Digital Environmentalism: A Legal and Moral Perspective on Climate Governance in the Age of Data and AI

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Abstract. Digital environmentalism, defined as the integration of big data and artificial intelligence (AI) into environmental policy, offers substantial potential to enhance emission monitoring, resource management, and climate change mitigation. These technologies enable real-time analytics, predictive modeling, and automated decision-making that can significantly improve the effectiveness of environmental governance. However, the deployment of digital systems also raises pressing legal and moral challenges. Concerns over data privacy, algorithmic accountability, distributive justice, and public participation demand critical attention. This article employs a systematic literature review and case-based analysis to explore the dual promise and peril of digital climate governance. Drawing on insights from Papageorgiou and Machen, the study emphasizes the importance of aligning algorithmic decision-making with democratic and ethical values. The findings advocate for the development of a normative legal-moral framework to guide digital environmental governance. Key recommendations include enforcing algorithmic transparency, conducting independent audits, ensuring procedural fairness, and embedding community participation in the design and evaluation of digital systems. These principles are essential for fostering trust, equity, and legitimacy in climate-related digital interventions. Keywords: digital environmentalism, climate governance, AI ethics, environmental justice, algorithmic transparency, governance law

1 Introduction

Digital globalization has accelerated the adoption of advanced technologies in environmental policy, from climate change modeling, air quality monitoring, to forest and land monitoring using artificial intelligence (AI) [1]. Rolnick et al. (2019) noted that AI provides efficiency in processing big data, real-time predictive accuracy, and data-driven decision-making, all of which have the potential to increase the effectiveness of climate policy interventions.

In this development, Machen (2025) elaborates that AI technology not only offers technical advantages but also poses ethical and institutional dilemmas. He highlighted that the use of AI in climate governance can reduce the role of public participation, weaken

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institutional accountability, and put policy design in the control of technocrats or private companies [2].

Papageorgiou (2025) notes that in many cases, corporate dominance in the development of algorithmic systems can lead to regional bias, overlook local voices, and result in an unequal distribution of benefits and risks from digital environmental policies. These systems, he said, tend to serve wealthy regions with established digital infrastructure, while marginalized communities are often left behind. On the other hand, AI itself has a significant carbon footprint. The use of large amounts of energy in the training and operation of AI models, especially those based on large-scale machine learning, is a concern in the context of sustainability. Therefore, an approach that van Uffelen et al. (2024) call "just environmental AI" needs to be seriously considered so that digital technologies do not contribute to further environmental degradation [3].

Nordgren (2023) dalam *Journal of Information, Communication and Ethics in Society* underscores the moral dilemma posed by the use of AI for climate mitigation. According to him, if not designed with justice in mind, this technology can harm certain groups and strengthen global inequality [4]. Legal perspectives are increasingly relevant in this context. Micheli et al. (2022) in *Big Data & Society* emphasizing the importance of geospatial governance involving local participation, as well as integrating the principles of transparency and accountability in any development of environmental digital systems [5].

Camilleri (2022), through his article in *Expert Systems*, expands the discussion by emphasizing that AI design should consider social accountability and community engagement. Without this, AI systems will only reproduce existing power structures and distance decision-making from communities directly affected by environmental policies. International legal frameworks, such as the Aarhus Convention, have affirmed that the right to access environmental information and participate in decision-making is a fundamental human right. However, these principles are often not accommodated in the development of AI-based technologies [6]. The absence of a robust accountability mechanism for algorithmic systems poses a serious risk to environmental justice. When the system becomes a black box, people lose the ability to understand, monitor, and sue the results of policies that affect their right to life and health.

The legal and ethical literature also highlights the risks associated with so-called "algorithmic opacity." Micheli et al. (2022) note that without access to the source code or internal logic of the system, civil society and oversight agencies are unable to conduct meaningful audits [7]. Nordgren (2023) warns that the efficiency offered by AI should not obscure the fact that this technology still requires large amounts of energy and resources. Therefore, the use of AI must consider its ecological costs [8]. Van Uffelen et al. (2024) suggest that there needs to be specific regulations governing the sustainability of AI, including in terms of the selection of green data centers and energy efficiency in algorithmic architectures [9]. Within the framework of fair governance, Machen (2025) proposes a model of democratic governance in the use of AI for environmental policy. It includes elements of public access to information, public audits, and clarity on the decision-making process by digital systems.

