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Artificial Intelligence for Mitigating the Spread of Communicable Diseases: Elephant Health and Population in the Dooars Region of North Bengal

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Abstract - The Dooars area of North Bengal is a highly sensitive border of built-up population and migratory elephant routes. This closeness forms a special avenue through which communicable diseases are passed. In this paper, the authors discuss the potentials of Artificial Intelligence (AI) to track the health of elephants, anticipate their behavior, and prevent the probability of a zoonotic spillover. After incorporating a single concept of health data with remote sensing, bioacoustics, and predictive modeling, AI provides a proactive design to the protection of the elephant conservation and health. In this paper, the author suggests a research agenda, outlines a conceptual model, explains methods of experiment and evaluation, ethical and implementation issues, and policy suggestions. It is aimed at practical, fair AI that will lower the risk of zoonotic and communicable diseases without undermining the health and maintenance of the elephants.

Index Terms - Artificial Intelligence (AI), Elephant, One Health, Dooars, North Bengal

I. INTRODUCTION

The Dooars is an entrance to the Himalayas, which comprises fertile tea gardens and broken patches of forests. It is also the home of the Asian elephant (Elephas maximus), and this is an animal that is becoming more and more present in the human environment. It is not just a battle of space but also a biological interaction [1]. Communicable diseases such as tuberculosis to foot-and-mouth disease may spread to these populations and in turn may be transferred to domestic livestock and human populations. The dense terrain usually makes traditional monitoring reactive and affected by

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the terrain. Artificial Intelligence is an offering of a fresh toolset to shift towards predictive mitigation and stop crisis management as a reaction to the problem at hand [2, 3]. The Dooars region, which covers the foothills of the Eastern Himalayas of North Bengal, is one of the most complicated ecological corridors in Asia. Covering other districts such as Alipurduar and Jalpaiguri, this is a landscape of patchworks of the preserved lands (Jaldapara, Gorumara, Buxa), tea plantations, and human dwellings [4]. The Dooars have been a hot area of fragmentation in the past. Studies conducted by Sukumar (1989) and subsequent revisions in the 2000s showed that the elephant corridors were cut by tea estates and railway tracks in Jalpaiguri and Alipurduar and that this created a physiological impact to the wildlife, which resulted in greater stress on the animals. Stress is also an immunosuppressant. Literature indicates that when the population of the elephants is stressed, they are much exposed to Mycobacterium tuberculosis which is normally acquired as a result of long-term association with human settlement [5 – 9].

Studies carried out recently in Africa (e.g., the utilization of the PAWS - Protection Assistant for Wildlife Security algorithm) have proven that AI is highly effective in predicting the patterns of poaching. Nevertheless, the next frontier is the application of this to disease mitigation [10]. The literature is currently moving in the direction of the term, Conservation Physiology, where AI processes hormonal (dung samples) and movement data to alert individuals who are not healthy before clinical symptoms occur [11]. The Elephas maximus, or the Asian Elephant is the flagship of the region. But, the fragmentation of the habitats has compelled these mega-herbivores to be in continuous contact with human beings. It is not just a place of physical strife (crop raiding) but a biological hot zone in terms of communicable disease transmission. Traditional conservation approaches are not working as the migratory patterns and immune strength of these peoples may be altered by climate change [12 – 14]. Role of AI: In this paper, the author aims to suggest a shift of the current veterinary intervention framework to an AI-assisted proactive bio-surveillance [15]. On the one hand, there is the possibility to predict and prevent disease outbreaks by analyzing environmental factors, physiological data, and movement patterns with the help of machine learning (ML) and prevent the species barrier [16 - 20].

This first section deals with Introduction, after which second section deals with Theoretical Framework, which is followed by section third: Major Communicable Diseases in Elephant Population. Section fourth deals with AI Applications for Disease Mitigation, which is followed by section fifth: Implementation Challenges in the Dooars. Section sixth deals with Discussion & Future Proposal, which is followed by section seventh: Conclusion. At last, the References have been provided for each individual topic.

