LEGAL STRATEGIES FOR HARNESSING ARTIFICIAL INTELLIGENCE TO PROMOTE ENVIRONMENTAL SUSTAINABILITY

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ABSTRACT

Artificial intelligence (here in after referred as AI) is quickly turning into a force of transformative change toward the achievement of environmental sustainability by amalgamating data analytics, predictive, modelling, and automation. AI has shown its ability to improve efforts in combating climate change, pollution, and ecological degradation.

This paper explores the role of AI in environmental protection and resource management from a legal standpoint emphasizing the need for regulations that address its energy consumption, ethical implications and the environmental costs of AI hardware, by examining the intersection of law, technology and sustainability, the paper suggests a comprehensive approach to govern AI's role in achieving sustainable development.

Keywords: AI, Sustainability, Environment, Law, Technology

Introduction:

AI-enabled solutions for tackling some of the most urgent ecological woes in India - climate change, deforestation, air and water pollution, loss of biodiversity etc. are on the rise. They acknowledge that AI can play a key role in the quest for sustainable development, and is a significant technology to foster pro-environment governance. Machine learning models powered by AI are changing the way we model climate and weather, enabling better prediction and preparation for natural disasters. These predictive abilities facilitate proactive intervention by the authorities, mitigating the effects of severe weather phenomena like cyclones, floods, and drought. In addition, AI-powered remote sensing solutions greatly reduce the cost of monitoring and addressing environmental degradation, as they enable real-time data reporting

about deforestation, changes in land use, and water pollution, further improving environmental regulation enforcement.

One of the most important ways AI inspires sustainability is in the improvement and optimization of energy consumption as well as the integration of renewable energy sources. Predicting electricity demand and balancing the supply from conventional and renewable sources makes AI-based smart grids more energy efficient. In India, it is especially relevant, as the transition to renewable energy is critical for cutting carbon emissions. While AI doesn't exactly create a renewable energy source, it does facilitate their proper use, minimizing unnecessary waste and helping to balance the power grid. Moreover, AI-driven automation in industrial and urban settings helps reduce energy usage using intelligent monitoring systems that identify inefficiencies in real-time. AI is being integrated into the Environmental Impact Assessment (EIA) process, one of the critical components that helps to conduct a feasibility study of whether a developmental project will be sustainable or not. AI analytics help data gathering and processing, they help to counter the human biases thus helping in the decision-making process. Thanks to these advances, infrastructure projects now adhere to environmental standards and reduce their ecological impact.

Yet while AI promises much, its use in environmental governance raises distinct legal, ethical and regulatory issues, such as data with privacy concerns, algorithmic bias, and transparency to AI decision-making processes. Without proper structuring and tuning, AI systems can impair existing biases and create unjust and misleading environmental measures. Moreover, AI applications are running in legal grey areas, causing a risk of falling into one or more regulatory challenges in sustainability initiatives due to an improper use of AI. Despite the capability for AI to transform industries, it raises serious ethical concerns that require thoughtful consideration and proper governance, a gap that does not have a process in place to hold these systems accountable. There are also legal complexities related to intellectual property rights in relation to ownership of data and AI innovation in green technology. We must establish clear rules around legal ownership of AI-generated knowledge so AI-driven environmental solutions do not remain in the hands of only the wealthiest few.

As environmental issues transcend national boundaries, international collaboration is also imperative to align AI regulations and exchange best practices. The potential of AI in achieving sustainable and responsible business practices can only be harnessed by ensuring that legal

frameworks adapt to emerging challenges without compromising on the essence of ecological preservation. India should craft responsive policies around ethical, intellectual property, standard of compliance, etc. regulation while rewarding innovation in environmental governance. An established and inclusive AI regulatory framework will not only encourage the responsible use of AI but also ensure that AI plays a significant role in environmental sustainability.[1]

AI in Environmental Sustainability: Applications in India:

India has a long history of effective environmental conservation and climate change mitigation actions, and artificial intelligence (AI) is emerging as a powerful enabler in such efforts. When applied to big data analytics and automation, AI can assist with environmental monitoring, energy grid management, and sustainable resource management. AI-based remote perception is also dangerous in monitoring deforestation in sensitive ecological zones like the Western Ghats, illegal mining and urban air pollution. Climate models based on AI will be able to provide early warnings of extreme weather conditions such as cyclones, flooding, heat waves, so that policy makers can intervene timely to limit damage. At the ground level the Indian government is using tools such as the Climate Resilience Information System and Planning to merge AI-driven predictive climate risk assessments into the rural landscape to better equip communities with readiness and adaptive measures.

