Legal Governance and Energy Sustainability: Between the Growing Demand for Data Centers in Latin America and the Limits of Legal Governance Frameworks

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Abstract

[Purpose] This article examines the rapid expansion of AI-driven data centers in Latin America, underscoring the friction between digital development goals and environmental sustainability imperatives. This study highlights the paradox of a region that, despite possessing a predominantly renewable energy matrix, confronts structural infrastructure constraints. These limitations are driving a new form of extractivism, posing threats to water security, grid stability, and regional sovereignty.

[Methodology/approach/design] Adopting a qualitative, interdisciplinary methodology, the study integrates legal and regulatory frameworks, strong sustainability theory, and engineering-based quantitative metrics. Three methodological pillars ground this analysis: a systematic review of academic and technical literature; an in-depth examination of market reports, international agency documents, and government procedures; and comparative case studies focused on governance conflicts in Latin American countries, with emphasis on the Brazilian legislative context. To support the analysis of these findings, the article is organized into four analytical sections, namely: (i) *The Hidden Face of AI: Critical*

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Analysis of Social-Environmental and Structural Impacts; (ii) *Fragmented Governance and Regional Risk: LATAM Cases*; (iii) *Regulatory Arbitrage of data centers Between the Global North and South: Governance, Sovereignty and Alternative Responses and Resistances*; and (iv) *Overcoming the Extractivist Paradigm: Proposal for an Integrated Regulatory Framework Based on the Concept of Systemic Governance*.
[Findings] The findings underscore that the projected exponential growth in energy demand from data centers will strain constrained transmission grids and deepen fossil fuel dependence, thereby challenging the prevailing 'green data center' narrative. The benefits, such as job creation, tend to be short-lived, while tax incentives erode public revenues. The study also reveals hidden environmental costs embedded in hardware lifecycles, contributing to transboundary e-waste flows and toxic "waste colonialism." Case studies demonstrate patterns of governance failure, regulatory arbitrage, and socio-environmental conflict, particularly affecting local and Indigenous communities.
[Practical implications] This study argues for a proactive governmental role and proposes an integrated regulatory framework grounded in systemic governance.
[Originality/value] By presenting a comprehensive diagnosis and a technically grounded governance framework, this study contributes an original roadmap seeking to guide policymakers, investors, and civil society toward a truly just and sustainable digital transition.

Keywords: Data centers. Artificial intelligence. Energy sustainability. Critical infrastructure. Systemic Governance.

INTRODUCTION

Latin America is currently at the epicenter of a massive digital transformation, catalyzed by a global investment cycle in Artificial Intelligence (AI) that is projected to reach up to USD 1.8 trillion by 2030 (Lee *et al.*, 2025), drawing billions in capital from leading technology corporations. The physical embodiment of this technological race is the rapid proliferation of data centers, infrastructure that has become the indispensable backbone of the digital economy. However, the prevailing narrative of modernization masks a central contradiction: the conflict between Latin America's predominantly renewable energy profile, often framed as a strategic asset for attracting sustainability-minded corporations, and the increasingly unsustainable water, energy, and carbon footprints of digital infrastructure. As high-density, continuous baseload consumers, data centers often generate demand that exceeds the reliable capacity of regional renewable sources, engendering a concrete risk of renewed dependence on fossil fuels to maintain grid stability. Far from being an ethereal or immaterial domain, the infrastructure enabling data extraction is, in fact, a vast and material network that requires the intensive and ongoing extraction of natural resources for its construction and maintenance. The material burden of the "cloud" falls

disproportionately on specific geographies and communities, establishing a direct connection between data colonialism theory and the emergence of concrete socio-environmental conflicts in affected territories.

In light of the growing tensions between the promise of digital transformation and the material conditions associated with its infrastructure, this study is guided by the following question: to what extent can the expansion of AI-focused data centers in Latin America be reconciled with socio-environmental sustainability and the resilience of local infrastructures, while preventing the reproduction of an extractivist development paradigm?

This study is premised on the hypothesis that the current growth trajectory is unsustainable not due to technological inevitability, but rather as a direct consequence of a significant void in public, legal, and regulatory governance. The analysis focuses on the fragmented, reactive, and occasionally absent state governance in the region. This regulatory void has allowed the privatization of profits generated by digital infrastructure, while environmental and infrastructural costs are socialized, disproportionately burdening local communities and public budgets. This model shifts the burden of negative externalities such as the overload of electricity grids, the intensification of water stress in already vulnerable areas, and the degradation of sensitive ecosystems onto public budgets and local communities.

Rather than reflecting a regulatory gap, it constitutes what critical literature identifies as a new manifestation of colonialism, namely *"data colonialism"*[1]. The extractive logic manifests when corporate sustainability strategies become vectors of conflict. An example is the participation of Amazon in the LEAF Coalition, a carbon credit initiative. The LAPIN (2025) report details how, in 2024, the government of the state of Pará signed an agreement with the coalition for the sale of nearly R$1 billion in carbon credits. The agreement was made without the free, prior, and informed consultation of Indigenous, Quilombola, and other traditional communities whose territories would be directly affected. This rights violation led the Federal Public Prosecutor's Office to file a public civil action to nullify the contract. This case exemplifies how the demand for carbon offsets, driven by the need to "green" the image of operations like data centers, can result in the commodification of territories and the violation of the rights of communities on

[1] Describes an emerging social order rooted in the appropriation of human life through data extraction. This practice extends the extractive logic of historical colonialism to the domain of life itself, where everyday human experiences, social interactions, locations, and communications, are commodified and transformed into data to generate economic value. These new data relations enable technology corporations to monitor, predict, and process life as a new resource to be exploited, establishing a new form of dispossession on a planetary scale (Couldry *et al*, 2019).

the front lines of environmental protection.

Under this model, Latin America risks consolidating its historical role as a provider of primary resources, not only minerals and agricultural commodities but also its data, "green" energy, and hydrological resources, all to sustain the digital economy of the Global North. Data center infrastructure thus materializes this neo-colonial configuration, in which the economic value produced is appropriated by transnational corporations headquartered in the northern hemisphere, while the socio-environmental costs and liabilities are systematically externalized to Latin American territories. Viewing the problem through this lens is paramount to ensuring that the solutions proposed are not limited to technical adjustments but are instead framed as acts that affirm both digital and environmental sovereignty.

To interrogate this hypothesis, the research adopts a qualitative methodology with an interdisciplinary approach, given that the phenomenon under examination is situated at the intersection of technology, law, public administration, economics, and environmental studies, making any single-disciplinary analysis overly reductive in capturing its complexity. The methodological process begins with a systematic literature review that includes academic contributions from fields such as environmental law, regulatory law, development studies, political ecology, and critical geography, as well as technical sources such as engineering reports on data center energy efficiency, studies on electrical grid stability under high demand, and hydrological assessments related to water consumption.