II. THEORETICAL FRAMEWORK

The One Health Framework in the Dooars / The One Health Integration:

The study falls under the One Health paradigm, which assumes that human health is inseparably connected to the health of every animal with other environmental entities. The One Health approach is the acknowledgement that the health of humans is strongly linked to the health of animals and the common environment. In the Dooars:

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- **Animal Health:** Elephant populations stressed by habitat loss are more susceptible to infections. General Well-Being (GWB) is a measure that is sometimes used in studies regarding the welfare or health of individuals.
- **Environmental Factors:** Water sources shared by elephants and tea garden workers can act as reservoirs for pathogens. The Wildlife (Protection) Act (WPA) of 1972 helps to protect environmental species.
- **Human Health:** Zoonotic diseases pose a significant threat to marginalized tribal communities and plantation workers.

Zoonotic Spillover Dynamics

In the Dooars, the spillover can happen in two directions:

1. Anthropo-zoonosis: Humans or domestic livestock (cattle in tea gardens) passing diseases like Tuberculosis or Foot-and-Mouth Disease (FMD) to elephants.
2. Zoonosis: Elephants acting as reservoirs for pathogens that can eventually affect human populations or local economy (livestock).

The Digital Twin Concept

An AI-driven approach involves creating a "Digital Twin" of the Dooars ecosystem—a virtual model that updates in real-time based on sensor data, allowing researchers to run "what-if" scenarios regarding disease spread. The schematic overview of AI-driven disease mitigation for Dooars elephant population is shown in Figure 1.

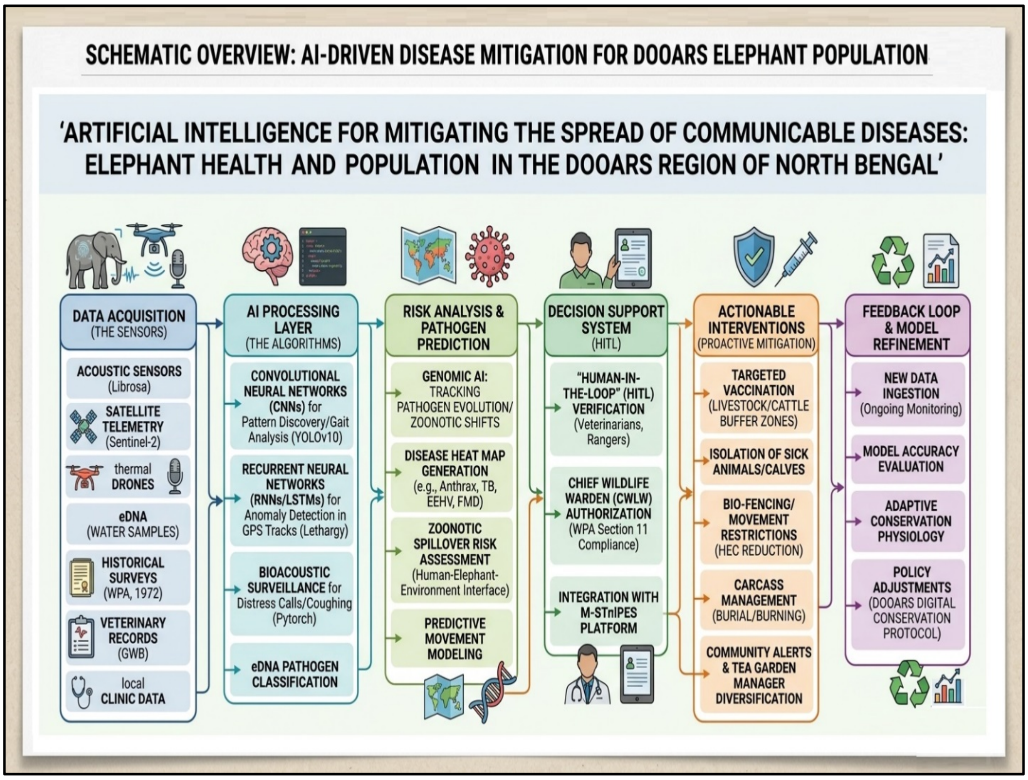

Fig. 1: Schematic overview of AI-driven disease mitigation for Dooars elephant population.