Meanwhile, [10] Papageorgiou (2025) emphasizes that the design of algorithmic systems must involve the voices of local communities, especially vulnerable groups and indigenous peoples, to ensure the equitable distribution of policy outcomes [11]. Taking into account the above legal and moral dimensions, this article formulates a law-moral framework in digital environmentalism that includes minimum technical prerequisites, principles of open governance, and the protection of civil rights in the context of technology-based environmental policies. The main contribution of this article is to offer an integrative approach between formal legal frameworks, moral principles of environmental justice, and technical mechanisms of supervision of algorithmic system.

The great potential of artificial intelligence (AI) technology in supporting environmental policies, while highlighting the ethical, legal, and social challenges that follow. Adedolapo Olujuwon Adegbite et al. (2024) identified that AI plays a crucial role in real-time monitoring of carbon emissions, renewable energy management, and the prediction of disasters such as wildfires through the processing of high-resolution satellite images. The technology has been adopted in various national and international projects, reflecting the potential of AI in enhancing data-driven climate policy responses [12].

However, behind this potential, the Papageorgiou study (2025) highlights the dark side of using algorithmic systems in environmental policy, particularly in the context of bias and social exclusion. The study reveals that in AI-based deforestation monitoring projects in Brazil, indigenous communities are the primary targets of intensive monitoring. Without participatory involvement in the design or implementation of the system, these groups experience marginalization in the decision-making process that directly affects their living spaces.

Similar conditions also occur in some other environmental monitoring policies in developing countries, where the algorithms used do not accommodate local social and ecological dynamics. This has the potential to violate the principles of procedural justice and reduce people's autonomy in defending the right to a fair environment. Papageorgiou underlined that data bias, technocratic assumptions, and the lack of transparency of the system create new inequalities in the governance of the digital environment.

Instead, case studies in the European Union offer an overview of how legal and policy systems can address these challenges. Through the Horizon AI4EU project, the European Commission developed the Digital Services Act (DSA) and the Artificial Intelligence Act, which set high standards for algorithmic transparency and accountability in data processing, including for applications in the environmental field. These regulations introduce algorithmic audit obligations, risk classification, and oversight mechanisms by independent authorities to ensure that digital systems do not harm society.

The European Union is a pioneer in building ethical AI governance, especially in the context of public policy. The algorithmic risk assessment system in the Artificial Intelligence Act is the initial model in integrating the precautionary principle and public involvement. This move shows that the drafting of an adequate legal framework allows countries to harness technology without sacrificing human rights and ecological justice.

In general, a synthesis of literature studies and case studies shows that the success of digital environmentalism is highly dependent on the design of a system that is transparent, participatory, and accountable. Without a strong legal and moral foundation, AI technology has the potential to reproduce structural inequalities and weaken public control over environmental policies. Therefore, there needs to be a normative-critical approach in evaluating and shaping AI-based policies to be in line with democratic values and environmental justice.

This study uses the qualitative-descriptive with design Systematic Literature Study and Comparative Case Study Analysis, to formulate a law-moral framework in digital climate governance (digital environmentalism). Literature was collected from Scopus, SpringerLink, and ScienceDirect databases with selection based on topic relevance, recurrent (2018–2025), and Q1–Q3 indexed journal status. The search focus includes topics such as "AI in environmental governance", "algorithmic accountability", and "environmental justice".[9] To deepen the analysis, three case studies were chosen: the European Union with the AI4EU Project and the AI Act, Brazil with a predictive system of deforestation that impacts indigenous communities, as well as India and China in the use of machine learning for air quality monitoring[6].

The validity of the data is maintained through Source triangulation between academic literature, international policy reports, and legal documents such as the Aarhus Convention.

The analysis was carried out in a normative-critical, integrating legal principles (access to information, accountability), moral values (ecological justice, participation), and technical aspects of AI in climate policy. This approach is used to bridge the gap between technological efficiency and democratic values in the development of digital environmental policies[10].