To supplement the initial theoretical framework, the research undertakes in-depth documentary analysis of a diverse corpus, including market reports produced by specialized consulting firms, publications by international organizations such as the International Energy Agency (IEA), and primary governmental documents, including environmental licensing procedures, energy auction notices, and national water management plans in the selected countries. The empirical core of the investigation consists in comparative case studies centered mainly on the Latin American countries of Mexico and Chile, with a particular focus on the legislative process in Brazil, where the research is primarily conducted. The emphasis on these countries is justified by their position as priority targets for data center investments, as well as by the relevance and diversity of their regulatory frameworks and socio-environmental challenges. The comparative analysis concentrates on variables such as legal frameworks for environmental licensing, incentive policies, documented socio-environmental conflicts, and the institutional responses of both the State and civil society to such conflicts. Finally, triangulating data from these three sources enables the construction of a robust governance failure diagnosis, thereby validating the research hypothesis and, crucially, providing the empirical foundation for the

regulatory framework proposed in the final section of this study.

The article is structured into four sequential sections. Section I, titled *The Hidden Face of AI: Critical Analysis of Socio-Environmental and Structural Impacts*, is devoted to a detailed diagnosis that unveils the multidimensional consequences of data center deployment beyond prevailing corporate sustainability narratives. It draws on quantitative data concerning electricity consumption in *terawatt*-hours and water demand measured in cubic meters. According to the International Energy Agency (IEA), the total electricity consumption of data centers is projected to surpass 1,000 TWh by 2026, roughly equivalent to Japan's annual electricity usage (2024). The water footprint is equally staggering, with projections indicating that AI-related water consumption could reach up to 6.6 billion cubic meters by 2027, comparable to the annual water consumption of 4 to 6 countries measured by the size of Denmark (Li, 2023). The carbon emissions from training a single large AI model like GPT-3 can be equivalent to the annual emissions of up to 61 cars (Cowls, 2023), depending on the cloud infrastructure used.

Also, it explores the complexity of the water-energy nexus, complex interplay in which the massive use of water for cooling puts data centers in direct competition with agriculture and human consumption, particularly in regions experiencing water stress, because the cooling system can account for more than 40% of the total electricity consumption of these facilities (Monserrate, 2023).

Proceeding to a deeper level of analysis, section II, titled *Fragmented Governance and Regional Risk: LATAM Cases*, advances the discussion from the "*what*" to the "*why*." It deepens the inquiry through comparative case studies to identify the root causes of governance failures in Mexico, Chile, and most prominently Brazil. This section examines how varying institutional frameworks and political contexts have responded, or failed to respond, to the emerging challenges posed by AI-driven data infrastructure. It analyzes Brazil's paradox, wherein a predominantly clean energy matrix coexists with escalating legislative and socio-environmental conflicts; Mexico's complex energy governance and its structural proximity to the North American market; and Chile's position as a purported clean tech *hub* despite facing an alarming water crisis. The examination illustrates the concrete consequences of absent or fragmented governance, including disjointed environmental licensing procedures and incentive policies that disregard infrastructure costs, ultimately resulting in recurring conflict and compounded vulnerabilities.

The third section, titled *"Regulatory Arbitrage of Data Centers Between the Global North and South: Governance, Sovereignty, and Alternative Responses and Resistances"*, examines the growing divergence between global regulatory frameworks. While the European Union has advanced toward increasingly

stringent legislation that mandates transparency and enforceable environmental performance metrics, many Latin American countries are moving in the opposite direction by relaxing licensing requirements and providing fiscal incentives in pursuit of foreign investment. This disparity fosters regulatory arbitrage, allowing corporations to relocate resource-intensive operations to the Global South. Consequently, they can maintain a facade of sustainability in the Global North while capitalizing on laxer environmental oversight elsewhere. The case of Brazil exemplifies this tension. Despite its clean energy sources and expanding digital infrastructure, the country still lacks a comprehensive regulatory framework that effectively integrates environmental, hydrological, and digital governance. The absence of participation by environmental authorities and the centralization of decision-making within economic ministries reveal institutional fragilities that undermine systemic governance and deepen territorial inequalities.

The fourth and final section, titled *Overcoming the Extractivist Paradigm: Proposal for an Integrated Regulatory Framework Based on the Concept of Systemic Governance*, consolidates the previous diagnostic findings to offer a concrete regulatory contribution. Drawing upon the identified gaps in the Brazilian legislation and case-based frameworks, particularly the prevailing narrow conception of data centers as mere energy consumers, this section proposes a new regulatory model anchored in three foundational pillars: the legal reclassification of data centers as critical infrastructure of public interest; the adoption of an integrated permitting regime that concurrently assesses energy, hydrological, and social impacts; and the establishment of environmental conditionalities that tie fiscal incentives to the fulfillment of verifiable efficiency and socio-environmental responsibility metrics. This proposal seeks to steer the regional expansion of digital infrastructure toward a technological transition that is sustainable, equitable, and sovereign, underpinned by the principles of systemic governance.

THE HIDDEN FACE OF AI: CRITICAL ANALYSIS OF SOCIO-ENVIRONMENTAL AND STRUCTURAL IMPACTS

The immaterial conception of Artificial Intelligence (AI) as an ethereal system, reinforced by the widely held notion that data resides *"in the cloud"*, contributes to the neglect of its underlying physical and material infrastructure. This "*cloud*," in reality, rests upon a dense and globally distributed network of data centers, whose operation depends on intensive energy and water consumption, generating significant environmental impacts (Hasselbalch & Van Wynsberghe, 2024). The surging demand for data processing and complex algorithmic systems is driving a proliferation of large-scale data centers that

require robust infrastructures with high energy and water costs, a dynamic that elicits critical inquiry regarding the actual sustainability of AI.

The scale of the problem is illustrated by recent data compiled by LAPIN (2025). The electricity consumption of global data centers is expected to exceed 1,000 TWh in 2026, equivalent to Japan's total annual electricity usage (IEA, 2024). The training of a single large AI model, like GPT-3, can emit the equivalent of 61 gasoline-powered cars for a year (Cowls, 2023). This impact growth is exponential and visible in the companies' own reports: *Google's* total emissions increased by 73% between 2020 and 2024; Microsoft's by 23.4% in the same period; and *Amazon's* by 33.37% since 2019 according to LAPIN (2025). In Brazil, the case of Scala Data Centers is even more dramatic, with an increase in total emissions of 2,407% since 2020. These figures directly contradict the sustainability narrative and demonstrate a growing and unsustainable impact trajectory.

