No. 1 - 2026

ISIL Occasional Paper

Crypto Mining and Green Justice: A Third World Perspective on State Responsibility under International Law

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Abstract

The rapid expansion of energy-intensive Proof-of-Work cryptocurrency mining has created a significant environmental footprint, a burden increasingly borne by states in the Global South. As miners migrate to jurisdictions with cheaper energy and weaker regulations, they impose severe stress on local power grids and ecosystems, exposing a critical gap in the international legal framework for ensuring environmental justice. This paper addresses this regulatory failure by examining the scope of state responsibility under public international law. Applying the customary international law principles of the no-harm rule and the due diligence standard, this analysis is critically informed by a Third World Approaches to International Law (TWAIL) perspective to reveal the structural inequities at play. The paper argues that a host state's failure to implement adequate regulatory and monitoring measures for the known environmental risks of crypto mining constitutes a breach of its due diligence obligation, thereby triggering its international responsibility. Ultimately, this study proposes a cooperative and operationalisable legal framework, complete with concrete domestic implementation strategies, to provide a clear pathway for holding states accountable and empowering the Global South to uphold green justice in the digital age.

Introduction

The 21st century's digital gold rush is powered by a staggering energy expenditure. The Bitcoin network alone consumes approximately 173 TWh of electricity annually, an amount comparable to the entire nation of Pakistan,[1] with a carbon footprint rivalling that of many industrial nations.[2] Following China's 2021 ban on cryptocurrency mining, a significant portion of this energy-intensive industry migrated, seeking refuge in jurisdictions with cheaper power and weaker regulations.[3] This exodus, a textbook example of regulatory arbitrage,[4] saw countries like Kazakhstan transformed, almost overnight, into global mining hubs, placing immense strain on their national energy grids and local environments.[5] This inequitable shift of the environmental burden from the Global North's financial centres to the resource infrastructure of the Global South has created a critical regulatory gap and a pressing challenge for international environmental justice.

This paper confronts this gap by addressing three explicit legal questions. First, can environmental harm caused by ostensibly private crypto-mining operations be attributed to the host state under international law? Second, does a state's failure to adequately regulate these operations constitute a breach of its due diligence obligation to prevent significant environmental harm, a duty rooted in the customary no-harm rule?[6] Finally, what are the legal consequences that arise for a state under the law of state responsibility when such a breach is established?[7] Recent advisory opinions on climate change have affirmed that these duties apply even to cumulative, global harms, making them directly relevant to the cross-border nature of crypto mining.[8]

To analyse these questions equitably, this paper employs a Third World Approaches to International Law (TWAIL) framework. TWAIL provides a critical lens to deconstruct how international legal norms, despite their neutral appearance, can perpetuate imperial-era legacies of exploitation, creating asymmetric power dynamics where the Global South bears environmental costs while the economic benefits flow to external actors.[9] This paper's central thesis argues that a state's failure to apply due diligence in regulating the known environmental risks of crypto mining is a breach of the customary no-harm rule, triggering its international responsibility. To build this argument, Part 2 first identifies the scale of the environmental problem and the inadequacy of current regulations. Part 3 then establishes the legal basis for state accountability, using a TWAIL perspective to expose underlying structural inequities. Following this analysis, Part 4 proposes a cooperative and operationalisable legal framework with concrete recommendations. Finally, the paper concludes in Part 5 by providing a clear pathway for the Global South to uphold green justice in the digital age.

The Problem: Environmental Realities and Regulatory Gaps

Quantifying the Environmental Harm

To ground the legal analysis in empirical reality, it's essential to first quantify the significant and multi-faceted environmental footprint of Proof-of-Work (PoW) cryptocurrency mining. The scale of the industry's resource consumption is staggering. At a macro level, the Bitcoin network alone consumes approximately 173 TWh of electricity annually, a figure comparable to Pakistan's national energy consumption. This immense energy demand is even starker at the transactional level, where a single Bitcoin transaction consumes roughly 1,335 kWh, equivalent to powering an average U.S. household for 45 days.