III. MAJOR COMMUNICABLE DISEASES IN ELEPHANT POPULATION

To mitigate spread, we must first categorize the threats. The following table outlines the primary diseases encountered in the North Bengal elephant populations, their symptoms, and standard remedies. The flow diagram of AI-driven disease mitigation for Dooars elephant population is shown in Figure 2.

Table 1: Clinical Profile of Communicable Diseases in Asian Elephants.

Disease Name	Causal Agent	Clinical Symptoms	Traditional/Clinical Remedy
Elephant Endotheliotropic Herpesvirus (EEHV)	DNA Virus (EEHV1-8)	Lethargy, cyanosis of the tongue, edema of head/trunk, internal hemorrhaging.	Antiviral drugs (Famciclovir), aggressive fluid therapy, plasma transfusions.
Anthrax	*Bacillus anthracis*	Sudden death, bleeding from orifices, bloating, high fever.	Antibiotics (Penicillin/Ciprofloxacin) if caught early; carcass burning/deep burial in lime.
Tuberculosis (TB)	*Mycobacterium tuberculosis*	Weight loss, chronic trunk discharge, coughing, weakness.	Long-term multi-drug regimen (Isoniazid, Rifampin, Pyrazinamide).
Foot and Mouth Disease (FMD)	FMD Virus	Lameness, vesicles/sores on the trunk and feet, salivation.	Supportive care, antiseptic washes for lesions, vaccination of local livestock.
Haemorrhagic Septicaemia	*Pasteurella multocida*	High fever, throat swelling, respiratory distress.	Prompt administration of antibiotics (Sulphonamides, Penicillin); Vaccination.

