ALBANIA'S ADOPTION OF AI GOVERNANCE FOR INDEPENDENT MONITORING OF INDONESIAN FORESTS

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Abstract

Indonesia's commitment to the Paris Agreement, as outlined in its Enhanced Nationally Determined Contribution (ENDC), mandates the transparent and accurate reporting of Greenhouse Gas (GHG) emissions. However, a critical gap persists between official administrative data and ecological reality. The 2025 hydrometeorological disasters in Sumatra, which were marked by the presence of massive drifting logs during flash floods, revealed significant discrepancies in deforestation reporting. This research analyzes the legal implications of these data disparities regarding Indonesia's State Responsibility and explores the conceptualization of an Independent Digital Auditor based on the Albanian Government's AI governance model, known as Diella.

Using normative legal research with a comparative and statutory approach, this study finds that inaccurate GHG reporting constitutes a breach of the due diligence principle and transparency obligations under international law. Such discrepancies prevent effective climate resilience planning and may trigger State Responsibility for administrative omissions. To address this, the research proposes adopting the Albanian Diella model as a radical technological intervention. This AI mechanism integrates Big Data and real-time satellite imagery through Difference Imaging, which is a technique adapted from astrophysical surveys, to instantly isolate physical alterations in land cover by comparing reference and new imagery. By utilizing Convolutional Neural Networks (CNN) for advanced feature extraction, the AI can detect illegal logging patterns invisible to manual monitoring. Furthermore, the system acts as a surrogate model, reducing the computational time required to audit complex carbon flows to milliseconds while maintaining high precision.

The study concludes that while AI acts as a radical transparency tool to restore the integrity of national reports, it must operate under a Human-Guided AI (HG-AI) framework. This framework ensures that while AI provides unalterable technical evidence, final policy decisions and legal enforcement remain with state authorities to uphold constitutional values and social justice. This synergy between law and technology is key to transforming public administration into an accountable and resilient system in the face of global climate change.

Keywords: Artificial Intelligence, Deforestation, Paris Agreement, State Responsibility, Human-Guided AI.

1. INTRODUCTION

Global climate change is rarely the result of a singular, cataclysmic event; rather, it is the cumulative consequence of consistent anthropogenic activities. Within this slow-moving crisis, the Forestry and Other Land Use (FOLU) sector occupies a paradoxical position. Forests, theoretically the planet's primary carbon sinks, are increasingly functioning as significant emission sources due to unchecked

deforestation. This transformation drives a dual crisis: firstly, the clearing of land releases carbon stored for centuries in biomass and soil back into the atmosphere (Obani, 2025, p. 1). Secondly, often omitted from standard reporting deforestation triggers immediate biophysical feedbacks. The massive loss of canopy cover alters surface reflectivity (albedo) and disrupts evapotranspiration cycles, destabilizing local weather patterns and microclimates (Lawrence, 2022, p. 2). Consequently, consistent deforestation erodes environmental resilience, leaving ecosystems fragile and prone to collapse under even minor climatic stress.

The empirical reality of this management failure was brutally illustrated by the hydrometeorological disaster that struck Sumatra and parts of Asia in late 2025. This event was characterized by rainfall intensities historically dismissed as "impossible" or statistically negligible. Yet, the devastation was absolute. Field data suggests a total collapse of the land's carrying capacity, a direct symptom of forest cover loss. In East Aceh Regency alone, preliminary financial losses from the flooding were estimated at IDR 5.39 trillion, effectively paralyzing local economic and social infrastructure (ANTARA News, 2025, p. 1). The human cost was even more staggering; the National Agency for Disaster Countermeasure (BNPB) reported that by mid-December 2025, the death toll across Sumatra had reached 1,016, with 212 individuals missing and over 624,000 displaced (Hutabarat, 2025, p. 1).