This energy use translates directly into substantial climate and environmental impacts. Globally, PoW mining operations generate an estimated 61 million metric tons of CO_2 equivalent each year, an emissions profile on par with that of a mid-size country.[10] Beyond global emissions, the industry imposes severe localised stress on energy infrastructure. In Kazakhstan, for example, surges in mining demand contributed to multiple regional blackouts in 2022, leading to scheduled rolling curtailments that affected over 2 million consumers.[11] Data from the Global Electricity Review confirms this trend, showing that mining hubs in both Iran and Kazakhstan have driven peak-load events more than 15% above forecasted demand in several districts.[12]

The environmental consequences extend beyond the power grid. A Harvard-led analysis linked power generation for mining in Inner Mongolia to a 12% increase in fine-particulate (PM 2.5) air pollution during peak hashing periods, demonstrating direct local health

impacts.[13] Furthermore, the industry produces significant physical waste and consumes vast quantities of water. The annual e-waste from obsolete mining hardware is estimated at 30,000 metric tons, while cooling systems and hydropower facilities can consume up to 7 cubic meters of water per MWh of electricity produced.[14] This empirical record establishes not merely a factual harm but a foreseeable and preventable one, precisely the threshold that activates a state's due diligence obligations under international environmental law.

Comparative Case Studies: A Third World Perspective

The global migration of crypto mining has produced divergent outcomes across the Global South. An examination of national responses in Kazakhstan, Kenya, and Venezuela reveals a spectrum ranging from reactive crisis management to proactive integration, starkly illustrating the challenges and opportunities states face.

Kazakhstan: A Reactive Model

Following China's 2021 mining ban, Kazakhstan rapidly emerged as one of the primary destinations for displaced cryptocurrency miners such as Canaan, largely due to its abundant coal-generated electricity and comparatively low energy prices.[15] Within a short period, the country became a major global hub for Bitcoin mining, with estimates suggesting that Kazakhstan accounted for a substantial share of the global network's hashing power in the months following the Chinese prohibition. However, this sudden concentration of energy-intensive mining operations placed severe and unexpected pressure on the national electricity grid, which had not been designed to accommodate such large industrial loads. Reports from energy authorities indicated that the influx of miners significantly increased electricity demand in several regions, forcing grid operators to impose power curtailments and emergency supply measures to stabilise the system. The government's response was largely reactive, aimed at controlling a sector that had already begun to overwhelm national infrastructure. A key measure was the introduction of a digital mining fee of 1 Kazakhstani tenge (KZT) per kilowatt-hour (kWh), effective January 1, 2022.[16] These measures required mining firms to obtain formal authorisation, disclose their energy consumption, and comply with regulatory monitoring by state authorities. Such regulatory efforts reflected an attempt to bring previously informal or lightly regulated operations under a structured legal framework. Policies linking electricity pricing to supply conditions and consumption levels were also introduced, signalling the government's recognition that unchecked mining demand posed a direct threat to national energy security.[17] Taken together, these policies illustrate a strategy of scarcity management, implemented only after mining activities had already produced significant stress on the national grid. Rather than preventing environmental and infrastructural pressure from emerging, regulatory measures were introduced primarily as corrective tools to stabilise an already strained system. Kazakhstan's experience, therefore, highlights the challenges that developing states face when rapidly evolving digital industries migrate across jurisdictions faster than domestic regulatory frameworks can adapt.[18]

Kenya: An Innovative Model

In contrast to Kazakhstan's reactive stance, Kenya is pursuing a more proactive model of integration that seeks to align cryptocurrency mining with the country's existing renewable energy strategy. Kenya possesses one of the most renewable-heavy electricity mixes in Africa, with geothermal, hydro, wind, and

solar energy collectively forming the backbone of the national grid. This renewable surplus has created an opportunity for energy-intensive digital industries to function as flexible consumers of excess electricity rather than as destabilising loads on the system. Recognising this potential, the Kenyan government has begun exploring ways to integrate crypto mining into its broader energy development policy while ensuring that such activities remain tied to sustainable power generation.