Furthermore, AI infrastructure also presents environmental challenges related to electronic waste (*e-waste*) disposal and the intensive use of water resources for cooling systems. Yuri Vasconcelos (2025) highlights that the continuous operation of data centers requires not only an uninterrupted electricity supply but also a significant volume of water to cool equipment, imposing a significant environmental burden. Moreover, the concentration of such centers in the Global South[2] exacerbates environmental degradation in the region, which is often used as final destinations for electronic waste, thus perpetuating socio-environmental and technological inequalities.

Notwithstanding the efficiency, innovation, and progress routinely attributed to AI, the technology's underlying material and infrastructural requirements remain largely absent from legal and public debates. Internet infrastructure is not a neutral substrate; it is configured by corporate and governmental interests that shape data geopolitics and dictate the siting of critical network nodes (Burrington, 2014). This reality engenders a paradox. Although AI

[2] The terms *Global North* and *Global South* are widely used to describe the geopolitical and economic divide that continues to shape contemporary international relations. While not strictly geographic, these categories reflect persistent structural inequalities rooted in centuries of colonization, imperial expansion, and economic dependency. The *Global North* typically encompasses industrialized nations with greater access to capital, technological infrastructure, and global political influence. In contrast, the *Global South* refers to regions historically subjected to exploitation and marginalization—nations that continue to face systemic challenges related to development, sovereignty, and equitable participation in global governance. These terms thus serve as analytical tools to understand how historical power dynamics continue to manifest in modern global structures. (BROOKE-HOLLAND, Louisa. *What is the Global South?* House of Commons Library, 2023. Available at: https://commonslibrary.parliament.uk/what-is-the-global-south/. Accessed on: July 20, 2025.)

is celebrated as an agent of disruption and transformation, its territorial expansion frequently entrenches extractive logic, structural asymmetries, and antiquated energy regimes (Koomey, 2008; GPAI, 2021; Iglecias *et al*., 2024). Far from inaugurating an emancipatory technological paradigm, AI reproduces economic arrangements marked by the concentration of decision-making power, escalating demands on natural resources, systematic externalization of socio-environmental costs, and the deepening of colonial relationships, particularly within peripheral jurisdictions (Silveira, 2022).

This extractive logic is not confined to material resources. The operation of AI systems relies heavily on the large-scale and continuous collection of data, much of which is drawn from public content, academic research, and sociocultural practices often produced in Global South countries (Silveira, 2022). Yet, the transformation of this data into commercial value through algorithms, language models, or predictive systems is predominantly controlled by corporations and technological hubs based in the Global North, with no proportional return to the societies that generated the original input (DCD, 2021; Penteado, *etal.*, 2024; Pinto, 2018). The result is a silent dynamic in which rights over knowledge, language, and culture become opaque, unregulated, and increasingly subject to commercial exploitation without redistribution or proper recognition.

This critique is substantiated through three interrelated dimensions examined in this section: (i) the growing and unsustainable consumption of energy and resources by algorithmic systems; (ii) the positioning of Latin America as a supplier of strategic inputs, infrastructure, and territory under asymmetrical conditions; and (iii) the emergence of conflicts in regions already affected by water scarcity and energy disputes. By exposing these contradictions, this section advocates for a critical reassessment of the socio-environmental costs of the so-called *"digital revolution"*. It underscores that any truly transformative technological agenda must necessarily incorporate environmental justice, the democratic governance of digital infrastructure, and the protection of intellectual property, recognizing the knowledge, practices, and contributions of affected communities as an essential part of the digital ecosystem.

The advancement of Artificial Intelligence is not an end in itself; it is grounded in a material infrastructure whose growing appetite for electricity is reshaping energy consumption patterns at both global and regional scales. According to the Latin American Energy Organization (OLADE), the energy demand from AI-dedicated data centers in Latin America and the Caribbean (LAC) is projected to increase from 1.6% of the region's total electricity consumption in 2023 to 5% by 2035 (OLADE, 2025). This percentage translates to over 120 *terawatt*-hours (TWh) of annual consumption, a demand that will directly compete for energy resources with essential sectors such as residential,

industrial, and transportation, as emphasized by OLADE's Executive Secretary (Agência Cenário Energia, 2025).

This projection is underpinned by the exponential growth of the market. The data center sector in Latin America, currently valued at USD 7.16 billion in 2024, is expected to more than double, reaching USD 14.30 billion by 2030, driven by a compound annual growth rate (CAGR) of 12.22% (Wood, 2025). This financial boom, fueled by investments from major technology corporations, serves as the primary driver behind the mounting pressure on the region's energy infrastructure. Table 1[3] illustrates the scale and the rapid pace at which AI-related energy demand is materializing.

Metric	2023	2030	2035
Number of Data Centers	455	~1,206 (165% growth)	>2,400
Electricity Consumption (TWh)	~22.75	~60.3 (+165%)	>120
Regional Electricity Share	1.6%	~4.24% (+265 bps)	5.0% (+340 bps)

Table 1: Projected Energy Demand of AI Data Centers in Latin America and the Caribbean (2023–2035)

The table illustrates that, within a span of just seven years (from 2023 to 2030), the number of AI-dedicated data centers in the region is projected to increase by 165% (OLADE, 2025), rising from 455 to approximately 1,206 facilities. This sharp expansion in infrastructure corresponds to an even steeper surge in energy consumption, which is expected to nearly triple, from 22.75 TWh to 60.3 TWh over the same period. The acceleration becomes even more pronounced in the projection for 2035, when energy consumption is anticipated to more than double again in just five years, surpassing 120 TWh.

The most striking data concerns the evolution of relative consumption: energy demand from AI-focused data centers, which accounted for 1.6% of total electricity consumption in the region in 2023, is projected to reach 5.0% by 2035.

[3] Data compiled by the authors based on OLADE (2025).

This sharp increase demonstrates that the sector is not only expanding in absolute terms but is also growing at a pace far exceeding that of the broader economy, shifting from a niche consumer to one of the primary sources of pressure on the regional power grid. It is the quantification of this fast and disproportionate growth that gives concrete form to the paradox of energy sustainability, a topic explored in greater detail in the following section. This disproportionate rise in energy demand, driven primarily by energy-intensive AI applications, not only challenges the region's power generation capacity but also exposes the often-overlooked social and environmental costs embedded in the expansion of this digital infrastructure.

Latin America is frequently heralded as a favorable jurisdiction for the establishment of *"green data centers",* owing to the predominance of renewable energy sources in its energy matrix such as hydropower in Brazil, wind energy in Uruguay, and solar generation in Chile. However, this prevailing narrative tends to obscure essential technical and regulatory complexities relevant to the continuous and balanced operation of the electric grid. The operational logic of data centers entails a constant, high-density baseload demand, which intermittent sources such as solar and wind energy are structurally incapable of sustaining on their own. In the absence of large-scale energy storage systems, the provision of uninterrupted energy supply to such infrastructure frequently requires the activation of dispatchable energy sources. In most jurisdictions across the Southern Cone, this translates into reliance on thermoelectric plants fueled by natural gas (St. John, 2025).