These floods should not be viewed merely as natural calamities but as forensic indicators of environmental negligence. The excessive surface runoff points to massive, unmonitored deforestation in upstream areas, regions that should have acted as natural sponges but were likely converted for other uses. Crucially, these landscape alterations are rarely reflected accurately in national Greenhouse Gas (GHG) emission reports or official land cover maps. There is a significant volume of "dark data" regarding deforestation that remains hidden behind administratively compliant reports.

Indonesia, having ratified the Paris Agreement via Law Number 16 of 2016, is bound by the Enhanced Transparency Framework (ETF). The ETF mandates that states report GHG inventories adhering to the principles of Transparency, Accuracy, Completeness, Consistency, and Comparability (UNFCCC, 2020, p. 2). However, verification in the forestry sector remains notoriously difficult. A fundamental disconnect exists between field realities and reported statistics. Deforestation driven by illegal encroachment, fragmented small-scale conversion, or remote plantation expansion often goes unreported due to monitoring limitations or methodological imprecision (Souza Bikiaris, 2025, p. 1). Furthermore, the general level of carbon emission disclosure in developing countries remains low, requiring significant systemic improvement (Wahyuningrum, 2025, p. 484).

This inaccuracy is as political as it is technical. States often face a conflict of interest, balancing environmental obligations against the economic revenues from extractive industries. This creates tacit incentives to "allow" deforestation or smooth over damage data to maintain investment stability. Such distortions violate the

principle of State Responsibility in international law. States hold an absolute obligation to prevent their territory from causing harm to other states or violating treaties; negligence in this duty incurs legal liability (Mangku & Radiasta, 2019, p. 28). When a state allows data manipulation for political expediency, it fails in its due diligence to protect its citizens from climate disasters a mandate that is legally binding (Dana, 2022, p. 60).

To break this deadlock of human bias and political interference, a radical technological intervention is necessary. A compelling precedent has emerged from Albania, where Prime Minister Edi Rama appointed an AI system named "Diella" to a role equivalent to a cabinet minister, specifically to oversee public procurement and eradicate corruption. This move acknowledges a hard truth: humans are inherently vulnerable to corruption and pressure, whereas AI operates strictly on data logic (Henley, 2025, p. 1). The Albanian model offers a blueprint for global environmental governance. If AI can be entrusted to audit state funds to ensure integrity, it should similarly be applied to audit "carbon flows." AI has the capacity to process high-resolution satellite imagery in real-time, detecting illegal clearing within hours and calculating emissions automatically, bypassing the intervention of interested officials (Pillay, 2025, p. 2).

The operational strength of the 'Digital Independent Auditor' lies in its ability to perform 'Difference Imaging,' a technique successfully utilized in astrophysical surveys such as the Zwicky Transient Facility (ZTF) to detect transient changes in the sky. By algorithmically subtracting a historical 'reference image' of the forest from a 'new image' in real-time, the AI can instantly isolate and emphasize physical alterations in land cover, bypassing the delay of manual visual inspection. Furthermore, utilizing Convolutional Neural Networks (CNN), the system can perform advanced feature extraction, identifying not only tree loss but also the specific spatial patterns of illegal logging, such as unauthorized road networks or the signatures of heavy machinery, which are often invisible to conventional monitoring methods (Dhuri, 2025. p. 5-8). To overcome the computational cost of processing vast biophysical datasets, the proposed AI framework functions as a 'surrogate model'. Similar to the application of CNNs in modeling complex blazar spectral energy distributions, this approach reduces the evaluation time of multi-variable carbon flow equations from several minutes to milliseconds while maintaining high accuracy. This enables the 'Independent Auditor' to deliver real-time emission estimates that reflect honest biophysical facts rather than administratively manipulated figures (Sahakyan, 2024. p. 7-9).

Given the critical gap between unreported deforestation and the urgency for transparent data following the 2025 Sumatra disaster, this study addresses two primary issues:

1. What are the legal implications of the discrepancy between actual deforestation rates and national GHG emission reports regarding Indonesia's State Responsibility under the Paris Agreement framework?

2. How can the AI governance model implemented by the Albanian Government ("Diella") be conceptualized and adopted as an Independent Auditor mechanism to prevent the manipulation of deforestation data in Indonesia?