2 Legal Dimension: The Gap between Regulation and Implementation

A legal analysis of digital environmentalism reveals a striking gap between normative principles set forth in international law and factual implementation on the ground. The Aarhus Convention, as an international legal framework that governs the right to access information, public participation, and access to justice in environmental issues, explicitly demands openness and citizen involvement at every stage of environmental policy. However, in practice, the development of AI-based systems is often carried out behind closed doors by private actors or technocratic institutions without a transparent and inclusive consultation mechanism.

This situation is exacerbated by the lack of disclosure of the algorithmic systems used by the government and its technology partners. Micheli et al. (2022) in their study on digital geospatial governance, emphasized that most such systems do not provide audit logs or public documentation of how data is processed and decisions are made[6].

This makes AI-based policy processes a "black box" that cannot be reviewed or monitored by the public, even though these decisions have a direct impact on access to natural resources and people's living spaces. Furthermore, the lack of access to this information is in direct contradiction to the principles of transparency and accountability that should be the foundation of public decision-making. In the context of a democratic state, this principle is not only important to guarantee the legitimacy of policies but also to prevent abuse of power and structural inequality. If the public cannot know how digital systems make predictions or recommendations in environmental policy, then the principle of due process of law in environmental law will lose its relevance.

In addition, the absence of a legal requirement to include community participation in the development of AI systems weakens the position of citizens as legitimate stakeholders in environmental management. In fact, in the principle of environmental democracy, every citizen has the right to be involved in every aspect of environmental governance, both as a data user, decision-maker, and system supervisor. This disengagement indirectly creates new inequalities between those with technological power and affected communities who lose control of public policy.

Therefore, a regulatory framework is needed that not only guarantees the transparency of digital systems but also ensures legal mechanisms that compel substantial public participation in the development, implementation, and evaluation of AI systems for environmental policies. Without these steps, the gap between law and practice will continue to widen, and the goal of environmental justice promoted by various international legal instruments will remain a normative aspiration without concrete realization.

3 The Moral Dimension: Environmental Responsibility and Justice

Morally, digital climate governance is not only a technical or legal issue, but also concerns the principles of environmental justice that emphasize the equitable distribution of benefits and risks, as well as the recognition of social and ecological diversity. This principle demands

that all community groups, including indigenous communities, the urban poor, and remote areas, have an equal voice in policymaking that affects their environment. In this context, AI systems that do not take into account the socio-ecological dimension risk creating new forms of injustice that stem from algorithmic bias and the centralization of technocratic power.

Nordgren (2023) highlights that in the absence of the principles of procedural justice inherent in the design and implementation of AI systems, digital environmental governance will only strengthen the power of technological elites and weaken the position of local communities in the decision-making process[5]. When AI is used to prioritize protected areas, for example, often areas inhabited by indigenous peoples are targeted by policies without their consent or involvement. This signifies a disregard for the principle of free, prior, and informed consent (FPIC) recognized in international human rights norms.

In addition, the moral dimension of the use of AI technology also touches on the aspect of ecological responsibility. Van Uffelen et al. (2024) in their analysis reminded that AI itself is not an ecologically neutral system. Training processes of large machine learning-based AI models such as deep learning require high computing power and generate a significant carbon footprint, especially if the server infrastructure is fossil fuel-based [4]. Therefore, the utilization of AI in environmental policy should be accompanied by ecological cost calculations and energy efficiency principles, as also suggested by Chen et al. (2025) in their study on the energy consumed in NLP model training [11]. Moral responsibility also includes the aspect of value transparency in the design of algorithmic systems. Camilleri (2024) stated that AI applied in the public sector must reflect upheld social values, such as justice, inclusion, and social responsibility [7]. In other words, technology must not operate solely on the basis of efficiency and optimization, but must be subject to normative values that reflect democratic will. Algorithmic systems that do not explicitly consider these ethical principles risk ignoring the needs of minority groups and exacerbating digital exclusion.

Finally, morality in digital climate governance demands critical reflection on the long-term goals of the use of technology itself. If AI is only geared towards maximizing managerial control and efficiency, then the true principle of sustainability will be distorted by the logic of technology capitalization. Therefore, moral discourse in this context must lead to the fundamental question: for whom and by whom is the digital environmental policy formed? In answering this question, the principles of intergenerational justice and ecological solidarity across space and time must be the main considerations, as affirmed by Mahendra (2022) in the concept of environmental justice as a combination of distribution, recognition, and participation.