Thus, the narrative of *"green data centers"* in Latin America may function as a form of geographical *greenwashing*[4]. This is often achieved through accounting practices, such as prioritizing 'market-based' emissions reporting, which relies on the purchase of Renewable Energy Certificates (RECs). As the LAPIN (2025) report details, many of these RECs are criticized for being 'non-additional,' as they do not finance new renewable energy generation but merely credit existing capacity, allowing companies to claim 'zero emissions' without a real-world reduction (Bjørn *et al,* 2022). The discrepancy is stark: *Microsoft's* main sustainability report, using a market-based approach, indicates a reduction in Scope 2 emissions. However, a supplementary document using a 'location-based' method, which reflects the actual energy matrix of the local grid, reveals that the company's Scope 2 emissions in Latin America nearly quadrupled between 2021 and 2024 (LAPIN, 2025).

[4] The term, coined by environmentalist Jay Westerveld in 1986, refers to the practice of organizations making environmental claims that cannot be substantiated. Its objective is to mislead the public into holding overly positive beliefs about the company's sustainability practices, thereby illegitimately gaining a competitive advantage and a favorable public image (SPANIOL et al., 2024).

The relevant metric for assessing sustainability is not the national average composition of the energy matrix, but rather the capacity of the local grid, at the point of consumption, to deliver clean and firm energy continuously, 24 hours a day. Technology corporations are drawn to the Latin American and Caribbean bloc by the promise of renewable energy and often enter into Power Purchase Agreements (PPAs) with renewable energy projects to meet their corporate sustainability targets (Wood, 2025). Yet, data center load is constant, while solar and wind generation is intermittent, and transmission infrastructure bottlenecks remain severe (Batson *et al.*, 2024). These transmission constraints, as detailed by Batson (2024), stem not merely from generation shortfalls but from structural regulatory and logistical deficiencies. The construction of high-capacity transmission lines to service such facilities can take four years or more not due to a lack of equipment, but because of prolonged licensing procedures and easement negotiations. This reality has prompted a fundamental shift in site selection criteria for new projects. The current race is for locations that already possess available capacity and proximity to existing transmission infrastructure. This *'infrastructure cannibalization'* intensifies the underlying paradox: even if a company enters into a PPA with a remote solar facility, the inability to efficiently transmit that energy to the consumption site results in the likely activation of local thermoelectric plants to ensure grid stability (Agência Cenário Energia, 2025). As a consequence, although a company may *"purchase"* green energy contractually, its actual operations may increase local emissions and reinforce fossil fuel dependency (St. John, 2025). These hidden impacts remain uncaptured by standard corporate sustainability metrics and are often overlooked by public authorities involved in energy governance and project licensing.

Despite the complex chain of hydrological and energy-related impacts, the primary rationale advanced by governments and corporations to justify the large-scale installation of data centers is the promise of economic development and job creation. A critical analysis reveals that this narrative, much like that of sustainability, obscures a far more complex reality, in which the purported economic benefits are highly questionable, and the associated social costs are substantial. The quantity and quality of jobs generated remain uncertain, the local economic impact is often constrained by extensive tax incentives, and working conditions, particularly during the construction phase, are frequently characterized by significant occupational risks.

The promise of job creation constitutes a powerful instrument within the public relations arsenal of the data center industry (Johnson, 2019). In Eldorado do Sul, located in southern Brazil, for instance, the *Scala Data Centers* project claims it will generate 3,000 direct and indirect jobs during its initial phase (Sedec, 2024). Industry reports reinforce this perception by citing cumulative impacts in

the millions when accounting for direct, indirect, and induced employment effects (PwC, 2023). Even so, the empirical reality on the ground challenges the simplicity of this narrative. The overwhelming majority of these jobs are temporary in nature, concentrated during the construction phase, which is indeed labor-intensive (Shein, 2025). Once the infrastructure becomes operational, its highly automated design demands a significantly reduced workforce. Industry analysts confirm that it is uncommon for a data center to require more than 100 to 200 permanent staff following its inauguration (Shein, 2025). While these operational roles are often technical and relatively well-compensated (Heartland Energy, 2025), their scarcity stands in stark contrast to the scale of capital investment and environmental impact, thus calling into question the long-term effectiveness of data centers as engines of employment generation.

Additionally, the multiplier economic impact of data centers on local communities is often overstated. Unlike traditional industrial complexes, an operational data center contributes little to the local economy beyond electricity and water consumption (Shein, 2025). This limited integration into local supply chains constrains its capacity to stimulate other sectors of the regional economy.

The primary tangible economic benefit for local administrations lies in tax revenue, particularly from property and equipment sales taxes (CBRE, 2024). Yet, this benefit is frequently eroded by intense competition among states and municipalities to attract such investments. Striving for competitiveness, governments offer aggressive incentive packages, including generous tax exemptions (Valente, 2025). A report by Policy Matters Ohio and additional sources indicate that these incentives can effectively offset any fiscal gains, with at least ten U.S. states losing over $100 million annually in revenue that would otherwise fund essential public services such as schools and infrastructure (Kneese and Strubell, 2025).

This development model raises a fundamental question: are local governments, in effect, subsidizing the infrastructure of the global digital economy while bearing the environmental and social costs? Beyond the impacts, it is necessary to question who do these computational capabilities serve and for what purposes they are mobilized, and how it is possible to align such infrastructures with the real needs of society and the ecological conditions that make them possible (Regattieri, 2025). The data center may function as a fiscal and labor *Trojan horse*. It enters local economies under the promise of prosperity, generates a short-term surge of employment during the construction phase, and leaves behind infrastructure that contributes minimally to sustained job creation and the local tax base, while placing considerable pressure on natural resources and public services. Investment attraction policies risk becoming subsidy mechanisms for the physical infrastructure that supports data colonialism. If the

economic and social legacy of this infrastructure remains questionable, its material legacy, at the end of a short operational life cycle, is undeniably vast and toxic (World Health Organization, 2024). The logic of accelerated obsolescence, inherent to the technology industry, compels a shift in focus beyond operational impacts to the pressing issue of e-waste, which constitutes the most persistent and unsafe environmental footprint of such ventures.