AI applications are being understood in an ever-growing number of environmental technologies including smart farming, renewable energy systems, water security solutions and smart air quality monitoring, to reference just a few of these exciting emerging fields. In agriculture, AI-based enters enhance irrigation while predicting crop production and detecting pests, allowing resource efficiency and climate-smart agriculture.[2] The National e-Governance Plan for Agriculture drives AI based agricultural innovations and partnership between technology giants like IBM and Microsoft and Indian farmers enable the realisation of AI informed agronomic recommendations for irrigation, fertilization and pest control.[3]

AI-driven autonomous drones can also monitor crop health, offering farmers the ability to

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[1] Sandeep Bhardwaj, The Interplay of Artificial Intelligence and Environmental Sustainability in India: Legal and Ethical Challenges (Oxford University Press 2022) 45.
[2] Dr. Nivash Jeevanandam,'Harnessing AI for climate action: Perspectives from the virtual convening on climate change and AI' (2024) available at www.indiaai.gov.in (last visited 15 January 2025)
[3] K Patel, 'Smart Farming with AI: The Future of Indian Agriculture' (2022) 12(3) Journal of Agri Tech 56.

practice precision agriculture, which is a more sustainable practice that ensures local ecosystem pollution is minimized.[4]

Forcing Supply-Side Efficiency:

AI facilitates improved demand-supply management in the power sector, justifying India's transition to green energy at a quicker rate. Electricity peak load management and data-driven distributed generation supported by block chain also play a crucial role in ensuring the intelligent flow of electricity between producers and consumer's demand.[5] Companies like Tata Power are deploying AI analytics to enhance grid stability and raise the proportion of solar and wind in India's energy mix which resonates with National Action Plan on Climate Change. In the energy sector, AI serves as a building block for energy storage management, ensuring periodic reliability of intermittent renewable sources and in turn, supporting India's net-zero emissions mission. AI applications are cutting down industrial carbon footprints by streamlining energy consumption in factories and increasing efficiency in urban infrastructure, in an effort to combat climate change as well.[6]

India's water resources need to adopt AI for better monitoring and conservation AI-enabled sensors and analytics monitor water quality in the world's major rivers including Ganges, identifying pollution sources at source, as they happen. By combining real-time monitoring, the Namami Gange initiative uses a network of AI-based monitoring systems to ensure that the necessary pollution control measures are being adhered to, encouraging initiatives to clean and restore India's biggest water body. By mapping aquifer levels and predicting possible shortcomings, AI can also aid groundwater management key in states like Rajasthan and Maharashtra, where insecurity is highest. AI enables sustainable access to water through efficient use of water resources.[7]

AI is also playing a major role in air pollution monitoring. AI models that process satellite imagery and data are used to monitor these pollution levels in cities like Delhi, Mumbai and Kolkata. For example, the Central Pollution Control board supervise the AI tools with the

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[4] Ministry of Agriculture, *National e-Governance Plan for Agriculture: AI Integration Report* (2023).

[5] IBM Research, 'AI in Precision Agriculture' (2023) available at https://www.ibm.com (last visited on Jan. 18, 2025).

[6] United Nations Environment Programme, "AI for Renewable Energy Efficiency" (2022), available at www.unep.org (last visited on Jan. 18, 2025).

[7] Government of India, *Namami Gange Programme* (2021), available at https://www.pmindia.gov.in (last visited on Jan. 20, 2025).

