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The Legal Landscape of Artificial Intelligence for Sustainability

Dr. Anju pandey
Assistant Professor (Selection Grade), School of Law, UPES, Dehradun. Email: a.pandey@ddn.upes.ac.in,

Prof. G N Sinha
Professor, School of Law, UPES, Dehradun. Email: gnsinha@ddn.upes.ac.in,

Abstract
The convergence of artificial intelligence (AI) and sustainability presents a transformative opportunity to address some of the urgent environmental challenges of our time. From optimizing energy consumption and improving agricultural practices to enhancing climate monitoring and protecting biodiversity, AI-driven technologies are increasingly integral to environmental governance and sustainable development. However, this technological integration introduces a complex array of legal, ethical, and governance challenges. These include questions of data privacy, algorithmic bias, intellectual property, and the equitable distribution of AI benefits. If left unregulated, the use of AI in environmental contexts risks reinforcing structural inequalities, infringing on human rights, and exacerbating environmental injustices, especially for marginalized communities and countries in the Global South.

This chapter explores the legal dimensions of deploying AI in sustainability initiatives, with a particular focus on ethical oversight, cross-border regulatory harmonization, and the need for inclusive governance structures. It critically examines the potential for AI to both support and undermine environmental justice, highlighting the risks of surveillance-based monitoring, disproportionate impacts on vulnerable populations, and the widening of global technological divides. The chapter concludes with a set of actionable policy recommendations, advocating for legal innovations such as AI-specific environmental legislation, ethical certification schemes, open-source mandates, and participatory legal frameworks. These proposals aim to embed equity, transparency, and sustainability into the core of AI governance. By future-proofing environmental law and fostering multilateral cooperation, policymakers can ensure that AI becomes a force for ecological resilience and social good rather than a driver of harm.

Keywords: Artificial intelligence, environmental law, sustainability, data privacy, algorithmic bias, environmental justice, legal frameworks, ethical AI, climate governance, technological equity, cross-border regulation, biodiversity conservation, responsible innovation.

1. Introduction

The concept of sustainability was notably articulated in the 1987 Brundtland Report published by the United Nations, which defined sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*." This definition underscores the importance of balancing current demands with resource preservation for the future, a principle increasingly relevant in the age of artificial intelligence (AI).

Today, AI is marked by a distinct duality: it drives efficiencies and fosters innovative solutions to complex environmental and social issues, while also presenting amplified resource demands beginning to rival the energy consumption requirements of whole nations.[1] The convergence of artificial intelligence and sustainability presents a transformative opportunity to address pressing environmental challenges, yet it also introduces a complex web of legal considerations that demand careful examination[2]. As humanity confronts climate change, biodiversity loss, and environmental degradation, AI's potential to mitigate environmental impacts and promote a more sustainable future is increasingly recognized[3]. AI algorithms can optimize energy consumption, improve agricultural practices, monitor wildlife populations, and enhance climate resilience, offering innovative solutions across various sectors. However, the deployment of AI for sustainability is not without its challenges. The integration of AI into environmental governance and sustainability initiatives brings forth a range of legal questions related to data privacy, algorithmic bias, accountability, and intellectual property rights[4]. These legal considerations necessitate a comprehensive understanding of the existing legal framework and the development of new legal approaches to ensure that AI technologies are deployed responsibly and ethically in the pursuit of sustainability[5]. The multifaceted sustainability challenges posed by integrating AI into various sectors require a comprehensive understanding of equity, ethics, and the long-term viability of AI-driven initiatives[6]. Furthermore, the legal landscape must address the potential for AI to exacerbate existing inequalities or create new environmental injustices[7].

2. **The Promise of AI in Sustainability**

Artificial Intelligence is emerging as a pivotal technology for advancing sustainability: it enables smarter, data-driven systems across energy, agriculture, climate, and biodiversity; each contributing to environmental progress[8].

2.1 Optimizing Energy Systems

AI makes energy systems both greener and more efficient by improving demand forecasting and smart grid management. Platforms such as DeepMind[9] and Grid4C[10] help balance supply

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[1] Litvinets, V., et al. (2024, November 14). *AI and sustainability: Opportunities, challenges and impact*. EY. Retrieved from https://www.ey.com/en_nl/insights/climate-change-sustainability-services/ai-and-sustainability-opportunities-challenges-and-impact

[2] Rohit Nishant, Mike Kennedy & Jacqueline Corbett, Artificial intelligence for sustainability: Challenges, opportunities, and a research agenda, *Science Direct*, Volume 53, August 2020, 102104, https://doi.org/10.1016/j.ijinfomgt.2020.102104.