The technology industry operates under the logic of constant innovation and accelerated obsolescence. In pursuit of maximum computational and energy efficiency, data center operators adopt extremely short hardware upgrade cycles, typically ranging from two to five years (Net Zero Insights, 2025). Although often justified in terms of performance, this practice results in the premature disposal of substantial volumes of electronic equipment (Nordic Computer, 2023). The Sustainable Digital Infrastructure Alliance (SDIA) estimates that some hyperscalers discard up to 400,000 servers annually, many of which were never utilized to their full capacity (Nordic Computer, 2023). This pattern contributes to one of the fastest-growing waste streams in the world. In 2022, approximately 62 million metric tons of electronic waste were generated globally, representing an 82 percent increase since 2010 (Eljarrat *et al.*, 2024). Forecasts indicate that this figure will rise up to 82 million tons by 2030 (Baldé *et al.*, 2024). The environmental discourse surrounding data centers almost exclusively focuses on operational energy consumption, typically measured by Power Usage Effectiveness (PUE), dangerously overlooking the embedded costs across the entire hardware lifecycle (Nordic Computer, 2023). Such a narrow focus neglects the broader material footprint of digital infrastructure, particularly its contribution to the generation of electronic waste and the depletion of non-renewable resources, ultimately underestimating the true extent of its socio-environmental costs. From the extraction of raw minerals to their eventual transformation into e-waste, the environmental and social burdens are disproportionately externalized to the Global South.

The production of a single server is an inherently globalized and resource-intensive process. It entails the extraction of rare earth metals and other non-renewable materials activities frequently associated with habitat destruction, water and soil pollution, and associated with socio-environmental conflicts and human rights violations (Santamaria, 2024). The energy consumed and the carbon emissions generated during the manufacturing phase of such hardware are comparable to, and in some cases exceed, the emissions produced throughout the entire operational life of the equipment (Nordic Computer, 2023). Studies indicate that the fabrication of a standard server can emit between 1,200 kg and 1,750 kg of CO_2 equivalent (Nordic Computer, 2023). When these figures are multiplied by the hundreds of thousands of servers deployed in hyperscale data centers, the

resulting "embodied" carbon footprint becomes staggering.

The problem is further exacerbated by the final destination of this waste. In 2022, less than one quarter (22.3%) of global electronic waste was formally collected and recycled (Baldé *et al.*, 2024). A significant share of the remainder is exported, often illegally, from high-income countries to low and middle-income countries across Asia and Africa (Gu, 2024). Although international agreements such as the Basel Convention seek to regulate the transboundary movement of hazardous waste, it is estimated that millions of tons of e-waste continue to be shipped annually to the Global South (Gu, 2024). In these receiving countries, the absence of safe recycling infrastructure and widespread economic vulnerability lead to informal and highly hazardous recycling practices. Open-air cable burning to extract copper, acid baths used to separate valuable metals, and the manual dismantling of electronic components release toxic substances such as lead, mercury, cadmium and dioxins into the air, soil and water (World Health Organization, 2024). These practices have devastating public health consequences, including neurological disorders, respiratory diseases and cancer, with children and pregnant women being particularly vulnerable (World Health Organization, 2024). This pattern reveals a profoundly disturbing dimension of digital colonialism, namely a form of *waste colonialism*. The relentless pursuit of computational performance and energy efficiency in the Global North is structurally sustained by the externalization of environmental and health costs to the Global South. The clean and immaterial cloud experienced through our screens is, in fact, underpinned by massive volumes of obsolete hardware that contaminate distant communities. A comprehensive and honest assessment of data center sustainability must therefore go beyond the Power Usage Effectiveness (PUE) metric and incorporate the entire life cycle of the hardware involved.

The environmental footprint of data centers extends beyond electricity consumption and is acutely manifested in water usage. The intensive reliance on freshwater resources for server cooling has become a central driver of socio-environmental conflict, particularly in regions increasingly affected by droughts and water stress. Mitigation efforts, however, expose the industry's core engineering dilemma: a fundamental technical trade-off between Power Usage Effectiveness (PUE) and Water Usage Effectiveness (WUE).

PUE (Power Usage Effectiveness) measures the energy efficiency of a data center (where a value closer to 1.0 indicates higher efficiency) while WUE (Water Usage Effectiveness) evaluates water efficiency (Henshaw, 2025; Higgins, 2024). The relationship between these metrics is often inverse, depending on the cooling technology adopted (Henshaw, 2025). This reveals a critical flaw in environmental regulation when it relies on a single indicator. In the absence of

robust and harmonized regulatory frameworks that account for this complexity, perverse incentives may arise. A policy mandating a WUE of zero to protect local water resources may paradoxically intensify water stress indirectly by encouraging energy-intensive cooling alternatives.

By mandating the adoption of air-based cooling systems, regulation increases electricity demand, resulting in a higher PUE (Higgins, 2024). This additional energy consumption must be met by electricity generation, which, whether hydropower or thermoelectric, also requires significant volumes of water. This "embedded water" in the power generation process is not captured by the standard WUE metric, which only accounts for water consumed on-site at the data center (Higgins, 2024). A regulator, under pressure from public opposition regarding water usage, may impose a zero WUE target. In response, the data center operator complies by adopting air cooling, which is significantly more energy intensive. The resulting increase in electricity demand places additional stress on the local grid. If the grid relies on thermoelectric power plants to meet this extra load, the water required for energy generation increases at the source. Thus, the water problem is not solved but merely displaced from the data center to the power plant, rendering it less visible, more diffuse, and harder to regulate.

FRAGMENTED GOVERNANCE AND REGIONAL RISK: LATAM CASES

The insatiable demand of data centers for essential resources places them on a direct collision course with the needs of local communities, fragile ecosystems, and pre-existing territorial rights. The cases studied reveal a global pattern of extraction and conflict. The absence of regulation capable of grasping this systemic dynamic leads to paradoxical outcomes and directly fuels territorial disputes. The concrete cases selected for this study demonstrate how the rapid expansion of this infrastructure has generated socio-environmental tensions across Latin America.

The conflict surrounding *Google's* $200 million data center in Cerrillos, Santiago is emblematic. The region has been experiencing a fifteen-year-long megadrought, making water management a matter of survival (Igini 2022). The project initially proposed the withdrawal of 169 liters per second from the vulnerable Santiago Central aquifer, a volume that raised serious concerns among local communities and authorities (BNamericas, 2024). Following a lawsuit filed by the municipality and local residents, Google revised the project to adopt air-based cooling, claiming this change would eliminate the use of groundwater (BNamericas,2024). Despite this, the Santiago Environmental Tribunal ruled that even with the shift to air cooling, the original environmental assessment conducted by the Environmental Evaluation Service (SEA) was inadequate. The

court partially annulled the environmental license and ordered a comprehensive reassessment. It specifically mandated that the assessment incorporates the impacts of climate change on the vulnerability of the aquifer (BNamericas,2024).

The decision by the Environmental Tribunal establishes a significant legal precedent that directly addresses the "PUE *versus* WUE" dilemma. It affirms that a regulator's responsibility is not limited to assessing the direct impacts of a project, such as on-site water consumption, but also includes consideration of its indirect and systemic effects, including the strain placed on the energy grid, all within the broader context of climate change. Although *Google* revised its project to implement air-based cooling and thereby eliminate groundwater usage, the Chilean court deemed this measure insufficient. The ruling was grounded in the inadequacy of the original environmental assessment and the application of the precautionary principle, which precludes the approval of projects based solely on retroactive mitigation measures (Lira, 2024). The court's reasoning underscores that one cannot resolve an environmental issue merely by transferring pressure from one resource, such as water, to another, such as electricity. It reinforces the argument that sustainability must be understood and regulated through a systemic approach.