On May 24, 2024, the Kenyan Ministry of Energy and Petroleum signed a Memorandum of Understanding (MoU) with the mining firm Marathon Digital, with reported investment expectations exceeding $80 million.[19] In contrast to Kazakhstan's reactive stance, Kenya is pursuing a more proactive model of integration that seeks to align cryptocurrency mining with the country's existing renewable energy strategy. Kenya possesses one of the most renewable-heavy electricity mixes in Africa, with geothermal, hydro, wind, and solar energy collectively forming the backbone of the national grid. This renewable surplus has created an opportunity for energy-intensive digital industries to function as flexible consumers of excess electricity rather than as destabilising loads on the system. Recognising this potential, the Kenyan government has begun exploring ways to integrate crypto mining into its broader energy development policy while ensuring that such activities remain tied to sustainable power generation. On May 24, 2024, the Kenyan Ministry of Energy and Petroleum signed a Memorandum of Understanding (MoU) with the mining firm Marathon Digital, with reported investment expectations exceeding $80 million.[20] Rather than allowing uncontrolled market entry by mining operators, the Kenyan approach reflects a structured effort by the state to guide the sector's development through formal cooperation with both domestic energy authorities and private firms. Kenya's electrical grid is already predominantly powered by renewable sources, with geothermal energy representing the single largest contributor to national electricity generation. The country's Rift Valley geothermal resources allow it to produce stable baseload renewable energy, which often generates excess capacity during periods of low domestic demand. This surplus electricity presents an opportunity for industries like crypto mining to act as "energy buyers of last resort," absorbing unused power that might otherwise remain unutilised. By linking mining operations to this surplus renewable energy, the Kenyan government aims to convert potential energy waste into a source of economic value while avoiding the environmental harms typically associated with fossil-fuel-powered mining. This strategy builds on existing successful deployments, such as the geothermal-powered mining operations by the firm Gridless at Hell's Gate.[21]

Regulatory Arbitrage and State Failure: The Case of Venezuela

Venezuela provides a stark example of how regulatory arbitrage can lead to total system failure in a state with a collapsing energy infrastructure. Amidst chronic power instability, miners were drawn to the country's heavily subsidised and nearly free electricity. However, this burden pushed an already fragile system to its breaking point.[22] In May 2024, the Ministry of Electric Power ordered all cryptocurrency mining farms to be disconnected from the national grid to preserve the country's power supply, effectively banning the industry. This drastic measure followed a pattern of nationwide shutdowns and seizures of mining equipment, underscoring the state's inability to manage the parasitic load of mining on its failing grid.[23]

Venezuela's experience illustrates the end-stage of unchecked regulatory arbitrage, where the state's only remaining policy option is a complete prohibition to prevent catastrophic infrastructure collapse.

The Doctrinal Framework: Due Diligence and State Responsibility

The No-Harm Rule and Due Diligence as a Core Obligation

The central pillar of a state's environmental responsibility is the customary international law principle known as the no-harm rule. This rule obligates every state to exercise due diligence to ensure that activities within its jurisdiction do not cause significant environmental harm to other states. This foundational principle is not based on strict liability, which would guarantee a harm-free outcome, but on the state's conduct.[24] Its legal roots are in the landmark Trail Smelter case, where Canada was held responsible for airborne pollution from a private smelter that damaged forests in the United States, establishing that a state must not permit its territory to be used to cause such transboundary injury.[25] This was reinforced by the Corfu Channel case, which confirmed a state's general duty of vigilance over its territory and its obligation not to knowingly allow it to be used for acts contrary to the rights of other states.[26]

In practice, due diligence requires a state to implement appropriate and proportional measures to prevent, reduce, and control risk. This includes procedural duties like conducting environmental impact assessments, substantive duties like setting and enforcing regulatory limits, and cooperative duties like notifying potentially affected states.[27] Contemporary interpretations have confirmed that this obligation applies to cumulative and diffuse harms, such as greenhouse gas emissions, making it directly relevant to the externalities of energy-intensive crypto mining.[28] Therefore, when a state fails to adopt reasonable licensing, monitoring, and enforcement measures for a high-risk industry like crypto mining, it has failed its due diligence duty. This attributes responsibility to the adequacy of the state's preventive measures, while recognising that the structural drivers of harm often lie beyond its full control.