[3] Most. Sohana Akter, *AI for Sustainability: Leveraging Technology to Address Global Environmental*, Journal of Artificial Intelligence General Science (JAIGS) ISSN: 3006-4023, Vol. 2, Issue 1, (Published online 16 February 2024), Available at: file:///C:/Users/a.pandey/Downloads/final+3+AI+for+Sustainability.pdf.

[4] M. Imran Khan, Tabassam Yasmeen, Mushtaq Khan, Noor Ul Hadi, Muhammad Asif, Muhammad Farooq & Sami G. Al- Ghamdi, *Integrating industry 4.0 for enhanced sustainability: Pathways and prospects*, Sustainable Production and Consumption, Vol. 54 (March 2025) 149–189, DOI: 10.1016/j.spc.2024.12.012.

[5] Lewis, D.; Hogan, L.; Filip, D.; Wall, P.J. Global challenges in the standardization of ethics for trustworthy AI. *J. ICT Stand.* 2020, *8*, 123–150.

[6] Anil Balan (2024) Examining the ethical and sustainability challenges of legal education's AI revolution, International Journal of the Legal Profession, 31:3, 323-348, DOI: 10.1080/09695958.2024.2421179

[7] https://www.unep.org/news-and-stories/story/ai-has-environmental-problem-heres-what-world-can-do-about

[8] Most. Sohana Akter, *AI for Sustainability: Leveraging Technology to Address Global Environmental*, Journal of Artificial Intelligence General Science (JAIGS) ISSN: 3006-4023, Vol. 2, Issue 1, (Published online 16 February 2024), Available at: file:///C:/Users/a.pandey/Downloads/final+3+AI+for+Sustainability.pdf.

[9] DeepMind, is a British–American artificial intelligence research laboratory which serves as a subsidiary of Alphabet Inc. Founded in the UK in 2010, it was acquired by Google in 2014 and merged with Google AI's Google Brain division to become Google DeepMind in April 2023.

and demand in real time while enabling more reliable integration of variable renewable sources[11]. Through the concept of Virtual Power Plants, distributed energy resources including solar panels, wind turbines, and electric vehicle batteries can be aggregated and managed by AI to optimize generation, storage, and consumption as unified entities[12]. AI is also applied in predictive maintenance and emissions monitoring, with companies like E.ON[13] and Shell[14] using it to predict turbine faults and identify methane emission sources, which reduces downtime and lowers carbon emissions[15]. The quantified impact of such systems is significant, as reinforcement learning and genetic algorithms can cut operational costs and carbon dioxide emissions by as much as one quarter while increasing overall system efficiency from seventy percent to over ninety percent. While these technologies are transforming energy infrastructure, they must be scaled responsibly, since AI itself contributes to rising data centre power consumption, projected to reach nearly half of total demand by 2025, making clean energy integration and robust carbon accounting frameworks essential[16].

2.2 Transforming Agriculture with AI

Data driven precision farming is enabling farmers to monitor crop health through drones, satellite imagery, and IoT sensors to optimize irrigation, pesticide use, and planting schedules, which leads to higher yields and reduced environmental impacts. By integrating multiple data streams such as soil quality, weather forecasts, and satellite information into AI models, farmers can lower chemical inputs and enhance resource efficiency. These applications not only increase productivity but also support resource conservation and biodiversity friendly farming, aligning with the goals of a circular economy[17].

2.3 Enhancing Climate Monitoring and Resilience

Building on known AI capabilities, AI processes satellite data and sensor inputs to predict extreme weather events such as droughts or floods, providing early warnings that support adaptation planning and disaster preparedness in vulnerable regions, thereby enhancing

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[10] Grid4C develops AI and Machine Learning Solutions to extract maximum business value out of smart meters IoT data, embedding AI Algorithms at the grid edge, while delivering predictive insights for energy providers, their customers and the grids.

[11] M. Imran Khan, Tabassam Yasmeen, Mushtaq Khan, Noor Ul Hadi, Muhammad Asif, Muhammad Farooq & Sami G. Al- Ghamdi, *Integrating industry 4.0 for enhanced sustainability: Pathways and prospects*, Sustainable Production and Consumption, Vol. 54 (2025), pp. 149–189, DOI: 10.1016/j.spc.2024.12.012.