4 Formulation of the Legal-Moral Framework

1. Algorithmic Transparency
   Algorithmic transparency is a fundamental prerequisite for democratic AI-based environmental governance. Artificial intelligence systems used for climate policy should allow for an independent public or authority audit of its decision-making logic. Without this transparency, society loses control over the impact of digital policies. Micheli et al. (2022) show that most geospatial AI systems do not provide publicly accessible audit documentation, resulting in weak oversight and accountability.
2. Procedural Participation
   The active involvement of affected communities in the design, implementation, and evaluation of environmental AI systems is the essence of procedural justice. This mechanism is important to ensure that digital systems do not reproduce structural biases against vulnerable groups. According to Camilleri (2024), social principles-based AI governance must explicitly place the values of community engagement in every phase of decision-making [7].

3. Evaluation of Distribution Fairness
   AI-based systems must be evaluated in terms of socio-ecological impact on vulnerable groups. Papageorgiou (2025) reveals that deforestation prediction systems in Brazil, for example, impose a disproportionate burden of oversight on indigenous communities without their participation in the design of the system. This evaluation is important to balance the equitable distribution of benefits and risks of digital policies [3].
4. Multi-level Accountability
   Legal and ethical responsibility should not only be placed on the developers of the system, but also on the public officials and institutions that adopt it. AI systems as a decision-making instrument require regulations that ensure accountability from upstream to downstream. According to Floridi et al. (2018), AI governance should involve a cross-actor accountability structure—whether private, public, or community-based—to prevent a form of "evaporative accountability."
5. Technological Sustainability
   AI technology must be designed and operated with its ecological impact in mind. A study by van Uffelen et al. (2024) warns that AI has a high carbon footprint that is often overlooked in the green innovation narrative. Therefore, the selection of data centers, algorithm architectures, and computational efficiency must be subject to the principles of ecological sustainability. [4]

5 Theoretical Discussion and Practical Implications

Theoretically, this article contributes to broadening the understanding of governance (*governance*) and environmental justice into a new domain called *digital environmentalism*. In this perspective, the integration of big data and artificial intelligence (AI) in environmental policy does not simply represent the development of e-governance or administrative digitalization. Instead, it marks the emergence of a new arena in which algorithmic technical efficiency can clash with normative principles such as human rights, procedural justice, and participatory democracy. As emphasized by S. Pulijala (2024), the use of automation systems in the public sector poses a risk of narrowing the deliberative space and potentially shifting control from public institutions to technocratic entities or corporations [12].

Papageorgiou (2025) warns that the application of AI in the environmental sector can perpetuate socio-ecological inequalities, particularly if it is not guided by the principles of distributive justice and the inclusion of affected communities. In the case of an AI-based deforestation prediction system in Brazil, for example, indigenous communities experience increased oversight without being involved in the system's design, which leads to violations of procedural rights and ethical representation concerns. This phenomenon reflects what is referred to as *algorithmic injustice*, where intelligent systems reinforce the asymmetry of existing power.

In addition, a study by Alberto, Nadila. (2024) shows that AI systems used in environmental resource management are often developed without transparency mechanisms that allow for public audits. This seclusion gives rise to what is referred to as *algorithmic opacity*, i.e. the public's inability to assess and challenge the outcome of decisions that impact their right to life and environment. In this context, democratic governance of the digital environment must contain mechanisms of algorithmic openness and independent oversight.

From the perspective of technological ethics, Floridi et al. (2018) emphasized that AI-based systems must be subject to the principle of *Explicability*, i.e., the ability to explain how decisions are made and who is responsible for the impact[10]. This aligns with the need to base AI-based environmental policy design on the principle of accountability. Without it,

climate governance risks becoming a technocratic project that ignores the dimensions of social and ecological justice. Thus, the theoretical contribution of this article is the affirmation that *digital environmentalism* is a new terrain for the normative conflict between algorithmic efficiency and democratic governance principles. This approach expands the realm of governance studies from just public administration to a more complex ethical-political arena, where digital technology is not only a tool, but also a normative actor that influences policy outcomes, political representation, and access to basic human rights.