From Breach to Accountability: The Consequences under the Law of State Responsibility

Having established the breach of a primary obligation, the analysis now turns to the secondary legal consequences under the law of State Responsibility. Under the Articles on Responsibility of States for Internationally Wrongful Acts (ARSIWA), every internationally wrongful act of a state entails its international responsibility.[29] A wrongful act exists when conduct, such as a regulatory omission, is attributable to the state and constitutes a breach of an international obligation.[30] Article 1 of ARSIWA establishes the foundational principle that "Every internationally wrongful act of a State entails the international responsibility of that State".[31] Article 2 defines the two core elements of such an act: conduct, including an omission, that is (a) attributable to the state, and (b) constitutes a breach of an international obligation.[32] In the context of crypto mining, the state's failure to exercise due diligence over private actors within its jurisdiction is the attributable omission that satisfies this requirement.[33]

Once responsibility is triggered, a clear set of secondary obligations arises. First, the responsible state has a duty of cessation and non-repetition. This requires the state to cease its wrongful conduct, in this case, its permissive regulatory failure, by imposing immediate and

effective controls.[34] Second, under Article 31 ARSIWA of the state is under an obligation to make full reparation for the injury caused by its wrongful act.[35] Under Article 34 of ARSIWA, full reparation for the injury caused shall take the form of restitution to re-establish the prior situation, compensation for financially assessable damage, and satisfaction for non-material harm, used either singly or in combination.[36] Under Article 29 of ARSIWA, the legal consequences of a wrongful act do not erase the original rule,[37] the state's primary obligation to exercise due diligence under the no-harm rule remains in full force alongside any duties of reparation.[38] Together, these secondary rules provide a robust and universally applicable framework for accountability.

The TWAIL Critique of the Due Diligence Standard

While the due diligence standard appears neutral and universally applicable, a Third World Approaches to International Law (TWAIL) perspective reveals how such formally equal rules can operate inequitably in a world characterised by deep structural inequalities. TWAIL scholarship argues that international law cannot be understood purely as a neutral body of rules governing relations between sovereign equals. Rather, it emerged historically alongside colonial expansion and global economic hierarchies, meaning that many legal doctrines continue to reflect the power asymmetries embedded in the international system. As a result, legal standards that appear universally applicable may impose formally identical obligations on states whose historical responsibilities, economic capabilities, and institutional capacities differ dramatically.[39] TWAIL's core thesis is that international law, despite its proclamations of sovereign equality, often carries forward the legacy of imperialism through doctrines that reproduce patterns of structural subordination for states in the Global South. These doctrines frequently present themselves as neutral procedural standards while obscuring the unequal political and economic contexts in which they operate.[40] This section therefore applies the TWAIL critique to the due diligence standard in international environmental law, using the Chagos case as a central analogy to illustrate how formally neutral legal principles may operate unevenly in practice.

The ICJ's Advisory Opinion on the Chagos Archipelago provides a powerful example of this dynamic. In its advisory opinion, the Court concluded that the United Kingdom's detachment of the Chagos Archipelago from Mauritius during the process of decolonisation was unlawful because it violated the principle of self-determination. The Court found that the separation occurred through a coercive negotiation process in which Mauritius, still under colonial administration, lacked genuine freedom to refuse the arrangement.[41] Although the formal procedures of decolonisation were followed, the opinion demonstrated how legal processes could be manipulated by powerful states while still maintaining the appearance of compliance with international law. From a TWAIL perspective, the case reveals how the gap between legal principle and geopolitical reality can allow dominant states to preserve strategic interests under the cover of formal legaliy.[42]