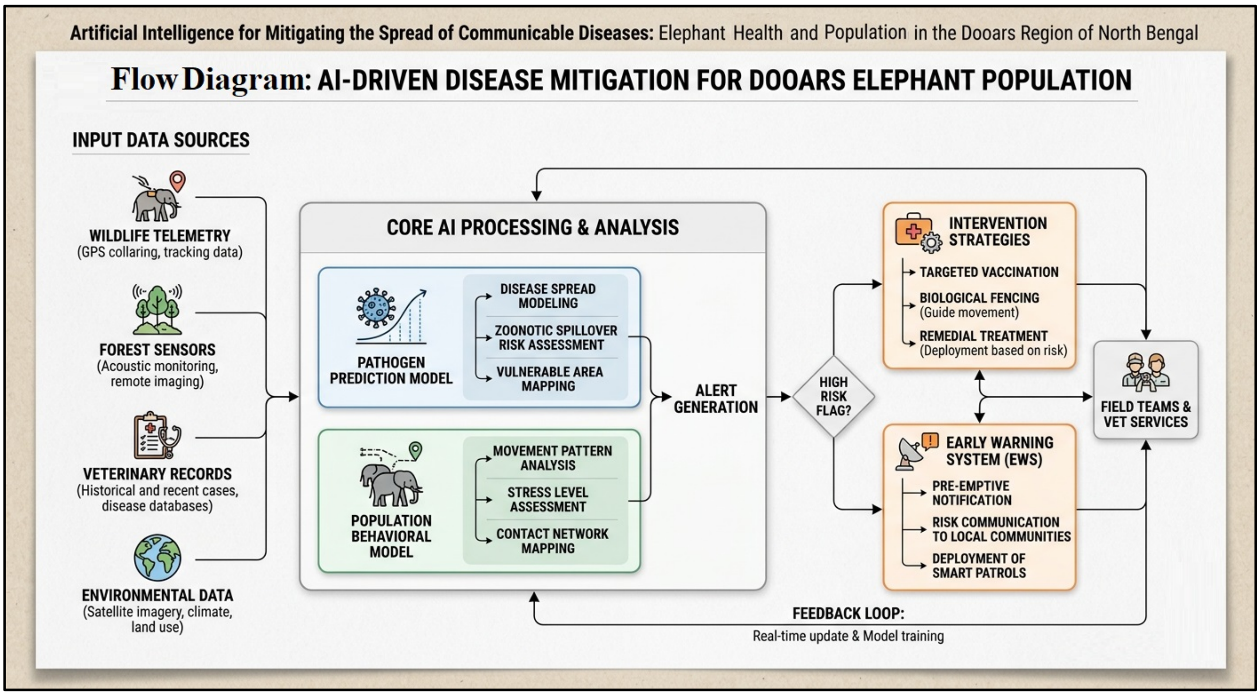

Fig. 2: Flow diagram of AI-driven disease mitigation for Dooars elephant population.

IV. AI APPLICATIONS FOR DISEASE MITIGATION

Machine Learning for Pathogen Prediction

Using Random Forest and Neural Network algorithms, researchers can input variables such as:

- Environmental Data: Rainfall, humidity, and temperature (which influence B. anthracis spores).
- Proximity Data: Distance of elephant herds to domestic cattle grazing lands.
- Historical Outbreak Maps: Spatial data from the last 20 years in North Bengal.

Outcome: The AI generates a "Heat Map" of risk, alerting the West Bengal Forest Department to vaccinate livestock in specific "High Risk" tea gardens before a predicted outbreak.

Machine learning algorithms can predict elephant movement with high accuracy.

A. Data Acquisition Layer (The Sensors)

- Acoustic Sensors: Deployment of "Audiomoth" or similar low-cost, high-fidelity sensors in Gorumara and Jaldapara. These sensors capture infrasonic rumbles and audible coughing/sneezing.
- Satellite Telemetry: High-resolution temporal data from Sentinel-2 satellites to monitor changes in vegetation (NDVI), which correlates with elephant nutritional health.
- eDNA (Environmental DNA): Sampling water holes in the Buxa Tiger Reserve. AI sequences these samples to identify pathogen DNA (like Bacillus anthracis) present in the environment.

B. The Processing Layer (The Algorithms)

- Convolutional Neural Networks (CNNs): Used for "Pattern Discovery" in drone footage. A CNN can be trained to recognize the "body condition score" (BCS) of an elephant by analyzing the visibility of the ribcage and pelvic bones.
- Recurrent Neural Networks (RNNs) & LSTM: Long Short-Term Memory networks are ideal for analyzing GPS sequences. An elephant suffering from an infectious disease often shows "lethargic movement patterns" or "abnormal circular roaming," which these models can flag as anomalies.
- Benefit: If a specific herd is known to be carrying a communicable pathogen, AI can predict their path toward human settlements, allowing authorities to implement "bio-fencing" or temporary movement restrictions to prevent contact.

The system overview for mitigating communicable diseases in elephants through AI-based one health data approach is shown in Figure 3.