National Air Quality Index the AI innovative model integrates Data Science and employing AI to the National Air Quality Index, enabling to forecast pollution accurately that helps the authorities to take early action that prevent emissions from industrial processes, vehicular emissions, and other pollution sources. such insights can be harnessed to shape targeted regulatory interventions, which lead to improved air quality and health outcomes. Furthermore, these tools also allow city managers to enhance traffic flow and reduce congestion, leading to a more sustainable and intelligent urban environment.[8]

Though AI holds significant promise, its deployment in environmental sustainability involves significant ethical, legal and environmental issues. AI systems of this kind must be trained on such huge datasets that they draw on massive amounts of computational resources, sending data centre energy consumption and carbon emissions soaring. The production and disposal of AI hardware also contribute to the creation of electronic waste (e-waste) and of resource depletion, with consequent further environmental hazards. Legal issues related to the use of AI in decision-making regarding the management of resources are also troubling, and should also be taken into account for transparent and fair use of this technology, but also to help avoid issues, including potential socio-economic impacts on vulnerable segments in India, by reducing any risk in accordance with the country's legal frameworks. Part of this is an IP-related concern regarding equitable access to AI-infused sustainability solutions based on the IP status of environmental data and technologies generated by AI.[9]

To make use of the benefits of AI while containing its dangers, India requires a strong regulatory framework that displays the applications of AI in environment. This should include policies surrounding energy efficiency, responsible e-waste management, and the ethical use of AI to enhance resource management, an aggressive environmental framework for AI built into legislation.[10] And the goal is going to demand that government agencies, technology companies, research institutions, and civil society organizations collaborate in creating policies that are aligned with ecological viability. Such a framework would be a major step forward at this critical junction of AI regulations embedded in further wide-reaching environmental legislation, enforcement of corporate accountability and promotion of AI-enabled sustainable

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[8] A Sharma, 'AI-Based Air Quality Forecasting in India' (2023) 8(4) Atmospheric Science Journal 134.
[9] A. Choudhary, "Energy Consumption Challenges of AI in Environmental Sustainability" (2023) 15 *Green Technology Journal* 78
[10] S. Verma, "AI and Intellectual Property in Environmental Solutions" (2022) 13(1) *Technology and Law Review* 112

innovations, which would allow the country to leverage the massive potential AI harms while facilitating responsible AI usage and set the tone internationally.

Defining Indian AI led environment efforts along global sustainability lines India's commitments to the Paris Agreement and the United Nations Sustainable Development Goals can help make this happen. As AI steps into a more prominent role in environmental governance, it will be crucial to take anticipatory regulatory actions to ensure that technological innovations do not erode the integrity of the environmental commons.[11]

AI-Environmentalism: Legal and Ethical Challenges:

Alongside the huge potential of Artificial Intelligence (AI) to reshape India's environmental governance, we also witness explicit legal and ethical issues regarding AI that demands immediate attention. While AI-empowered solutions may help improve climate accountability, energy efficiency, and environmental regulations, there is no doubt that AI solutions will generate regulatory gaps, ethical problems, and socio-economic disparities. A major legal barrier is because there's no system of extensive AI-related environmental regulation. The Environment Protection Act, 1986 and the Energy Conservation Act, 2001 are examples of our existing environmental regulations that are proposed to be made compatible with the concerns around AI, yet which do not directly address the high energy consumption, risk of algorithmic bias and corporate accountability associated with AI-based decision-making regarding the environment.

A specific ethical concern is around algorithmic transparency and fairness in AI-based environmental governance. The AI models that are applied towards climate risk assessments, pollution monitoring, and resource management and rely on large data sets, and bias in such data sets could lead to forms of discriminatory environmental policy.[12] One of the ways this could happen is through biased training data for environmental control systems coupled with artificial intelligence where documentation or targeting of pollution control leans heavier on marginalized communities than non-marginalized communities creating an strengthening of climate injustice at those sites. In addition, AI's "black box" problem which reduces transparency regarding how a particular decision was reached raises issues of accountability

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[11]UNDP, *Sustainable Development Goals (SDGs) and AI Integration* (2023), available at https://www.sciencedirect.com (last visited on Jan. 25, 2025).
[12] A. Sharma, "Bias in AI-Driven Environmental Policies" (2023) 8(4) *Journal of Environmental Law and Policy* 176.

of environmental policy enforcement. Then for ethics on AI we can ensure how to make more transparent the AI models nicer and how to involve more diverse stakeholders in the decisions of the environment.[13]

A further pressing issue is the role of AI in degrading the environment through its enormous carbon footprint. The real powering of AI infrastructure data centres, complex machine-learning computations draws massive amounts of electricity and contributes to increasing greenhouse gas emissions. A study found training one big AI model up to par takes as much energy as a few cars over their entire life. AI helps renewables integration, yet its reverse environmental footprint necessitates laws pressing for energy-wise AI tech. Policies mandating carbon-neutral AI practices, as well as instituting incentives for green computing, could help address this issue.