[12] John Smith, *"AI and Virtual Power Plants: The Future of Smart Energy Grids"*, EnergyTech Insights, 12 March 2024, available at: https://www.energytechinsights.com/ai-vpp-smart-grids (last visited on 9 Aug. 2025).

[13] E. ON is one of Europe's largest energy companies with the business areas of energy distribution grid, energy infrastructure solutions and energy sales. With 1.6-million-kilometre-long energy distribution grid and around 47 million customers, it is playing a leading role in shaping a green, digital and decentralized energy world.

[14] Shell plc is a British multinational oil and gas company, headquartered in London, United Kingdom. Shell is a public limited company with a primary listing on the London Stock Exchange and secondary listings on Euronext Amsterdam and the New York Stock Exchange.

[15] Kingsley Ukoba, Kehinde O. Olatunji, Eyitayo Adeoye, Tien- Chien Jen & Daniel M. Madyira, *Optimizing renewable energy systems through artificial intelligence: Review and future prospects*, Energy & Environment, Vol. 35, Issue 7 (2024), pp. 3833–3879, DOI: 10.1177/0958305X241256293

[16] Manal Kouihi, Souhaila Bikndaren, Mohamed Moutchou, Abdelhafid Ait ElMahjoub & Radouane Majdoul, *Comprehensive review of classical and AI- driven energy management strategies for hybrid renewable energy systems*, Prime, (2025), Article No. 101085, DOI: 10.1016/j.prime.2025.101085.

[17] Vijendra Kumar, Kul Vaibhav Sharma, Naresh Kedam, Anant Patel, Tanmay Ram Kate & Upaka Rathnayake, *A comprehensive review on smart and sustainable agriculture using IoT technologies*, Smart Agricultural Technology, Vol. 8 (2024), Art. 100487, DOI: 10.1016/j.atech.2024.100487

resilience and enabling policymakers to calibrate climate action based on robust simulations and real-time insights.[18].

2.4 Biodiversity and Wildlife Surveillance

Recent frameworks confirm the transformative impact of AI in conservation by showing that systems integrating remote sensing, acoustic monitoring, and citizen science inputs can deliver species detection accuracy above ninety percent and improve invasive species management by up to eighteen and a half percent compared with traditional methods. AI enabled camera traps and bioacoustics sensors make it possible to automatically identify wildlife populations, conduct anti-poaching surveillance, and monitor habitats in real time, and these innovations further support data driven conservation policies while ensuring equitable access to biodiversity monitoring tools.

Table: Summary of AI's Sustainability Contributions

Sector	AI Applications	Key Benefits
Energy	Demand forecasting, maintenance, VPPs, emissions control	Efficiency gains, CO_2 reduction, cost savings
Agriculture	Precision farming, resource optimization, imaging	Higher yields, less waste, environmental protection
Climate	Extreme weather prediction, adaptive planning	Improved resilience and policy targeting
Biodiversity	Automated species detection, habitat mapping	Accurate monitoring, enforcement, planning

In summary, AI offers powerful, scalable solutions across multiple sectors aligned with sustainability goals. Real-world applications-from grid optimisation to precision agriculture and wildlife tracking are already delivering measurable environmental benefits. However, careful regulation is essential to manage AI’s own energy footprint and to ensure equitable, ethical, and inclusive implementation.

3. Legal Dimensions of AI in Sustainability

While AI presents transformative potential for achieving sustainability goals, its integration into environmental systems and decision-making also generates complex legal challenges. These include evolving regulatory frameworks, uncertainties around intellectual property (IP) in AI innovation, and notable gaps in AI-specific environmental regulations. Addressing these concerns is essential to ensure that AI applications align with ethical principles, legal norms, and sustainability objectives.

3.1 The Evolving Legal Framework

The legal landscape surrounding AI and sustainability is still emerging and often fragmented across jurisdictions. Most existing environmental laws were not designed with AI in mind, leading to tensions between innovative technology use and outdated regulatory structures[19].

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[18] Shivam Singh & Manish Kumar Goyal, *Enhancing climate resilience in businesses: The role of artificial intelligence*, Journal of Cleaner Production, Vol. 418 (2023), Art. 138228, DOI: 10.1016/j.jclepro.2023.138228.