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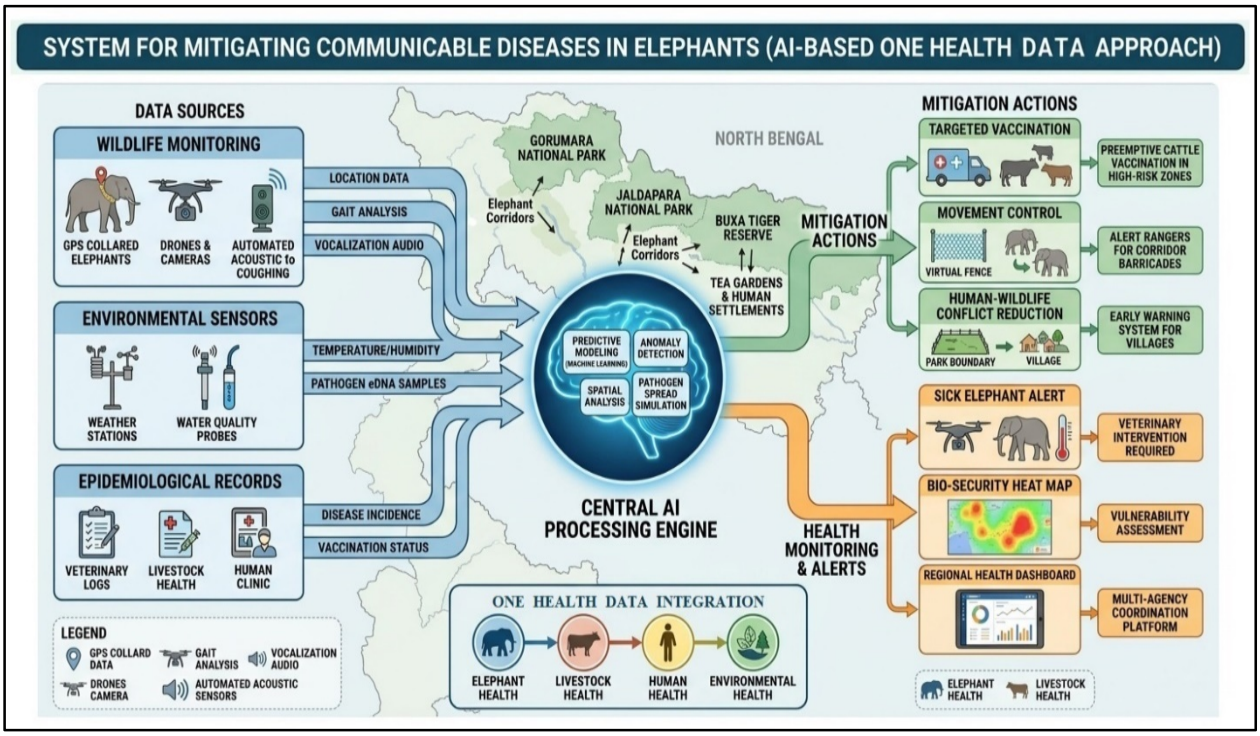

Fig. 3: System overview for mitigating communicable diseases in elephants.

Computer Vision and Automated Diagnostics

Deploying high-altitude drones equipped with Thermal Sensors and 4K Cameras allows for non-invasive health checks.

- Gait Analysis: AI algorithms can detect subtle changes in an elephant's walk (lameness), which is an early sign of FMD or joint-related infections.
- Automated Counting & Identification: Convolutional Neural Networks (CNNs) can identify individual elephants by their ear shapes and tusks, tracking the health history of specific "problem" bulls or matriarchs.

Drone-based thermal imaging and high-resolution cameras can be processed via AI to detect physical anomalies. AI can identify skin lesions, abnormal gait, or lethargy in individuals within a herd, providing a non-invasive "check-up" from a distance.

Bio-acoustic Surveillance

The Dooars' dense foliage often makes visual sighting impossible. AI models trained on Bioacoustics can monitor the forest 24/7. The "Sick Call" Detection: AI can distinguish between a healthy social rumble and a cough or distressed vocalization caused by respiratory pathogens like TB. AI-powered acoustic sensors placed across Gorumara or Jaldapara National Parks can analyze elephant vocalizations. Benefit: Subtle changes in "rumble" frequencies or the presence of coughing sounds can be flagged by Deep Learning models as early indicators of respiratory distress or illness before a physical carcass is ever found.