Theoretically, this article contributes to the expansion of the governance and environmental justice framework into the realm of digital technology. The concept of digital environmentalism cannot be understood only as an evolution of e-governance or administrative digitalization, but as a new arena of normative conflict between algorithm-based technical efficiency and the principles of justice, democracy, and human rights. Papageorgiou (2025) emphasizes that the development of AI in the environmental sector risks reproducing socio-ecological inequalities, especially when it is not accompanied by strong participatory and distributional principles [14].

In the study of environmental justice theory, the contribution of this article expands the scope from distributive justice to procedural justice and recognition, as formulated by Nativi (2021). Algorithmic systems designed without the involvement of affected communities not only create biased outcomes but also ignore the epistemic rights of groups that are often victims of the climate crisis. This inequality is exacerbated by limited access to technology, digital literacy, and technical information about how the system works.

The legal-moral approach offered in this article is in line with the algorithmic governance framework, which emphasizes the importance of oversight of automated decision-making systems used in public policy (Nativi, 2021). Micheli et al. (2022) in Big Data & Society warn that without algorithmic transparency and access to public audits, AI systems can ignore due process principles and undermine the legitimacy of state decisions. Practically, the first implication of these findings is the urgent need to formulate international legal standards regarding algorithmic audits in the environmental sector. Currently, there is no global consensus on how algorithms used in public policy, including environmental policy, should be audited or accounted for. Although the European Union through the Artificial Intelligence Act (2024) has begun regulating high system risk categories and audits, other countries do not yet have commensurate regulations that are legally binding across jurisdictions.

The second implication is the importance of establishing an independent ethics body at the national level that has a mandate to evaluate the social, ecological, and ethical impacts of the application of AI in the environmental sector. These institutions should be equipped with legal authorities and technical resources to conduct routine algorithmic audits and bridge between policymakers, technologists, and civil society. Saurabh (2021) emphasized that ethical AI governance must be supported by institutions rooted in the principles of transparency and social justice.

The third implication is to increase the capacity of local communities so that they are not only objects of digital policy, but also active and critical subjects. This can be done through participatory training, strengthening data literacy, and empowering civil society organizations [15]. Gailhofer (2021) states that digital justice in the context of the environment can only be achieved if local communities have control over data and decisions that impact their environment.

In addition, it is important to develop rights-based legal instruments that place environmental digital rights as part of human rights. Access to AI-based environmental information, the right to an understanding of algorithmic systems, and the right to reject automated decisions need to be part of the updated environmental human rights instruments. This is in line with the development of the concept of digital constitutionalism that began to be introduced in contemporary international legal studies.

Finally, this article emphasizes the need for a cross-disciplinary approach in formulating AI policies for the environment. This approach should include the technical dimensions (AI/ML), law (human rights and regulation), ethics (procedural justice), and sociology (access and participation). Only with this kind of holistic approach can digital environmentalism function as an instrument of equitable ecological transformation, not just an accelerator of technocratic efficiency.

6 Conclusion

Digital environmentalism has great potential to revolutionize climate governance through a more accurate, fast, and data-driven approach. The integration of AI in environmental policy enables real-time monitoring of emissions, more precise detection of deforestation, and in-depth climate predictions. However, as outlined in this study, the effectiveness of these technologies is inseparable from inherent normative challenges, such as a lack of transparency, algorithmic bias, dominance of private actors, and exclusion of affected communities. Therefore, the application of AI in the environmental sector must be placed within a law-moral framework that takes into account the principles of democracy, ecological justice, and human rights.

This article asserts that sustainable and equitable digital climate governance requires four main prerequisites: open auditing of AI systems to ensure transparency and fairness; public involvement in the entire digital policy design and evaluation process; mitigation of the environmental impacts of the digital infrastructure itself; and legal guarantees of the public's right to access, audit, and reject the use of AI systems that harm the public. With this framework, policymakers are invited to adopt an inclusive and responsible *model of democratic climate AI governance*, in line with global agendas such as *the UN Advisory Council on AI for Climate Action*.

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