Aligning with the problems identified, the objectives of this research are:

1. To analyze the legal consequences of data discrepancies in the forestry sector concerning Indonesia's international obligations and the principles of State Responsibility in climate change mitigation.

2. To conceptualize a framework for deploying AI as an autonomous instrument capable of collecting, verifying, and reporting deforestation and GHG emission data, free from political intervention, by adapting the digital governance model from Albania.

2. METHODOLOGY

Describe the methodological procedures of your study. A complete paper should contain the following sections: Abstract, Introduction, Methodology, Results, Conclusions, Acknowledgements (optional), and References. Ensure the title and author list match the accepted abstract.

Research Approach This study employs a normative-juridical research method complemented by a comparative case study approach. The normative-juridical aspect is utilized to analyze the gap between the practical implementation of Greenhouse Gas (GHG) reporting in Indonesia and the binding obligations of international law, specifically the Paris Agreement and the principle of State Responsibility. Meanwhile, the comparative approach is adopted to examine the digital governance transformation in Albania, specifically the deployment of the AI system "Diella" in public procurement, to evaluate its feasibility and adaptability as a model for environmental auditing in Indonesia.

Data Sources The research relies on secondary data obtained through comprehensive literature review (*library research*). The data materials are classified into three categories:

1. Primary Legal Materials: Authoritative international instruments, including the Paris Agreement (2015), United Nations Framework Convention on Climate Change (UNFCCC) documents regarding the Enhanced Transparency Framework (ETF), and relevant Indonesian legislation ratifying these treaties.

2. Secondary Legal Materials: Academic literature, including peer-reviewed journals and research reports analyzing the legal implications of State Responsibility (e.g., Mangku & Radiasta, 2019), the biophysical impacts of deforestation (e.g., Lawrence, 2022), and carbon emission quantification studies (e.g., Obani, 2025).

3. Tertiary Legal Materials: Non-legal documents that provide context and empirical evidence, including investigative news reports (TIME, The Guardian, Global

Government Forum) regarding the Albanian AI initiative and the 2025 Sumatra hydrometeorological disaster (ANTARA News, Liputan6).

Collected data were analyzed using a qualitative descriptive-analytical technique. The analysis proceeds in three stages: first, diagnostic analysis, which maps the correlation between the 2025 Sumatra floods and unreported deforestation data to identify gaps in the current manual reporting system. Second, comparative analysis, which dissects the operational mechanisms of the Albanian AI model to isolate specific features (autonomy, real-time processing, and anti-corruption algorithms) suitable for environmental application. Finally, prescriptive synthesis, which formulates a conceptual framework for the "Independent AI Deforestation Auditor," integrating technical feasibility with legal compliance requirements under international law.

The reasoning process utilizes deductive logic, starting from the major premise of international obligations (pacta sunt servanda), moving to the minor premise of current reporting failures and technological availability, and concluding with the necessity of algorithmic intervention to ensure compliance.

3.   FINDINGS AND DISCUSSION

3.1   Legal Implications of Deforestation Data Disparities on the Responsibility of the Indonesian State

Deforestation is a vital component that must be reported by every country as part of the Greenhouse Gas (GHG) emission inventory under the Paris Agreement framework ratified through Law No. 16 of 2016. Indonesia itself has set an ambitious target in the Enhanced Nationally Determined Contribution (ENDC) document, namely a 31.89% emission reduction with the support of its own efforts and 43.20% with international support (Santoso, 2024, p. 1). Ecologically, forests function as carbon sinks, but when deforestation occurs, the remaining carbon returns to the atmosphere, which drastically disrupts the global carbon balance and climate stability (Ceccarelli, 2024, p. 1). Legally, inaccurate data in this report can trigger state responsibility under international law if there is evidence of violations in supervision (Mangku & Radiasta, 2019, p. 25). The principle of international legal accountability also emphasizes that the use of monitoring technology must be carried out with due care to minimize risks to civilian areas (Ariestu et al., 2025, p. 1).