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Table 2: Comprehensive Pathogen Matrix and AI Indicators.

Disease	Primary Vector/Source	AI Detection Indicator	Clinical Remedy & Prevention
Elephant Endotheliotropic Herpesvirus (EEHV)	Latent virus in adults; fatal to calves.	Thermal drones detecting facial/trunk edema (swelling).	**Remedy:** Famciclovir. **AI Role:** Early isolation of calves from suspected shedding adults.
Tuberculosis (TB)	Human-to-elephant (Reverse Zoonosis).	Acoustic detection of chronic coughing; lethargy in GPS tracks.	**Remedy:** Ethambutol/Isoniazid (12-month course). **Prevention:** Health screening for tea garden workers.
Surra (Trypanosomiasis)	Biting flies (*Tabanus*).	Abnormal "head pressing" or circling captured on camera traps.	**Remedy:** Quinapyramine methyl sulfate. **AI Role:** Predicting fly-outbreak seasons using humidity data.
Pox Virus	Direct contact or contaminated water.	Computer vision identifying skin lesions/pockmarks on the trunk.	**Remedy:** Supportive therapy, topical antiseptics, and isolation.
Internal Parasites	Contaminated grazing land/water.	AI analysis of dung texture/color via smartphone app for rangers.	**Remedy:** Broad-spectrum anthelmintics (Albendazole/Ivermectin).

V. IMPLEMENTATION CHALLENGES IN THE DOOARS

Challenges: The primary hurdles include the "black box" nature of some AI models, which can be difficult for forest rangers to trust, and the lack of consistent internet connectivity in remote forest beats.

While the technology exists, the implementation in North Bengal faces localized hurdles:

1. The "Shadow" Areas: Parts of Buxa Tiger Reserve have zero connectivity, requiring "Edge AI" (processing data on the device itself rather than the cloud).
2. Data Silos: Veterinary data, forest patrol logs, and veterinary hospital records in Siliguri/Jalpaiguri are rarely integrated.
3. Human-Wildlife Conflict: Local communities may view high-tech surveillance with suspicion if they believe it is used for policing rather than health.

Table 3: Regional Pathogen Reservoir Mapping (The Dooars Context).

Geographic Zone	Potential Disease Reservoir	AI Risk Factor Analysis	Recommended AI Mitigation
Buxa Tiger Reserve	Shared water holes with feral cattle.	High risk of Haemorrhagic Septicaemia spillover.	Automated water-quality sensors with eDNA sequencing.
Malbazar Tea Estates	Domestic dogs and human waste.	High risk of Rabies and Tuberculosis transmission.	Computer vision to track inter-species proximity in labor lines.
Jaldapara Grasslands	Dense populations of One-horned Rhino.	Risk of cross-species Anthrax outbreaks.	Multi-spectral satellite imagery to detect "carcass blooms" (sudden vegetation changes).

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The success of AI in the Dooars depends on Data Fusion. This involves merging:

1. Epidemiological data from local clinics.
2. Veterinary records from the Forest Department.
3. Climatic data (humidity and rainfall levels which affect pathogen survival).

Ethical Considerations:

AI surveillance needs to be implemented with care to the local human-elephant relationship. Surveillance must not be a measure of more policing of the communities living in forests but as an exercise of a health-safety net. In addition, the privacy of the biological information of a threatened species should not be subjected to poaching interests.

VI. DISCUSSION & FUTURE PROPOSAL

AI stands as the “Force Multiplier” that is required to conserve the elephants in the Dooars. Moving towards the automated data-driven health surveillance system, not only can we save the great herds of North Bengal, but we can also save the health of the human communities that are occupying their landscape. The paper concludes by proposing a policy framework that the North Bengal administration can adopt, termed here as the "Dooars Digital Conservation Protocol."