[19] Esmat Zaidan & Imad Antoine Ibrahim, *AI Governance in a Complex and Rapidly Changing Regulatory Landscape: A Global Perspective*, Humanities and Social Sciences Communications, Vol. 11 (2024), Art. No. 1121 (1–18), DOI: 10.1057/s41599-024-03560-x

For example, environmental impact assessments may not account for algorithmic systems that autonomously manage resources or infrastructure.
Governments and international bodies are beginning to adapt the European Union's AI Act, for instance, includes provisions aimed at high-risk applications such as environmental monitoring and infrastructure management. However, many national legal systems still lack robust guidelines for the deployment, auditing, and oversight of AI systems in environmental contexts[20]. This regulatory lag can hinder both innovation and accountability.
Furthermore, jurisdictional inconsistencies raise cross-border governance issues, especially in areas like climate monitoring or biodiversity protection, where data is global but legal authority is often local. A harmonized, international approach to AI regulation in environmental contexts is urgently needed.

3.2 Intellectual Property in AI-Driven Innovation

Intellectual property (IP) law plays a dual role in applying AI to sustainability. It safeguards innovation while potentially limiting direct access to data and tools essential for environmental research and response. AI-generated outputs, particularly in predictive modelling and automated data processing raise complex questions of ownership, including whether rights rest with the human developer, the AI system, or the institution deploying the model. While patenting AI-based sustainability solutions can stimulate private sector investment, it may also restrict public access to critical environmental tools such as climate modelling software, pollution tracking systems, or precision agriculture algorithms. In addition, traditional IP frameworks often struggle to accommodate the collaborative, iterative nature of machine learning, which relies heavily on open-source datasets and shared platforms.
As the UN and WIPO explore frameworks for AI and IP, environmental sustainability demands special attention. Legal reforms could include open-access mandates for AI models that serve critical ecological functions or global commons[21].

3.3 **Regulatory Gaps in Environmental AI Applications**

The deployment of AI in environmental sectors reveals several regulatory blind spots that require urgent attention. Data governance is a key issue since AI systems depend heavily on large scale environmental and personal data, raising privacy concerns when surveillance tools such as drones or sensors are used for environmental monitoring[22]. Algorithmic opacity is another major challenge, as many AI systems function as black boxes, making it difficult to understand how decisions on matters like water allocation or land use classification are reached. Without legal requirements for transparency and explainability, affected communities may be left without meaningful recourse. Accountability and liability also

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[20] Esmat Zaidan & Imad Antoine Ibrahim, *AI Governance in a Complex and Rapidly Changing Regulatory Landscape: A Global Perspective*, Humanities and Social Sciences Communications, Vol. 11, Art. No. 1121 (2024), DOI: 10.1057/s41599-024-03560-x.
[21] High-Level Committee on Programmes (HLCP), Inter-Agency Working Group on Artificial Intelligence (IAWG-AI), *United Nations System White Paper on AI Governance: An Analysis of the UN System's Institutional Models, Functions, and Existing International Normative Frameworks Applicable to AI Governance*, United Nations System Chief Executives Board for Coordination (CEB), May 2024, available at: https://unsceb.org/united-nations-system-white-paper-ai-governance (last visited on 10 Aug. 2025).
[22] David B. Olawade, Ojima Z. Wada, Abimbola O. Ige, Bamise I. Egbewole, Adedayo Olojo & Bankole I. Oladapo, *Artificial Intelligence in Environmental Monitoring: Advancements, Challenges, and Future Directions*, Hygiene and Environmental Health Advances, Vol. 12 (2024), Article No. 100114, DOI: 10.1016/j.heha.2024.100114

present pressing concerns because responsibility for environmental harm caused by autonomous systems, such as faulty emissions monitoring or AI driven resource mismanagement, remains unclear, and existing tort and environmental liability laws may not adequately address these scenarios. Ethical implications further complicate the picture, as unregulated AI could reinforce environmental injustices, disproportionately affecting marginalized communities through biased datasets or exclusionary decision-making frameworks[23]. These gaps highlight the urgent need for tailored AI governance that integrates environmental justice principles, technical safeguards, and enforceable standards. A right based and precautionary approach is essential to ensure that AI supports both ecological sustainability and human wellbeing.

