecological connectivity crucial for elephant populations.[40] In sum, the trajectory of AI in wildlife recognition and conservation—encompassing species identification, anti-poaching surveillance, habitat restoration, and elephant-specific monitoring—strengthens the broader legal-policy discourse on HEC management. It advances a holistic framework where technological innovation is aligned with ecological sustainability, community safety, and robust regulatory safeguards, ensuring that conservation science and policy evolve together towards coexistence-centered outcomes in Assam.

This study shows that while India possesses a robust environmental and wildlife protection regime through statutes like the Wildlife (Protection) Act, 1972, and the Forest (Conservation) Act, 1980, these laws were not designed with digital or AI-based technologies in mind. The absence of explicit legal provisions and regulatory guidelines on the use of AI in conservation creates ambiguity, operational hurdles, and potential risks related to data governance, privacy, and accountability. Moreover, Assam, despite being at the frontline of HEC, lacks a comprehensive state policy that systematically integrates AI into wildlife management. The existing initiatives, though promising, remain fragmented, pilot-driven, and heavily dependent on external funding and technical partnerships. Going forward, there is an urgent need to reform and modernize the legal framework to accommodate technological innovations in a manner that is ecologically sensitive and socially inclusive. This includes not only amending existing laws but also formulating state-specific policies, enhancing institutional coordination, building local capacity, and establishing clear ethical standards for AI deployment. Ultimately, technology should be seen not as a replacement for human engagement or ecological understanding but as a tool that, when used responsibly, can support the broader goal of coexistence. For Assam, and India as a whole, embracing this balanced approach can pave the way for sustainable conservation practices that protect both wildlife and human communities in the years to come.

40. (Oladele, Oluwaseyi Kolawole, "AI in Wildlife Conservation: Species Monitoring, Poaching Prevention, and Habitat Restoration" (March 2025) ResearchGate https://www.researchgate.net)

References

1. Aditi Bansal, 'Conservation vs Development: The Legal Dilemma of Protecting Wildlife Corridors in India' SSRN Electronic Journal 5263169 (2025).
2. Amrita University Introduces Innovative AI System to Monitor Wild Elephant Movements, Amma.org, available at:https://amma.org/news/amrita-university-introduces-innovative-ai-system-to-monitor-wild-elephant-movements/ (last visited 20 June 2025).
3. Animal Welfare Board of India v. A Nagaraja, (2014) 7 SCC 547 (Supreme Court of India).
4. Anwaruddin Choudhury, 'Status and Conservation of the Asian Elephant Elephas maximus in North-Eastern India' (1999) 29 Mammal Review 141–174.
5. Anwaruddin Choudhury, 'Human–Elephant Conflicts in Northeast India' (2004) 9 Human Dimensions of Wildlife 61–270.
6. Assam State Disaster Management Authority (ASDMA), Monsoon Damage Report 2023 (Government of Assam, Guwahati, 2024).
7. 'AI Cameras, Thermal Imaging New Tools for Bonai to Curb Man–Elephant Conflict', New Indian Express (20 January 2025), available at: https://www.newindianexpress.com/states/odisha/2025/Jan/20/ai-cameras-thermal-imaging-new-tools-for-bonai-to-curb-man-elephant-conflict-3 (last visited 20 June 2025).
8. Bandara NS & Bandara DP, 'Elemantra: An End-to-End Automated Framework Empowered with AI and IoT for Tackling Human–Elephant Conflict in Elephant-Range Countries' arXiv Preprint 2310.15012 (2023).
9. Bhatia G, 'Surveillance, Privacy and the Rule of Law in India' (2020) 13(3) NUJS Law Review 1–27.
10. Brickson L, Zhang L, Vollrath F, Douglas-Hamilton I & Titus AJ, 'Elephants and Algorithms: A Review of the Current and Future Role of AI in Elephant Monitoring' (2023) 20 Journal of the Royal Society Interface 20230367.
11. Chakraborty P et al., 'Camera Trap-Based Monitoring of a Key Wildlife Corridor Reveals Opportunities and Challenges for Large Mammal Conservation in Assam, India' (2021) 62 Tropical Ecology 186–196.
12. Chartier L, Zimmermann A & Ladle RJ, 'Habitat Loss and Human–Elephant Conflict in Assam, India: Does a Critical Threshold Exist?' (2011) 45 Oryx 528–533.
13. Cocks L, 'A New Elephant Monitoring System to Protect the Last Remaining Asian Elephants', Earth.Org (29 June 2023).