A similar tension between formal equality and substantive inequality is visible in the principle of Common But Differentiated Responsibilities (CBDR). Incorporated into the framework of the United Nations Framework Convention on Climate Change (UNFCCC), CBDR was designed to recognise that developed states bear a greater responsibility for addressing environmental harm due to their historical

contributions to global emissions and their superior financial and technological capacities.[43] In theory, the principle attempts to correct structural inequalities by distributing environmental obligations in accordance with capability and responsibility. However, TWAIL scholars argue that CBDR has often remained largely aspirational because it lacks strong enforcement mechanisms capable of compelling meaningful compliance from developed states. As a result, developed countries may acknowledge differentiated responsibilities rhetorically while resisting binding commitments that would impose significant economic costs.[44]

When applied to the environmental challenges associated with cryptocurrency mining, this dynamic of formal equality producing substantive inequality becomes particularly evident. The due diligence standard requires states to take all reasonable measures within their capacity to prevent significant environmental harm originating within their jurisdiction. In principle, this obligation applies equally to all states regardless of their level of development. However, the practical ability to regulate energy-intensive industries such as cryptocurrency mining depends heavily on regulatory capacity, technological infrastructure, and financial resources. States with well-developed institutions and advanced energy systems are better positioned to monitor mining activities, enforce environmental regulations, and transition towards cleaner energy sources.[45] By contrast, many states in the Global South face significant constraints in administrative capacity, infrastructure reliability, and regulatory enforcement. When mining operations relocate to jurisdictions offering cheaper electricity and weaker oversight, the environmental burdens associated with these activities can become concentrated in countries least equipped to manage them effectively. This structural imbalance allows the environmental costs of cryptocurrency mining to be externalised onto developing states while the economic benefits of the industry remain concentrated elsewhere. In effect, a formally universal standard of environmental prevention is imposed on states whose structural position within the global economy limits their ability to satisfy it in practice.[46]

A De Lege Ferenda Sidebar: The Jus Cogens Contention

Finally, the duty to prevent catastrophic environmental harm is arguably evolving towards the status of a peremptory norm of general international law (jus cogens). Defined under Article 53 of the Vienna Convention on the Law of Treaties as a norm from which no derogation is permitted,[47] jus cogens norms are considered hierarchically superior to all other rules of international law as they protect the fundamental values of the international community.[48] While traditionally reserved for prohibitions like genocide and torture, the concept is beginning to extend to environmental protection. In a landmark 2025 Advisory Opinion, the Inter-American Court of Human Rights (IACtHR) became the first international court to explicitly recognise the jus cogens character of the obligation to prevent irreversible damage to the global environment.[49] In contrast, the International Court of Justice (ICJ) in its 2024 Climate Advisory Opinion took a more cautious approach. While the ICJ confirmed that obligations to safeguard the climate system are erga omnes, owed to the international community as a whole, it stopped short of a full jus cogens declaration, a position described by some as only a "small step away" from doing so.[50] This judicial reticence, however, is increasingly challenged

by a growing consensus in academic scholarship and other legal fields, such as investment arbitration, that environmental protection is an emerging jus cogens norm.[51] Therefore, while not yet universally settled law, the trajectory suggests that the duty to prevent catastrophic environmental harm is on a path towards recognition as a fundamental, non-derogable obligation.

The Solution: An Operationalisable Framework for Green Justice

Foundational Principles for Action

The recommendations advanced in this paper are not abstract policy goals; they are grounded in the fundamental principles of international cooperation and obligations owed to the international community. The legal basis for collective action stems from the concept of obligations erga omnes, which are duties that every state has an interest in protecting.