4. Ethical and Governance Challenges

While AI has the potential to reshape sustainability practices for the better, its deployment raises critical ethical and governance questions. These concerns range from the handling of sensitive data in environmental monitoring, to algorithmic bias in decision-making, and the difficulty of establishing accountability for AI-driven actions. Without robust ethical frameworks and governance structures, AI could reinforce existing inequalities or create new forms of environmental injustice[24].

4.1 Data Privacy and Environmental Monitoring

AI-enabled environmental monitoring often relies on continuous data collection through sensors, satellites, drones, and mobile devices. While this data can provide critical insights into climate trends, deforestation, air quality, and resource consumption, it can also include personally identifiable or community-specific information especially in densely populated or marginalized regions.

For example, environmental surveillance tools deployed in urban areas may inadvertently collect data on individuals' behaviours, locations, or property use. Without clear legal safeguards or informed consent mechanisms, such practices can violate privacy rights and erode public trust[25]. The ethical concern becomes more pronounced in low-income or Indigenous communities, where consent processes may be bypassed under the guise of public interest or scientific research.

This tension highlights the need for privacy-by-design principles in environmental AI systems ensuring that data minimization, anonymization, and community consent are embedded into technological design and deployment.[26]

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[23] David B. Olawade, Ojima Z. Wada, Aanuoluwapo Clement David- Olawade, Oluwaseun Fapohunda, Abimbola O. Ige & Jonathan Ling, *Artificial intelligence potential for net zero sustainability: Current evidence and prospects*, Next Sustainability, Vol. 4 (2024), Art. 100041, DOI: 10.1016/j.nxsust.2024.100041.

[24] David B. Olawade, Ojima Z. Wada, Aanuoluwapo Clement David- Olawade, Oluwaseun Fapohunda, Abimbola O. Ige & Jonathan Ling, *Artificial intelligence potential for net zero sustainability: Current evidence and prospects*, Next Sustainability, Vol. 4 (2024), Art. 100041, DOI: 10.1016/j.nxsust.2024.100041.

[25] Patricia Haley, *The Impact of Biometric Surveillance on Reducing Violent Crime: Strategies for Apprehending Criminals While Protecting the Innocent*, Sensors, Vol. 25, No. 10 (17 May 2025), Art. 3160, DOI: 10.3390/s25103160.

[26] Nazish Khalid, Adnan Qayyum, Muhammad Bilal, Ala Al-Fuqaha & Junaid Qadir, *Privacy-preserving Artificial Intelligence in Healthcare: Techniques and Applications*, Computers in Biology and Medicine, Vol. 158 (May 2023), Art. No. 106848, DOI: 10.1016/j.compbiomed.2023.106848, available at: https://doi.org/10.1016/j.compbiomed.2023.106848.

4.2 Algorithmic Bias in Environmental Decision-Making

Environmental AI systems often draw on historical or incomplete datasets, which may contain structural biases. These biases can result in skewed outcomes such as underestimating the vulnerability of marginalized communities to environmental hazards, or misallocating climate adaptation resources[27].

For instance, predictive models used in disaster risk reduction or urban planning may favor well-documented, wealthier areas with better-quality data. Meanwhile, underrepresented communities may be excluded from decision-making frameworks, leading to further marginalization[28]. Similarly, AI-based land classification tools can mislabel Indigenous territories, leading to legal disputes or misinformed conservation policies.

Addressing algorithmic bias requires:

Using diverse and representative training data, continuously auditing, and validating models, and involving affected stakeholders in model design and evaluation are all essential steps, and ultimately, transparency in how AI models are developed and applied is critical to ensuring environmental equity and fairness.

4.3 Accountability in AI-Enabled Sustainability Projects

A central governance challenge in deploying AI for sustainability is determining who is accountable when things go wrong. AI systems especially autonomous or semi-autonomous ones can make decisions that have real-world impacts, such as allocating water resources, shutting down energy grids, or approving land-use changes. When these systems fail or cause harm, traditional accountability structures may not be equipped to respond.

Questions arise over who is liable if an AI driven decision leads to ecological harm or human displacement, and whether an algorithm can be held legally responsible or if liability falls on the developer, deployer, or end user. Remedies available to affected individuals or communities remain uncertain, and these dilemmas are further complicated by the black box nature of many AI systems, which lack explainability and transparency. Without clear audit trails or decision rationales, holding actors accountable becomes exceedingly difficult. Governance frameworks must therefore establish clear lines of responsibility, along with requirements for impact assessments, ethical review boards, and algorithmic transparency, especially when AI is applied in contexts that affect ecosystems or human rights.