Well, the other very important thing regarding e-waste is AI deployment. The fast-changing AI hardware like sensors, computing systems, smart devices, and paves way for larger degrees of intelligence waste. E-waste management is already challenging and this is getting worsened through AI enabled industries. Without regulation, discarded AI hardware would leach toxic materials that threaten ecosystems and human health. To effectively face this rapidly unfolding issue, the implementation of Extended Producer Responsibility (EPR) rules402 should be a priority for AI manufacturers to promote ethical recycling and encourage alternative energy-efficient and sustainable AI hardware.[14]

Also complex are the legal and ethical issues around intellectual property (IP) rights for AI-generated environmental data and solutions. This leads companies to take the easy road to patenting sustainability innovations using machine learning and AI, then disabling access to the machines critical for sustainability from the public. Such concentration of AI-enabled nature-based solutions could inhibit collective action on climate resilience still further. For a curriculum of equal access, India must implement equitable licensing or open-source frameworks around AI-led sustainability initiatives.

A multi-stakeholder approach by government authorities, technology firms, lawyers and environmentalists are needed to tackle these challenges. Strengthening environmental policy

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[13] R Gupta, 'AI and Environmental Injustice in India' (2023) 15(1) Human Rights & Environment Review 97.
[14] A. Choudhary, "Energy Consumption Challenges of AI in Environmental Sustainability" (2023) 15 *Green Technology Journal* 78.

that applies explicitly to AI, enforcing thoughtful ethical principles of AI governance and incentivising more sustainable AI infrastructure will all be essential to helping the existential potential of AI help our environmental sustainability rather than make things worse. More measured guidelines allow us to bring this tech into harmony with the environment, making AI a carbon-neutral accelerator for a greener economy, instead of an unrestrained destructing juggernaut.

AI's Role in Combating Climate Change, Pollution, and Ecological Degradation: Artificial Intelligence is a tool that has recently taken the spotlight in finding solutions to environmental crises, such as climate change, pollution and waste management, and the degradation of ecosystems. The truth is that with India grappling with ever-growing greenhouse gas emissions, deteriorating air and water quality, and biodiversity loss, AI-augmented technologies are playing a crucial role in seeking a sustainable development path. By virtue of its capability to bring innovative solutions, AI has the potential to be a big game-changer in improving the Environmental Governance in India as some of its application areas include, predictive climate modelling, real-time pollution monitoring and ecosystem conservation. However, since the implications of AI are really beneficial, they also come with energy consumption, regulatory and ethical implications that should require a delicate balance when integrating AI into the pursuit of environmental sustainability.

AI for Climate Change Mitigation and Adaptation:

Artificial Intelligence has also been used for Environmental protection and one of the most significant application is combating climate change with big data utilization that involves eco-friendly forecasting, energy management and carbon footprint reduction. Evaluating extensive data sets because of AI-based climate models leads to the better precision of forecasting the weather, foretelling extreme events, and predicting long-term effects of climate change. AI-based simulations, for instance, help policymakers project the impact of rising temperatures and shifting monsoon and sea levels, so they can pre-emptively act and adapt.[15]

AI, to take just one example, tackles problems in the energy sector with its ability to assist in the balancing of supply and demand for energy and enhance the efficiency of the electrical grid when integrating renewable energy sources such as solar and wind. The integration of

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[15] NITI Aayog, *AI Policy for Climate Resilience* (2023), available at https://www.niti.gov.in (last visited on Feb. 2, 2025).

artificial intelligence (AI) with smart grids will enable electricity demand pattern prediction, minimizing transmission losses, and seamless integration of decentralized renewable energy systems.[16] Energy suppliers including Tata Power and various other Indian energy suppliers have begun to embrace AI to supply superior power storage systems to make sure that the supply of energy remains steady and sustainable.