This problem is further compounded by the Mexican impasse. In the semi-arid state of Querétaro, an area facing a high risk of desertification, the construction of a major data center hub by *Amazon*, *Google*, and *Microsoft* has sparked significant protests. Local communities interpret the conflict through the lens of extractivism (Branford *et al.*, 2024), perceiving that their vital resources, particularly water and energy, are being extracted to serve a global industry that offers minimal local benefits, such as few permanent jobs. This perception is exacerbated by a long-standing history of unfulfilled governmental promises regarding water infrastructure (Alvarez, 2024). While the National Water Commission (Conagua) asserts that no new concessions have been granted, it admits that existing concessions can be transferred privately. This is how Microsoft acquired its water rights, a fact uncovered by activists uncovered only through journalistic investigation, thereby making democratic deliberation and accountability virtually impossible (Alvarez, 2024). This case exemplifies the problem of displaced environmental footprints.

Amazon pledged to use air-based cooling, presenting it as a solution to conserve water (Ammachchi, 2024). Critics and experts argue that this increases electricity demand in a country where 77% of electricity is generated from fossil fuels, which themselves are major water consumers, thereby merely shifting the data center's water footprint to the power plant (Alvarez, 2024). The Querétaro case illustrates how regulatory vacuums facilitate socio-environmental conflict and corporate opacity. The absence of a mandatory, transparent, and public

regulatory process for water allocation creates an environment in which corporate power and capital can circumvent community consent. The existence of a "shadow market" for public trust resources constitutes not merely a failure of transparency, but a systemic feature of the regulatory landscape that privileges powerful actors (Alvarez, 2024).

Similarly, across the Atlantic, the expansion of data centers in Spain directly collides with the country's increasing vulnerability to drought. In Talavera de la Reina, *Meta's* planned €1.1 billion data center is expected to consume 665.4 million liters of potable water annually from the Tagus River basin (Arandia, 2024). The regional government of Castilla-La Mancha declared it a *"Project of Singular Interest",* expediting its approval despite warnings from the Tagus River Basin Authority regarding the pressure on local water supply (Arandia, 2024). In Aragón, Amazon's expansion places the tech giant in direct competition with local farmers. The company holds a license to extract over 755,000 cubic meters of water annually and has requested an increase of nearly 50% for its existing facilities in a key agricultural region already facing rising temperatures and drought. Activist groups such as *"Tu Nube Seca Mi Río"* (Your Cloud Dries My River) have called for a moratorium, highlighting the imbalance of power between *big techs* and depopulated rural areas (Camillo, 2025). The situation is further aggravated by the fact that, unlike other sectors, data centers in Spain are not specifically regulated as such, creating a "regulatory grey area" that companies are able to explore (Anarte *et al.*, 2025).

The cases observed in Spain expose a structural vulnerability in development policy: the classifications such as "fast-track" or "project of special interest" are used to bypass standard environmental management protocols and natural resource governance. These procedural instruments often marginalize warnings issued by water authorities and other institutional stakeholders already operating in the affected territories. The political justification is frequently framed around promises of job creation and investment attraction (Navas, 2025), although activists have pointed out that many of these positions may be remote and that the number of local hires is negligible when compared to the environmental impacts incurred (Mendoza, 2024). This pattern reveals how political will, seduced by the rhetoric of progress and the prestige of technological capital, tends to subvert existing environmental regulatory frameworks, thereby enabling regulatory exceptions and deliberate deregulatory practices.

In the United States, a fragmented regulatory landscape likewise creates fertile ground for conflict. The case of *Google* in The Dalles, Oregon, is concerning. The company classified its water consumption as a "trade secret" prompting the city to file a lawsuit against a local newspaper in an attempt to prevent disclosure. After a year-long legal battle, it was revealed that *Google's*

water usage had tripled and accounted for one-quarter of the city's total water consumption (Iruoma, 2023).

In the state of Arizona (USA), a moratorium on new residential developments that rely on groundwater does not apply to industrial projects such as data centers (Walton, 2025). This creates a clear regulatory asymmetry that privileges industrial water consumers over residential needs. Although the water consumption of a single data center may seem modest compared to agricultural usage, the cumulative impact is substantial. In Maricopa County, Arizona, it is estimated that the water used by more than 60 data centers is equivalent to the annual consumption of 1.47 million people, or 89% of the population of the capital city, Phoenix (Sherlock, 2025). This underscores the danger of evaluating such projects in isolation rather than through a cumulative lens. Amazon's water return scheme in Oregon— which the company supplies flushing water to farmers—is promoted as a community benefit. This initiative, however, critics such as WaterWatch of Oregon dismiss as a 'feel-good corporate tactic' that does not mitigate the initial environmental harm triggered by water extraction from the ecosystem (Associated Press, 2021).

These cases expose an arrangement operating beyond geographical boundaries and local particularities. Data centers operate similarly to historical extractive enclaves such as mines or plantations as Regattieri (2025) points out, the systemic problem is that decisions about land use, the direction of energy flows, and water management are no longer determined in public deliberation forums but are instead governed by global standards and contracts. In this scenario, the infrastructure itself operates as an agent of land reconfiguration and centralization of power over 'assets' vital to national sovereignty (Regattieri, 2025). The data center thus becomes a material expression of data colonialism, establishing sacrifice zones where the environmental and social burdens of the global digital economy are disproportionately imposed on vulnerable communities". They are established in specific territories, consume large volumes of essential local resources, and function under conditions of opacity, often facilitated by local governments that issue permits and offer tax incentives (Alvarez, 2024). The value they generate, represented by the data processed, is exported to serve global markets and interests, while the resulting negative externalities remain in the host communities, which often receive limited economic benefits in return. Community resistance, whether led by the *Mbyá-Guarani* defending their ancestral lands, farmers in Aragón protecting local water resources, or activists in Querétaro demanding transparency, cannot be dismissed as a simple *"Not In My Backyard"* reaction. Rather, it constitutes a broader struggle for resource sovereignty and the protection of livelihoods that are increasingly threatened by this emergent digital extractive frontier. The data

center becomes a material expression of data colonialism, establishing sacrifice zones where the environmental and social burdens of the global digital economy are disproportionately imposed on vulnerable communitie**s.** Such a development model, which globalizes resource consumption without fundamentally new technology, is inherently flawed. It echoes the principle that '*spreading old ways to create wealth around the world will result in devastation, not wealth*,' proving ultimately unsustainable in a world of scarce resources (Thiel and Masters, 2014).