1. Mandatory Vaccination Buffer: AI-identified high-risk corridors must have a 5km "Vaccination Buffer" where 100% of domestic livestock are immunized against FMD and Anthrax.
2. AI-Veterinary Rapid Response Teams (RRT): Dedicated teams in the Jalpaiguri Forest Division equipped with AI tablets to receive real-time health alerts.
3. Community Engagement: Training local "Halla Parties" (elephant driving teams) to use AI apps to report "Sick or Abnormal Behavior" rather than just chasing animals away.

To successfully implement this AI framework, the following policy shifts are recommended for the West Bengal Forest Department:

1. Creation of a "Wildlife Health Data Bank": A centralized, AI-driven server in Siliguri that integrates data from the Bengal Safari Park, Gorumara, and Jaldapara.
2. Training "Digital Forest Rangers": Moving beyond traditional patrolling, a new cadre of forest guards should be trained in operating AI-interface tablets and drone deployment.
3. Cross-Border Cooperation: Since elephants are migratory and often cross into Bhutan (Samtse/Phuentsholing), a SAARC-level AI Data Sharing Protocol should be established to track transboundary disease spread.

Future Roadmap:

- Integration of AI tools into the M-STrIPES (Monitoring System for Tigers - Intensive Protection and Ecological Status) platform already used by forest guards.
- Development of a localized "Early Warning System" app for tea garden managers.
- Genomic AI is the future of the Dooars. Using AI to compare the DNA sequences of the pathogens present in the elephant dung will allow us to monitor the Evolutionary Drift of

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the viruses. Should a virus start to evolve to become more easily spread to humans, AI can issue an early warning that it is a possible pandemic event, causing a state-level response to the threat of public health prior to the first human being even infected.

Table 4: Global AI-Wildlife Health Projects Comparison.

Project Name	Location	Primary Technology	Focus Area	Applicability to Dooars
WPS (Wildlife Protection System)	South Africa	Thermal Cameras + AI	Anti-Poaching / Health	High (Drones for night monitoring).
Elephant Listening Project	Central Africa	Bioacoustics	Population Census	High (Monitoring "Sick Calls" in dense forests).
Smart Parks	Netherlands/Africa	LoRaWAN Sensors	Real-time Tracking	Critical (For "Dark Zones" in Buxa).
Project Premonition	Global (Microsoft)	Robotic Mosquito Traps	Pathogen Discovery	Experimental (For tracking zoonotic shifts).

VII. CONCLUSION

Artificial Intelligence that seemed a far-fetched concept has turned out to be a crucial companion in the Dooars whereby its power can help in preserving the ecological equilibrium of the area. A combination of AI and research on the movement of the elephants and patterns of communicable diseases will create a protective buffer that will help to save the biological integrity of North Bengal. This strategy is an integration of the latest data analytics and the fine art of local ecological understanding, which can lead to a more efficient monitoring, early detection, and targeted intervention. This smart combination of technology and tradition is the conservation future of the Dooars, offering resilience ecosystems to generations to come, and is also creating a sustainable livelihood to the local communities in the present.

REFERENCES

1. World Health Organization, UNEP United Nations Environment Programme, & World Organisation for Animal Health. (2022). One health joint plan of action (2022–2026): working together for the health of humans, animals, plants and the environment. World Health Organization.
2. Majumder, R. (2022). Human-elephant conflict in West Bengal, India: present status and mitigation measures. European Journal of Wildlife Research, 68(3), 33.
3. Sukumar, R. (2003). The Living Elephants: Evolutionary. Ecology.
4. Naha, D., Sathyakumar, S., Dash, S., Chettri, A., & Rawat, G. S. (2019). Assessment and prediction of spatial patterns of human-elephant conflicts in changing land cover scenarios of a human-dominated landscape in North Bengal. PloS one, 14(2), e0210580.
5. Chatterjee, N. D. (2016). Man-elephant conflict: a case study from forests in West Bengal, India. New York, NY: Springer.
6. Bist, S. S. (2002). An overview of elephant conservation in India.
7. Pant, D. R., Techato, K., Pradit, S., Gyawali, S., & Baniya, B. (2023). The wild mega-grazers maintaining vegetation assemblages in grassland ecosystems are under threats: a systematic review on grassland ecosystems across the globe. Indian J Environ Prot, 43(3), 219-226.
8. Paudel, S., & Sreevatsan, S. (2020). Tuberculosis in elephants: Origins and evidence of interspecies transmission. Tuberculosis, 123, 101962.