Monitoring and controlling air pollution:

The new data also could change how we measure pollution, providing ways to detect and reduce air, water and soil contamination in real time. From AI-powered sensors in buildings of cities like Delhi and Mumbai to IoT-automated air quality monitors positioned at vantage points, these systems consistently feed information on pollution levels to the authorities, empowering them to act immediately to control emissions from industries and vehicular traffic. AI models are used to analyse satellite images to track air pollution, identify emission hotspots, and develop policies that can effectively target pollution sources.

Some AI applications have focused on water pollution control, as well. A similar tool powered by Artificial Intelligence, to monitor the Ganges River, is closely being used by the National Mission for Clean Ganga (Namami Gange), to analyse water quality, track pollution sources, and ensure data-driven compliance. The Ai-powered Wastewater treatment solution minimizes chemical usage in purification process and lowering the industrial and agricultural path of contaminants to enter into bodies of water. Whether to measure the extent of pollution or for remediation methods, AI-driven tools for soil analysis also help in covering these factors ensuring smart land management practices.

AI for Ecological Conservation and Biodiversity Protection:

Artificial intelligence is acquiring a crucial role in protecting India's rich biodiversity and natural habitats. This includes tracking endangered species using AI-powered image recognition and acoustic monitoring technologies, as well as studying migration patterns and helping to prevent poaching efforts. AI-enabled camera traps deployed by the Wildlife Institute of India to track tiger numbers and monitor other endangered species across national parks and

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[16] A. Choudhary, "AI-Driven Smart Grids and Renewable Energy" (2023) 14 *Green Energy Review* 112

wildlife reserves are transforming conservation efforts.[17]

AI-driven ecological modelling enables researchers to simulate the impact of deforestation, habitat fragmentation and climate change on biodiversity. In the environmentally sensitive regions of the Western Ghats and Northeast India, remote sensing technologies that an employ AI to identify illegal deforestation, to assist law enforcement agencies to act quickly to environmental violations. With the help of artificial intelligence, it becomes a piece of cake to know about the soil quality and the type of tree species that could flourish better and land usage that could be decorated in more moonlight based on the moonlight tree species.

AI also supports marine conservation by employing deep-learning models to analyse oceanic data to detect illegal fishing, track coral reef health and predict shifts in marine biodiversity catalysed by climate change. Such AI-driven visibility allow governments and environmental organizations can formulate evidence-based policies to safeguard India's coastal and marine ecosystems.

Challenges and Perspectives:

But while AI offers opportunities to bolster environmental sustainability, it can also pose challenges to sustainability if done carelessly. Models can require a lot of computing power, resulting in energy consumption and carbon emissions in data centres. Implementing energy-efficient frameworks for AI and coupling it with renewable energy can mitigate this problem. In addition, availability of high-quality datasets is essential for utilizing AI effectively within environmental governance. To build defences for good innovation in AI-enabled environmental policies, we must do better with measures of data bias, AI explain ability and privacy.

Regulatory frameworks need to be adapted to AI's environmental footprint as well. While there are no environmental laws such as the Environment Protection Act, 1986 in India that would include a framework to make AI environmentally sustainable, India needs policies that not only promotes responsible use of AI, but also prevent corporates from monopolizing environmental resources. As the focus turns to the governance of AI-specific pollution control, biodiversity conservation, and climate adaptation, guidelines will be necessary to enable a role

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[17] Wildlife Institute of India, *AI in Biodiversity Conservation* (2023), available at https://www.indiascienceandtechnology.gov.in (last visited on Feb. 4, 2025).

for such technologies in an effective and capacity building way to promote the benefits of AI and mitigate its risks.