The data center infrastructure transfers pressures between resources without accounting for the cumulative and interdependent effects of these systems. The cases examined illustrate how a fragmented regulatory landscape, combined with a legal system that may be instrumentalized to shield big tech interests, creates an optimal operational environment for resource-intensive industries to maximize extraction while minimizing public accountability. This fragmented system enables a form of regulatory arbitrage, allowing corporations to site their facilities in jurisdictions where oversight is weaker or where legal mechanisms can be leveraged in their favor. Such dynamics incentivize a "race to the bottom" among municipalities eager for tax revenues (Iruoma, 2023), culminating in permissive regulatory conditions or a lack of critical scrutiny. The consequence is a systemic failure to manage resources at watershed or regional levels. In the absence of robust, participatory, and integrated public regulation, the expansion of the algorithmic economy will continue to exacerbate inequalities, undermine environmental governance, and compromise fundamental rights such as access to water and access to information.

REGULATORY ARBITRAGE OF DATA CENTERS BETWEEN THE GLOBAL NORTH AND SOUTH: GOVERNANCE, SOVEREIGNTY AND ALTERNATIVE RESPONSES AND RESISTANCES

As the impacts of data centers become increasingly evident, markedly divergent regulatory approaches are emerging across different regions of the world. The European Union (EU) is developing a stringent legislative framework centered on transparency and accountability, whereas many Latin American nations, in their pursuit of attracting foreign investment, appear to be moving in the opposite direction by favoring deregulation.

The EU has positioned itself at the forefront of digital sustainability regulation through two key legislative instruments. The revised Energy Efficiency Directive (Directive (EU) 2023/1791) establishes, for the first time, mandatory data disclosure obligations for all data centers within the EU with an installed IT power demand of at least 500 kW (EUDCA, 2024). As of 15 September 2024,

operators will be required to report a series of Key Performance Indicators (KPIs) annually to a centralized and publicly accessible EU database (EUDCA, 2024). The metrics to be disclosed are comprehensive and include total energy consumption, water usage, the amount of residual heat reused, and the share of renewable energy consumed. Based on this information, sustainability indicators such as Power Usage Effectiveness (PUE), Water Usage Effectiveness (WUE), Energy Reuse Factor (ERF), and Renewable Energy Factor (REF) will be calculated and made public, introducing a significant degree of transparency into the sector.

Beyond the EED, the Corporate Sustainability Reporting Directive (CSRD) represents a paradigm shift in the way companies report their impacts. Replacing the previous Non-Financial Reporting Directive (NFRD), the CSRD significantly expands its scope to approximately 50,000 companies, including large enterprises, listed SMEs, and subsidiaries of non-EU companies with substantial operations within the European market (Talcott, 2024). The directive mandates comprehensive reporting on environmental, social, and governance (ESG) issues, in accordance with the stringent European Sustainability Reporting Standards (ESRS) (Informatica, 2024). Two of its most transformative features are the introduction of the "double materiality" principle, which obliges companies to report not only how sustainability issues affect their business but also how their operations impact society and the environment, and the requirement for independent third-party assurance (Talcott, 2024). Crucially for the globalized economy, the CSRD extends its scope to the entire value chain, requiring companies to disclose their emissions across upstream and downstream activities. This, in turn, compels suppliers worldwide, including in Latin America, to provide data on their own environmental and social impacts (Talcott, 2024).

Conversely, the prevailing trend in several Latin American nations is to expedite data center deployment through deregulation and the provision of investment incentives. In Chile, for instance, the government amended regulatory frameworks to exempt new data centers from undergoing environmental impact assessments, requiring only sectoral permits under what has been described as a *plug-and-play* policy (Peña, 2025). This measure has been criticized by environmental organizations as a means of weakening environmental oversight in favor of attracting foreign capital (Peña, 2025).

In Brazil, the federal government is currently developing a National Data Center Policy, which includes proposals for substantial tax exemptions on the importation of AI-related hardware, as well as the incorporation of data center services into Export Processing Zones (ZPEs), which benefit from favorable tax regimes (Valente, 2025). While these policies are typically justified on the grounds of economic development and the strategic positioning of the region as a

competitive digital *hub*, they are often formulated with limited engagement from other societal sectors, such as local communities and environmental organizations (Peña, 2025).

This regulatory divergence between the Global North and South is not merely coincidental. It reflects a broader dynamic of regulatory arbitrage. Multinational technology corporations, confronted with increasing compliance costs and tighter scrutiny in Europe, may be incentivized to relocate their most resource-intensive and least sustainable operations to jurisdictions with more lenient regulations and generous tax incentives. In this way, companies are able to present a "*green"* and responsible image in Europe by complying with CSRD requirements while continuing to operate extractivist business models in regions such as Latin America. This results in a bifurcated global system: sustainability becomes a regulatory imperative in the Global North, while the externalization of environmental and social costs remains the prevailing practice in the South, thereby perpetuating colonial dynamics under the guise of development policy and foreign investment promotion.

Brazil: Between Technological Leadership and Institutional Fragility

Brazil, as the largest country and economy in Latin America, is consolidating its position as a strategic actor in the digital era (Carvalho *et al.*, 2025), combining predominantly renewable energy sources with an expanding technological infrastructure (International Trade Administration, 2024). With approximately 44.8% of its energy composed of clean sources (Bamisile *et al.*, 2024), the country is attracting growing interest from technology companies for the installation of data centers and artificial intelligence (AI) support systems. The country has established itself as an attractive hub for investments in digital infrastructure, particularly in the data center sector, as noted by Luciana Novaes Magalhaes (2025).

The movement is driven by multiple factors, such as the accelerated growth in global demand for AI, restrictions on expansion in already saturated markets like the United States and Europe, and Brazil's relatively favorable macroeconomic and institutional conditions, including political stability, renewable energy availability, and a continuous increase in domestic digital consumption. Large national and international companies have been expanding their presence in Brazilian territory. These investments consolidate Brazil as a competitive emerging market in the global digital economy, with the concrete capacity to act as a regional hub for connectivity and data processing in Latin America.

This energy leadership, especially when compared to countries with fossil-

fuel-based mixes, such as the United States, which during the second Trump administration considered the intensive use of coal to meet AI's energy demand (Dlouhy, 2025), positions Brazil as a key player in the geopolitics of the digital transition. The data center and cloud computing sector in Brazil is experiencing accelerated growth, consolidating its position as the main market in Latin America. According to the IBA (2025), estimated investments in the country's digital infrastructure are set to reach R$258.1 billion between 2024 and 2027, with a projected compound annual growth rate (CAGR) of around 11% until 2029. This momentum stems from four main drivers: (i) a legal framework that classifies such services under a free enterprise regime, reducing the regulatory burden; (ii) robust domestic demand, stimulated by the advancement of Industry 4.0, artificial intelligence (AI), the internet of things (IoT), augmented reality (AR), and virtual reality (VR), in a country with over 186 million internet users; (iii) natural advantages such as a clean energy sources, water abundance, competitive land costs, and a local equipment supply chain; and (iv) public policies designed to stimulate the sector, including funds, credit lines (such as those from BNDES), incentivized debentures, and the recent Brazilian AI Plan (Noberto, 2025).