However, the reality on the ground contrasts sharply with written reports. Hydrometeorological disasters, such as the recent flash floods in North Sumatra, Aceh, and West Sumatra, have revealed the grim reality of numerous driftwood logs, evidence of undetected or officially unreported deforestation. In East Aceh Regency alone, the impact of this disaster has caused material losses estimated at IDR 5.39 trillion, including damage to thousands of homes and public infrastructure (Antara,

2025, p. 1). This contradictory data demonstrates the need for a stronger oversight role, as international organizations like the UN play a crucial role in crisis mitigation and ensuring compliance with international law amidst global conflict (Aryawan et al., 2023, p. 1). As described in the Albanian case study, human intervention in bureaucracy often creates loopholes for "administrative errors" or perceived inconsistencies in objective data (Henley, 2025, p. 2).

The implications of disparities in deforestation data extend to the point where countries lack contingency plans capable of dealing with extreme heavy rainfall events or unexpected peak cycles. Without real-time deforestation data, disaster mitigation becomes a reactive measure without adequate infrastructure preparedness, potentially leading to complex environmental problems, such as marine pollution caused by oil spills (Purwendah et al., 2019, p. 1). This uncontrolled deforestation also has a direct impact on air quality and significant temperature increases, with climate records showing extreme temperatures in some parts of Indonesia reaching over 38°C (BMKG, 2024, p. 1). Beyond ecological losses, ignoring the reality of deforestation is a denial of the state's humanitarian responsibility to protect its citizens from the impacts of disasters, a principle of protection that aligns with the obligation to protect victims under international law (Mangku, 2021, p. 170).

To address this accountability crisis, Indonesia needs a revolutionary breakthrough in the form of adapting the AI concept from the Albanian government for implementation in its deforestation reporting and recording system. Synergy between legal reform and technology is key to a fairer and more transparent justice system and public administration (Kbarek et al., 2023, p. 123). By adopting a virtual minister model that acts as an independent auditor without vested interests, Indonesia can ensure that every inch of forest cover change is processed objectively (Pillay, 2025, p. 4). This step will eliminate interference by vested officials, ensuring that national emissions reports maintain strong legal integrity and comply with global transparency standards (Çani & Mazelliu, 2025, p. 527).

3.2 Conceptualization of the AI Model "Diella" as an Independent Auditor in Indonesia

The Albanian government has made a revolutionary breakthrough by introducing Diella, an artificial intelligence (AI)-powered digital assistant appointed as a member of its virtual cabinet to manage public procurement. This concept is not simply a technological innovation, but a revolutionary legal strategy to eliminate human bias and systemic corruption within the bureaucracy. Diella is designed to objectively assess every tender, ensuring that every state contracting process runs with 100% transparency without the interference of vested interests (Aldane, 2025, p. 1). Diella's appointment marks a fundamental shift in public administration, demonstrating that technology can be elevated from a mere supporting tool to an "active participant" in governance, capable of upholding integrity where human oversight often fails (Henley, 2025, p. 2).

The AI approach employed in Albania can be applied in Indonesia through the creation of a dedicated "Digital Independent Auditor" mechanism to objectively monitor deforestation. The implementation of this technology must be supported by adequate national legal instruments to create clear boundaries of authority, as national legislation is crucial in creating legal certainty over national boundaries to avoid conflict (Purwanto & Mangku, 2016, p. 1). As an independent auditor, AI will stand outside of local political interests, verifying Greenhouse Gas (GHG) emission reports based on immutable physical evidence, thus ensuring Indonesia meets its international obligations in accordance with global legal standards (Mangku, 2020, p. 161). The presence of AI as an independent auditor will ensure that there is no further data manipulation that harms the public interest, making transparency in emissions reporting a concrete manifestation of human rights protection and ecological justice (Kbarek et al., 2023, p. 123).