5. Risks and Potential for Environmental Injustice

While AI has the potential to improve environmental outcomes and promote sustainability, it can also entrench or exacerbate social and environmental injustices if not carefully designed and governed. Unequal access to technology, historical biases in data, and insufficient regulatory oversight can lead to disproportionate harms-especially for Indigenous populations, low-income communities, and countries in the Global South[29]. To ensure equitable outcomes, sustainability-driven AI must be assessed not only for environmental effectiveness but also for its socio-political implications.

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[27] Sustainability Directory, *Algorithmic Bias in Environment*, published on 16 April 2025, available at: https://climate.sustainability-directory.com/term/algorithmic-bias-in-environment/ (last visited on 10 Aug. 2025).

[28] United Nations Office for Disaster Risk Reduction (UNDRR), *Global Assessment Report on Disaster Risk Reduction 2019*, United Nations, 2019, ISBN: 978-92-1-004180-5, available at: https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2019 (last visited on 10 Aug. 2025).

[29] David Danelski, *AI Creates New Environmental Injustices, but There's a Fix*, UC Riverside News, 12 July 2023, available at: https://news.ucr.edu/articles/2023/07/12/ai-creates-new-environmental-injustices-theres-fix (last visited on 10 Aug. 2025).

5.1 AI and the Risk of Widening Inequities

AI systems are frequently developed in and for high-income contexts, often without sufficient consideration of the realities in marginalized or resource-constrained communities. This technological asymmetry risks reinforcing existing power imbalances. Wealthier nations and corporations may benefit disproportionately from AI-driven efficiency gains and climate resilience tools, while vulnerable communities are left without access to critical technologies or decision-making power.[30]

Additionally, access to AI-enabling infrastructure-such as reliable internet, cloud computing, or skilled labour is limited in many parts of the world. As a result, global sustainability initiatives risk becoming technologically exclusionary, undermining the principle of environmental justice.

This disparity underscores the need for inclusive technology development and capacity-building investments to ensure that all communities can participate in and benefit from AI-enabled sustainability solutions.

5.2 Surveillance vs. Stewardship: Ethical Tensions

AI's use in environmental monitoring can blur the line between environmental stewardship and social surveillance. Tools such as drones, satellite imaging, and automated sensors can collect vast amounts of data on land use, movement patterns, and local behaviours. While intended to support conservation or climate adaptation, these tools may be misused to surveil communities, particularly Indigenous peoples and environmental defenders, without consent or oversight.[31]

For example, conservation technologies deployed in forested or protected areas have at times led to the criminalization of subsistence activities or community land use. When AI systems are embedded within militarized or extractive frameworks, they risk becoming tools of dispossession rather than empowerment.

Ethical AI deployment in environmental governance must prioritize community consent, transparency, and benefit-sharing, ensuring that technology reinforces, rather than undermines, local agency and traditional ecological knowledge.

5.3 Disproportionate Impacts on Vulnerable Communities

AI systems trained on incomplete or biased datasets can generate decisions that disproportionately impact communities already burdened by environmental hazards. For example, predictive models may divert flood protection infrastructure away from informal settlements due to poor quality data, AI based land use classification may mislabel community managed lands as vacant or underused, justifying expropriation, and disaster response systems may deprioritize low-income neighbourhoods due to skewed risk models or insurance metrics. These examples reflect a broader trend in which, without intentional

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[30] Apoorve Dubey, *How AI Can Enhance Digital Inclusion and Fight Inequality*, World Economic Forum, 4 June 2025, available at: https://www.weforum.org/stories/2025/06/digital-inclusion-ai/ (last visited on 10 Aug. 2025).

[31] Mitul Harishbhai Tilala, Pradeep Kumar Chenchala, Ashok Choppadandi, Jagbir Kaur, Savitha Naguri, Rahul Saoji & Bhanu Devaguptapu, *Ethical Considerations in the Use of Artificial Intelligence and Machine Learning in Health Care: A Comprehensive Review*, Frontiers in Artificial Intelligence, 2024, PMCID: PMC11249277, PMID: 39011215, available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC11249277/ (last visited on 10 Aug. 2025).

safeguards, AI can reproduce structural inequalities in access to resources, exposure to risks, and participation in decision making.[32]

To avoid such harms, environmental AI must be accompanied by social impact assessments, bias mitigation strategies, and participatory governance models that centre the voices and rights of those most affected.