14. Cocks T, ‘A New Elephant Monitoring System to Protect the Last Remaining Asian Species’, Earth.Org (20 July 2023), available at: https://earth.org/elephant-monitoring-system/ (last visited 20 June 2025).
15. ‘Critical Analysis of the Forest (Conservation) Amendment Bill, 2023’, LinkedIn, available at: https://www.linkedin.com/pulse/critical-analysis-forest-conservation-amendment-bill-2023-q3h7c/ (last visited 20 June 2025).
16. Devi G et al., ‘Seismic Signatures of Asian Elephants’ (2024) 327 Journal of Zoology 201–211.
17. Digital Personal Data Protection Act, 2023 (India), Act No. 22 of 2023, enacted 11 August 2023; Overview, Parliament of India/Wikipedia (accessed 2025).
18. ‘Elephant Drone Behavior Tracking’, Colossal Foundation, available at: https://colossalfoundation.org/project/non-invasive-elephant-monitoring-and-ai-enabled-behavior-movement-analytics/ (last visited 20 June 2025).
19. The Environment (Protection) Act, 1986 (India), ss 3, 6, 8, 25; Shastri SC, Environmental Law (6th edn, Eastern Book Company, Lucknow, 2014) ch 7; Ministry of Environment and Forests (MoEF), Statement of Objects and Reasons, The Environment (Protection) Bill, 1986 (Government of India, New Delhi).
20. Godavarman Thirumulpad TN v. Union of India, (2012) 3 SCC 277 (Supreme Court of India).
21. Hitendra Padalia et al., ‘Assessment of Historical Forest Cover Loss and Fragmentation in Asian Elephant Ranges in India’ (2019) 191 Environmental Monitoring and Assessment 1–13.
22. The Information Technology Act, 2000 (India), ss 2, 43, 65, 66, 66B–66F; Singh P, Information Technology Law and Practice (2nd edn, LexisNexis, New Delhi, 2020) chs 3 & 7.
23. Joshi R & Bist S, ‘Elephant Corridors in India: A Review’ (2013) 139 Indian Forester 8–15.
24. Menon V & Tiwari S, ‘Population Status of Asian Elephants Elephas maximus and Key Threats’ (2019) 53 International Zoo Yearbook 1–15.
25. Ministry of Environment, Forest and Climate Change (MoEFCC), Annual Report 2023–24 (Government of India, New Delhi, 2024).
26. Ministry of Environment, Forest and Climate Change (MoEFCC), Forest Clearance Database, PARIVESH Portal, data for Assam forest clearance proposals 2014–2023 (accessed 1 June 2025).
27. Ministry of Environment, Forest and Climate Change (MoEFCC), National Wildlife Action Plan (2017–2031) (Government of India, New Delhi, 2017).
28. Nagaraj N, ‘Automated Approach for Wildlife Detection and Tracking Using YOLOv8 Deep Learning Algorithm’ (2025) 2 Discover Electronics Art 107.
29. Oladele OK, ‘AI in Wildlife Conservation: Species Monitoring, Poaching Prevention, and Habitat Restoration’ (March 2025) ResearchGate, available at: https://www.researchgate.net/publication/390066060_AI_in_Wildlife_Conservation_Species_Monitoring_Poaching_Prevention_and_Habitat_Restoration
30. Palandurkar VR, Kulal A, Gholap A & Ingavale B, ‘AI-Based Wildlife Recognition System’ (2024) 5(4) International Journal of Research Publication and Reviews 1861–1867.
31. People’s Union for Civil Liberties (PUCL) v. Union of India, (2017) 10 SCC 1 (Supreme Court of India).
32. Pradhan T, Sarkar D & Nanda C, ‘Transformative Solutions through AI and Digital Platforms in Human–Elephant Conflict Management’ (2025) 9 RAIS Journal for Social Sciences 221–230.
33. ‘Radio Collar Use to Track Elephant Movement in Sonitpur District’, Sentinel Assam, available at: https://www.sentinelassam.com/north-east-india-news/assam-news/radio-collar-use-to-track-elephant-movement-in-sonitpur-district-563632 (last visited 20 June 2025).
34. Schwartz R et al., ‘Towards a Standard for Identifying and Managing Bias in Artificial Intelligence’, NIST Special Publication 1270.
35. Singh D & Sharma A, ‘Implementation of the Wildlife Protection Act, 1972: A Focus on the Protection of Elephants’ SSRN Electronic Journal 4976716 (2024).
36. ‘The Elephant in the Room: AI’s Challenge with Data Quality and Self-Training’, NineTwoThree Blog, available at: https://www.ninetwothree.co/blog/the-elephant-in-the-room-ais-challenge-with-data-quality-and-self-training (last visited 20 June 2025).
37. Wrege P et al., ‘Acoustic Monitoring for Forest Elephants’ (2023) 14 Methods in Ecology and Evolution 311–325.