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9. Saha, R., & Datta, C. (2017). Analysing Land Use/Land Cover Changes, Prediction and Fragmentation in Jaldapara-Buxa Forest and its Corridor, West Bengal, India, Using Geoinformatics. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 5, 12.
10. Nad, C., Roy, R., & Roy, T. B. (2022). Human elephant conflict in changing land-use land-cover scenario in and adjoining region of Buxa tiger reserve, India. Environmental Challenges, 7, 100384.
11. Guntawang, T., Sittisak, T., Kochagul, V., Srivorakul, S., Photichai, K., Boonsri, K., ... & Pringproa, K. (2021). Pathogenesis of hemorrhagic disease caused by elephant endotheliotropic herpesvirus (EEHV) in Asian elephants (Elephas maximus). Scientific Reports, 11(1), 12998.
12. Kochagul, V., Srivorakul, S., Boonsri, K., Somgird, C., Sthitmatee, N., Thitaram, C., & Pringproa, K. (2018). Production of antibody against elephant endotheliotropic herpesvirus (EEHV) unveils tissue tropisms and routes of viral transmission in EEHV-infected Asian elephants. Scientific Reports, 8(1), 4675.
13. Jayashree, A., Suresh, K. P., Dikshitha, J., Gulati, B. R., Balamurugan, V., Jacob, S. S., ... & Hemadri, D. (2024). Exploring the impact of climate variables on livestock anthrax outbreaks: A machine learning approach. International Journal of Environment and Climate Change, 14(3), 494-507.
14. Paudel, S., & Sreevatsan, S. (2020). Tuberculosis in elephants: Origins and evidence of interspecies transmission. Tuberculosis, 123, 101962.
15. Mullick, R. K., & Mandal, R. K. (2025). Application of Improved YOLO-LSTM with Combined MQTT-LoRaWAN for AI Surveillance in Tea Plantations to Prevent Elephant Intrusion. International Journal of Advanced Computer Science & Applications, 16(12).
16. Wall, J., Wittemyer, G., Klinkenberg, B., & Douglas-Hamilton, I. (2014). Novel opportunities for wildlife conservation and research with real□time monitoring. Ecological Applications, 24(4), 593-601.
17. Zeppelzauer, M., & Stoeger, A. S. (2015). Establishing the fundamentals for an elephant early warning and monitoring system. BMC research notes, 8(1), 409.
18. Kongyim, N., & Kaitwanidvilai, S. (2026). Smart Surveillance with Conversational Alerts for Wild Elephant Early Warning. Remote Sensing Applications: Society and Environment, 101924.
19. Rastogi, S., Bhattacharyya, S., Vimal, K., Dinerstein, E., Shah, W. A., Nagano, Y., ... & Sekar, N. (2025). Promoting human–elephant coexistence through integration of AI, real□time alerts, and rapid response. Conservation Science and Practice, 7(12), e70186.
20. Ahmed, S. T., Basha, S. M., Ramachandran, M., Daneshmand, M., & Gandomi, A. H. (2023). An edge-AI-enabled autonomous connected ambulance-route resource recommendation protocol (ACA-R3) for eHealth in smart cities. *IEEE Internet of Things Journal*, *10*(13), 11497-11506.
21. Roy, A. (2026). Understanding Human-Elephant Conflict Through More-than-Human Political Ecology Framework in North Bengal, India (Doctoral dissertation).

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