Yet model training on data demonstrates the case for learning from climate change, and research that is here to vision for the combat of climate change, pollution, and repair of ecosystems in India. By leveraging such AI-powered innovations in fields such as climate modelling, pollution monitoring, and biodiversity conservation, Indian cannot just boost its environmental governance but will also be able to meet the SDGs. But practical use of AI for environmentalism is a long way from being ethically and effectively realised — it needs robust legal frameworks, energy-efficient AI design to provide a plan of action to policymakers, and cooperation between environmentalists and AI academics. To achieve the full potential of AI for ecological sustainability, we must work collaboratively with government departments and agencies, technology firms, environmental researchers, and civil society organizations.[18]

Recommendations and Conclusion:

India needs to find a way to use Artificial Intelligence for the betterment of environmental sustainability and allows them to cross the challenges it brings forward and for that it needs to follow a multi-prong approach through regulatory framework, technology and governance for ethical use of AI.

First, it must come up with AI-specific environmental regulations under existing laws like the Environment Protection Act, 1986 and the Energy Conservation Act, 2001. Such policies must impose energy-efficiency requirements on AI-driven systems, regulate AI's use for climate adaptation and pollution control, and create guidelines to ensure responsible use of AI in resource use. Establishing a national AI framework focused on environmental governance will facilitate the adoption of AI solutions, while also ensuring that legal compliance and accountability are guaranteed.[19]

Secondly, the deployment of AI in environmental protection must also be in line with India's sustainability commitments under international treaties, such as the Paris Agreement and the United Nations Sustainable Development Goals. For this, India should scale up investment in

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[18] S Verma, 'Regulatory Challenges of AI in Environmental Governance' (2022) 7(1) Indian Journal of Legal Studies 45.
[19] Ministry of Environment, Forest and Climate Change, *AI and Environment Regulations* (2023), available at https://www.indiascienceandtechnology.gov.in (last visited on Feb. 4, 2025).

AI-driven renewable energy projects - smart grids, predictive analytics for wind and solar - to hasten the transition to a low-carbon economy. This could facilitate joint efforts by government agencies, private tech firms, and research institutions to build AI assimilating carbon capture technologies and energy-efficient computing infrastructure to cut AI's carbon footprint.

The third is to broaden the role of AI in conservation biodiversity and monitoring environmental pollution by building data-sharing mechanisms and strengthening inter-agency coordination. Real-time pollution data should dictate regulatory enforcement and public policy decisions, and AI-powered air and water quality monitoring systems should be integrated into urban planning initiatives. In wildlife conservation, camera traps, acoustic sensors and remote sensing tools driven by AI should be upscaled to safeguard endangered species and tackle illegal deforestation. Furthermore, open-source ecological models based on AI will have to be constantly updated to improve predictions of the effects of climate change on biodiversity in India.[20]

Fourth, the ethical and legal implications of the use of AI in environmental governance need to be discussed. AI models can adopt biases present in training datasets, and thus could make biased decisions. To combat this, AI algorithms should be more transparent and there should be enforced requirements for audits of AI systems and how explain ability for AI-based environmental policies. Similarly, intellectual property (IP) rights associated with data generated by AI systems and environmental solutions must also be adequately delineated to facilitate equitable access to AI-driven sustainability innovations. Additionally, community engagement and participation in AI-based projects affecting their environment are essential to avoid marginalization of such communities by relying on AI automated tools to apply resources to critical efforts.[21]

The application of AI can prove to be significant and revolutionary in the area of environmental governance in India right from climate change mitigation, pollution control (air, water, land) and biodiversity conservation. However, the large-scale adoption of AI needs to be guided through a robust legal and ethical framework to ensure sustainability, fairness, and transparency. India can leverage the power of AI while reducing its risks by incorporating AI into existing environmental policies, investing in energy-efficient AI infrastructure, and

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[20]Wildlife Institute of India, *AI Applications in Conservation* (2023), available at https://wii.gov.in (last visited on Feb. 10, 2025).

[21] S. Verma, "Legal Challenges of AI in Environmental Policy" (2022) 7(1) *Indian Journal of Legal Studies* 45.

encouraging ethical AI development. The Ego of the world would need to work such way that policymakers, environmental scientists, ai researchers and civil society organisations would work together to reach a futuristic environmentally sustainable world by taking their ai driven technological advantages.[22]

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[22] K.S. Rautela, "Transforming Air Pollution Management in India with AI and Machine Learning Technologies" (2024), available at www.nature.com (last visited on Feb. 12, 2025).