The International Court of Justice first articulated this concept in the Barcelona Traction case, explaining that certain obligations, by reason of the importance of the rights involved, are the concern of all states.[52] This principle was recently affirmed in the Chagos Advisory Opinion, where the Court found that because self-determination is an obligation erga omnes, all member states are under an obligation to cooperate with the United Nations to complete the decolonisation of Mauritius.[53]

By analogy, the duty to prevent significant harm to the global environment, particularly from cumulative and transboundary sources like greenhouse gas emissions, can be characterised as an erga omnes obligation. This characterisation establishes a legal interest for all states in addressing the environmental harm caused by industries like crypto mining, regardless of where the mining occurs. It provides the legal foundation for the duty of international cooperation and the collective countermeasures that underpin the actionable recommendations that follow.[54]

Actionable Recommendations and Domestic Implementation

To translate the legal duty of due diligence into practice, states should adopt practical regulatory tools that align environmental protection with digital-era challenges. First, Green Licensing Regimes, implemented through national Energy Acts, can require miners to meet minimum renewable energy procurement and hourly matching obligations.[55] These regimes should also include mandatory environmental impact assessments before approving large-scale mining projects and require public reporting on energy sources to ensure transparency and accountability.

Second, a Climate Levy, enacted through the Tax Code or Tariff Orders, can link electricity costs to the real-time carbon intensity of the grid, forcing mining operators to account for their environmental impact. The revenue generated from such levies can be directed towards renewable energy investments, grid upgrades, and environmental restoration, ensuring that the costs of pollution are internalised within the industry rather than externalised onto communities.[56]

Finally, South-South Cooperation through shared model laws, regional guidelines, and capacity-building initiatives can help harmonise environmental standards and reduce regulatory arbitrage.[57] Such cooperation allows states in the Global South to pool expertise, exchange technical knowledge, and create common standards that reflect their developmental priorities. This approach promotes greater legal and environmental autonomy, ensuring that developing states are

not passive recipients of external regulation but active shapers of green governance.

Together, these measures turn the principle of due diligence into a workable and forward-looking framework that strengthens environmental accountability while promoting sustainable digital growth.

A Legally Cautious Approach to Enforcement

Ensuring compliance with these environmental obligations requires a legally cautious cascade of responses that prioritises cooperation over confrontation. The foundational step is to enhance international cooperation and transparency, reflecting the general obligation of states to work together to address issues of common concern. Should good-faith cooperation prove insufficient, states can employ procurement and finance conditionality, linking international financial support for energy projects to the host state's implementation of and compliance with robust environmental regulations for high-load industries.[58]

If a breach persists, states can escalate to retorsion, which consists of unfriendly but lawful acts taken in response to another state's wrongful act, such as the withdrawal of voluntary financing or the downgrading of diplomatic relations.[59] As a final resort, and acknowledging their controversial nature, states may consider countermeasures. Governed by Articles 49-54 of ARSIWA,[60] countermeasures must be non-forcible, proportionate to the injury suffered, and aimed at inducing the responsible state to return to a state of legal compliance, rather than serving as a form of punishment.[61] This graduated approach provides a clear and defensible pathway for enforcement, ensuring that coercive measures are reserved only for situations where cooperation has failed.

Conclusion

This paper has demonstrated that the migration of energy-intensive crypto mining to the Global South is not merely an economic trend but a significant challenge to international environmental justice. By documenting the industry's severe environmental footprint and analysing the piecemeal national responses, this research has established a clear regulatory gap. The central argument of this paper has been to fill that gap by applying established principles of public international law. It has shown that a state's failure to adequately regulate the foreseeable harms of crypto mining constitutes a breach of its due diligence obligation under the customary no-harm rule, an act which triggers the secondary rules of state responsibility.

This legal framework, however, was critically analysed through a TWAIL perspective, which revealed how a formally neutral rule like due diligence can operate inequitably in a world of unequal capacities. In response, this paper did not stop at critique but proposed a framework for empowerment. The recommendations of Green Licensing Regimes, a real-time Climate Levy, and robust South-South Cooperation are presented as concrete, operationalisable tools that enable Third World states to fulfil their international obligations while protecting their environments. These measures, backed by a cautious cascade of enforcement mechanisms, provide a clear pathway for accountability. Ultimately, this paper concludes that international law possesses the necessary doctrines to address this modern challenge. What is required is a shift in perspective, one that uses these legal tools not to assign blame, but to ensure that crypto mining does not become the next extractive industry where the Global South pays the environmental price for the Global North's financial gain.

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