6. Towards a Responsible AI Legal Framework

To harness the transformative potential of AI for sustainability while safeguarding rights and ensuring justice, a robust and future-oriented legal framework is essential. This framework must go beyond regulating AI as a technical tool-it must embed ethical values, anticipate future risks, and promote international cooperation. Without such legal foresight, AI's integration into sustainability may exacerbate global inequities and environmental degradation rather than mitigate them.[33]

6.1 Embedding Equity and Ethics into AI Laws

AI laws and regulations must be designed to incorporate principles of equity, inclusivity, and intergenerational justice. Given that sustainability inherently involves long-term thinking and collective wellbeing, AI governance should reflect these same priorities.

Key proposals include:

- Mandatory ethical impact assessments for AI systems used in environmental decision-making.
- Community consultation protocols that ensure affected populations have input into the design, deployment, and oversight of AI technologies.[34]
- Bias auditing and transparency requirements, particularly for AI models that influence public infrastructure, resource distribution, or conservation outcomes.
- Laws must recognize the socio-technical nature of AI and avoid treating it as a neutral instrument. Embedding ethics into legal codes would help align technological development with sustainability's human-cantered values.

6.2 Cross-Border Legal Harmonization for Global Challenges

Environmental issues such as climate change, deforestation, and biodiversity loss are transboundary in nature, yet AI laws remain nationally fragmented. This creates significant obstacles to both innovation and enforcement, particularly when AI systems rely on cross border data flows and are deployed in international conservation or climate finance programs. To address this, international cooperation is essential. A harmonized legal approach could include global AI standards for environmental applications established through multilateral institutions such as the United Nations, WTO, or WIPO; international treaties or soft law instruments that set principles for ethical AI use in sustainability, including transparency, explainability, and environmental justice; and cross border data governance mechanisms that protect sovereignty and privacy while enabling scientific collaboration and global environmental modelling. A coordinated international legal framework would support

[32] Apoorve Dubey, *How AI Can Enhance Digital Inclusion and Fight Inequality*, World Economic Forum, 4 June 2025, available at: https://www.weforum.org/stories/2025/06/digital-inclusion-ai/ (last visited on 10 Aug. 2025).

[33] Lewis, D.; Hogan, L.; Filip, D.; Wall, P.J. Global challenges in the standardization of ethics for trustworthy AI. *J. ICT Stand.* 2020, *8*, 123–150.

[34] Lewis, D.; Hogan, L.; Filip, D.; Wall, P.J. Global challenges in the standardization of ethics for trustworthy AI. *J. ICT Stand.* 2020, *8*, 123–150.

consistency, reduce regulatory arbitrage, and promote trust in AI powered sustainability efforts.

6.3 Future-Proofing Environmental Governance Structures

As AI technologies evolve rapidly, environmental laws and institutions must be agile and resilient. Future-proofing governance involves anticipating emerging risks, enabling adaptive regulation, and fostering interdisciplinary oversight.

Strategies include:

- Dynamic legal instruments that can evolve with technological changes, such as algorithm registries, regulatory sandboxes, and sunset clauses.
- Institutional innovation, including the creation of cross-sectoral bodies that oversee AI deployment in environmental domains, combining expertise from law, ecology, ethics, and data science.
- Legal experimentation at local or regional levels to pilot inclusive and sustainable AI governance models that can be scaled based on outcomes.
- Ultimately, embedding flexibility, participation, and anticipatory governance into environmental law will be critical to managing the uncertain and rapidly changing intersections between AI and sustainability.

7. Recommendations and Policy Implications

Considering the complex legal, ethical, and environmental challenges posed by AI in sustainability efforts, it is imperative to move from analysis to action. Effective policy responses must bridge the gap between rapid technological innovation and slower-moving legal institutions. These recommendations emphasize how legal systems, international bodies, and stakeholders can promote AI that is not only effective in achieving environmental goals but also ethically grounded and socially equitable.