The use of AI in forest monitoring is a concrete manifestation of the state's responsibility to protect the rights of its citizens. Just as states have an obligation to promote and protect the rights and dignity of vulnerable groups through the ratification of international conventions into national law (Nazifah et al., 2021, p. 272), states also have a mandate to protect communities' rights to a healthy environment through honest monitoring technology. Operationally, this audit mechanism serves to close the "accountability gap" that arises in manual reporting, while providing a strong legal basis for states to prevent further environmental damage (Mangku, 2020, p. 163).

The development of these audit algorithms must be based on the use of Big Data and high-resolution satellite access capable of capturing signs of illegal deforestation in real time. The advantage of AI lies in its ability to detect not only tree cover loss but also "invisible" yet tangible biophysical impacts, such as changes in surface temperature and disruption of the water cycle in deforested areas (Lawrence et al., 2022, p. 1). This is crucial because environmental destruction can cause permanent damage to natural sustainability and disrupt the natural resources on which human life depends (Purwendah et al., 2019, p. 1). By detecting illegal logging activities through digital sensors, AI can provide accurate emissions data to maintain global climate stability (Bikiaris, 2025, p. 1).

The independent reports generated by AI must be immediately followed up legally by relevant institutions such as the Ministry of Environment and Forestry or law enforcement officials. The validity of AI findings can serve as key evidence in holding those involved in illegal land clearing accountable, similar to the accountability mechanisms used in oil spills at sea (Purwendah et al., 2019, p. 1). If AI audit results indicate state negligence in monitoring its territory, leading to flash floods, this could trigger state responsibility under international law (Mangku & Radiasta, 2019, p. 25). Failure to act on tangible digital evidence could be considered a neglect of the protection responsibilities stipulated in international conventions (Mangku, 2021, p. 170; G.W. et al., 2021, p. 96).

To emphasize, AI is positioned purely as an auditing and reporting tool, not as a policy-making entity. Strategic decisions regarding sanctions or regulatory changes remain in the hands of human authorities to ensure that the values of justice and moral considerations remain at the core of the legal system (Çani & Mazelliu, 2025, p. 527). This synergy ensures that technology serves as an instrument to modernize Indonesia's legal and governmental systems to make them more accountable, while political and legal responsibility remains with institutions. Recognizing the 'black box' challenge inherent in advanced algorithms, this research advocates for the Human-Guided AI (HG-AI) framework. In this model, human expertise from legal and environmental domains guides the AI's objectives and validates its outputs, ensuring that the auditing process is not only robust but also interpretable and transparent. This synergy ensures that while AI provides unalterable technical evidence of deforestation and emissions, the legal responsibility and final policy decisions remain with human authorities, upholding the principles of State Responsibility and due diligence under international law (Sahakyan, 2024. p. 11-12).

4. CONCLUSION

The disparity between actual deforestation rates and national Greenhouse Gas (GHG) emission reports is not simply an administrative failure but has serious legal implications for state responsibility under the Paris Agreement. Empirical evidence from flash floods in various provinces in Indonesia demonstrates an accountability gap in the manual reporting system, which remains vulnerable to interference from human interests and bureaucratic bias. The failure to present accurate data constitutes a disregard for international due diligence obligations and the protection of citizens' human rights to a healthy environment.

As a strategic solution, the conceptualization of the Diella AI governance model offers a breakthrough through the establishment of an Independent Digital Auditor mechanism. By leveraging Big Data and real-time satellite imagery through Difference Imaging techniques, this system can verify deforestation data radically and transparently. The integration of Convolutional Neural Networks (CNN) for feature extraction allows for the detection of illegal land-clearing patterns that often escape manual oversight. Furthermore, by functioning as a surrogate model, the AI can process complex carbon flow calculations in milliseconds, thereby ensuring that national emissions reports maintain strong legal integrity and comply with global transparency standards.

However, this technological integration still positions AI as a data auditor rather than a policymaker. Human authority, through the Human-Guided AI (HG-AI) framework, retains control over strategic decisions and law enforcement to uphold the values of justice and social equity. This synergy between law and technology is key to

transforming public administration into an accountable, credible, and resilient system in facing the challenges of global climate change in the future.

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