7.1 Legal Innovations for Ethical AI Deployment

To ensure responsible and ethical AI deployment in sustainability domains, legal reforms must address current regulatory gaps, anticipate future risks, and embed values of equity and environmental justice. Key legal innovations should include the creation of AI specific environmental legislation that directly regulates the use of AI in sectors such as energy, agriculture, urban planning, and conservation, with clear mandates for transparency, fairness, and ecological safety. Ethical AI certification schemes should also be established through independent mechanisms that assess systems for compliance with standards on bias mitigation, data privacy, accountability, and sustainability metrics. Open-source mandates for sustainability critical AI are equally important, requiring that models used for climate modelling, biodiversity tracking, and pollution control be made publicly accessible, particularly when they are funded through public resources, thereby promoting innovation and equity while preventing monopolization. In addition, mandatory environmental and social impact assessments for AI systems should be introduced to evaluate potential harms and benefits prior to deployment, ensuring that both environmental and human rights considerations are addressed in advance. Dynamic regulatory tools such as supervised regulatory sandboxes[35] and algorithm registries should also be supported to enable safe

[35] Regulatory sandboxes are a key element of digital and sustainable transformation. They can quickly and safely launch the use of innovative solutions that are not yet formally approved. And they also show how innovations of the future should be regulated to allow everyone to benefit from them in the end. Examples of

experimentation, real time learning, and adaptation. By embedding ethical, social, and environmental values into the legal architecture surrounding AI, policymakers can guide technological development in ways that serve long term planetary wellbeing.

7.2 Stakeholder Engagement and Multilateral Cooperation

Policy frameworks for AI and sustainability must be built through inclusive, participatory, and globally coordinated processes. Sustainability is inherently a collective endeavour, and AI governance must reflect that reality. Key policy directions include:

Inclusive stakeholder engagement is essential, involving marginalized communities, Indigenous groups, civil society, and local governments in all stages of AI project design and implementation, as participatory governance ensures that AI systems reflect diverse values and lived realities. Multilateral cooperation on AI standards is equally important, with international organizations such as the United Nations, the Organisation for Economic Co-operation and Development, and regional trade blocs encouraged to coordinate ethics standards, environmental AI protocols, and cross border data governance rules so that the global nature of environmental challenges can be addressed while avoiding regulatory fragmentation.

Collaboration between the Global South and the Global North, as well as South partnerships, should be strengthened through knowledge and technology transfer mechanisms that support AI capacity building in developing regions, including funding for digital infrastructure, open access data platforms, and joint environmental research. Finally, environmental justice must be promoted as a core governance principle, ensuring the protection of those most vulnerable to environmental harm while guaranteeing equitable access to the benefits of AI innovation.

8. Conclusion

As the convergence of artificial intelligence and sustainability deepens, the urgency to develop responsive legal and ethical frameworks grows more pronounced. AI offers powerful tools to address global environmental crises ranging from climate change to biodiversity loss, but its transformative potential must be matched by thoughtful governance. Without legal and ethical safeguards, AI risks reinforcing existing inequalities and creating new forms of environmental injustice. The integration of AI into environmental governance requires a new generation of legal thinking that is dynamic, interdisciplinary, and globally coordinated. Traditional environmental laws, many of which predate the digital age, are ill equipped to regulate the algorithmic systems now shaping land use, conservation, energy systems, and climate adaptation. Moving forward, environmental law must evolve in three keyways by proactively regulating emerging technologies before deployment rather than after harm has occurred, by incorporating ethical, social, and ecological considerations into AI related legal structures, and by adapting to cross border complexities while recognizing that environmental systems and AI data flows often transcend national jurisdictions.

A forward-looking legal framework must also be participatory, allowing local communities, especially those historically excluded from technological decision making, to shape the rules governing the role of AI in their ecosystems and lives[36]. Innovation alone cannot solve the environmental crisis. While AI can enhance sustainability strategies, its design and use must be grounded in responsibility, equity, and transparency. Embracing innovation responsibly

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testing for innovations like self-driving and networked buses, ships or drones, telemedicine, eGovernment and sustainable district-based solutions all show the diverse potential that regulatory sandboxes provide.

[36] Lewis, D.; Hogan, L.; Filip, D.; Wall, P.J. Global challenges in the standardization of ethics for trustworthy AI. *J. ICT Stand.* 2020, *8*, 123–150.

means ensuring that AI tools do not become instruments of surveillance, exclusion, or environmental harm, embedding sustainability and justice principles into technological development from the outset, and cultivating international cooperation to harmonize standards, share knowledge, and close global equity gaps.

Ultimately, the future of environmental governance will not be shaped by technology alone but by the values and legal institutions that guide it, and if designed with care, AI can become a critical ally in the global effort to build a more just, sustainable, and resilient planet.