However, the social and environmental impacts of this new technological configuration often fall upon peripheral territories and vulnerable populations, without due public debate or regulatory control (Sass *et al.*, 2025). Brazil cannot be seen merely as a territory of energy and logistical viability, but as a space where the balance between innovation, socio-environmental justice, and digital sovereignty is contested. The perspective of strong sustainability, which recognizes the existence of non-negotiable ecological limits and values socio-territorial diversity (Sass, 2016; Bosselmann, 2015), must guide any technological advancement in Brazilian territory, so that it does not reproduce extractivism and deepen historical inequalities.

The absence of specific regulations for large-scale digital ventures, such as data centers, connectivity networks, and high-impact algorithmic systems, reveals regulatory gaps that endanger fundamental collective rights. It is urgent for the Brazilian legal system to advance in the formulation of a regulatory framework compatible with the complexity of the digital transformation. Laws such as the Escazú Agreement, the National Environmental Policy (Law No. 6.938/1981), the LGPD (Law No. 13.709/2018), and the constitutional principles of the socio-environmental function of property and the dignity of the human person offer relevant foundations, yet they remain insufficiently articulated with contemporary digital dynamics.

The digital future cannot be built at the expense of eroding socio-environmental rights or normalizing asymmetries between the Global North and

South. Brazil's leadership in the field of AI-associated digital infrastructure must be accompanied by legal responsibility, effective social participation, and a commitment to a truly sustainable development model. This includes the effective involvement of bodies such as the Ministry of the Environment in regulatory processes, especially in projects with high hydrological and territorial impact, as evidenced in the recent cases of Caucaia (located in the Northeast) and Eldorado do Sul (located in the South of Brazil). It also demands legislative clarity, avoiding distortions such as those present in Bill No. 2338/2023, which confuses data center operators with data managers (Maranhão *et al.*, 2025), thereby compromising environmental governance and the protection of fundamental rights, particularly in peripheral contexts.

Even so, this enormous growth potential directly contrasts with a profound institutional fragility. The formulation of a national policy for the sector has been marked by the absence of crucial actors, revealing a fragmentation that compromises sustainability from its inception. A clear example is the lack of participation from the Ministry of the Environment and water agencies (Martins, 2025), revealing an institutional fragmentation incompatible with the challenges posed by the expansion of this infrastructure. According to the Ministry itself, the assessment of data center installations is the responsibility of the National Water Resources Council (linked to the MIDR) and the National Water Agency (ANA). The MIDR admitted that the Council was not invited to participate in policy discussions, nor was it called upon for assessments or to issue hydrological availability grants. The ANA likewise confirmed that it was not involved in the decisions and did not receive requests for water usage rights from ventures in the sector (Martins, 2025). This institutional void highlights a model that neglects the need for coordination and systemic governance, thereby compromising the creation of a solid, transparent regulatory environment capable of ensuring regulatory certainty and environmental sustainability. This is not merely an administrative failure but a dynamic that enables new forms of extractivism under the guise of sustainability. A stark example is the controversy surrounding the LEAF Coalition (Ministério Público Federal, 2025), a carbon credit initiative in which Amazon is a key participant. In 2024, an agreement for the sale of carbon credits was signed with the state of Pará without the legally required free, prior, and informed consultation with the Indigenous and traditional communities whose territories are directly affected. The agreement was subsequently challenged by the Federal Public Prosecutor's Office, which filed a public civil action to nullify the contract, arguing it violated the rights of these communities (Ministério Público Federal, 2025). This case perfectly illustrates how corporate carbon offset strategies, intended to green the image of data center operations, can directly perpetuate land-based conflicts and undermine local sovereignty

Far from being a mere administrative oversight, the absence of inter-ministerial coordination constitutes an affront to the foundational principles of Brazilian environmental law. The National Environmental Policy (Law No. 6.938/1981) establishes environmental licensing as a mandatory preventive instrument for potentially polluting activities, predicated on the coordinated action of agencies within SISNAMA (National Environmental System). By excluding environmental and water agencies from formulating policy for such a high-impact sector, the Brazilian State violates the principles of prevention and precaution, effectively treating digital infrastructure as if it operated in an ecological vacuum—disconnected from the territory and its resources.

Such institutional weakness stands in sharp contrast to the leading role Brazil has been assuming in the global digital and energy arena. The country has consolidated itself as a strategic actor, combining a predominantly renewable energy matrix with an expanding technological infrastructure (International Trade Administration, 2024). While Brazil presents distinct energy and logistical advantages over countries dependent on fossil-fuel, it simultaneously suffers from a lack of effective regulatory mechanisms to ensure environmental control and the protection of collective rights.

The current institutional arrangement not only diminishes the oversight power of federal entities but also compromises the regulatory certainty necessary for responsible investors seeking regulatory clarity and predictability. Furthermore, the lack of coordination between the environmental, energy, and technological spheres impedes the establishment of integrated guidelines for expanding digital infrastructure on sustainable foundations. Such disjointed governance is exacerbated as social and environmental impacts increasingly fall upon peripheral territories, mirroring patterns observed in other jurisdictions.

The scale of the problem is alarming: a medium-sized data center (15 MW) can consume a volume of water equivalent to three hospitals (Spindler *et al.*, 2024). These data should serve as a warning to Brazil, whose absence of a specific regulatory framework and effective environmental oversight mechanisms can result not only in socio-environmental injustices but also in legal uncertainty and long-term reputational risks for investors.

The urgency of such a warning is amplified by the recent trend of siting data centers in Brazilian regions already characterized by severe hydrological and socioeconomic vulnerabilities. As highlighted by The Intercept Brasil (2025), at least three major projects, located in Caucaia (CE), Campo Redondo (RN), and Igaporã (BA), secured approval in municipalities that have operated under drought emergency decrees for more than half of the last 21 years. In Caucaia, for instance, the Casa dos Ventos project serving the TikTok platform purports to rely exclusively on deep wells, claiming 'near-zero' consumption of treated water. Yet,

this assertion lacks auditable technical substantiation and has not been subject to transparent dialogue with potentially affected populations. Such regulatory opacity and the accompanying lack of social oversight are not isolated incidents but rather indicative of a systemic gap repeated across the region.

In Ceará, the accelerated advance of data centers mobilizes both the private sector and public authorities, forming a movement to consolidate the state as a technological *hub*. Bill 545/2025 is currently pending in the Legislative Assembly, which requires the publication of annual reports on energy and water consumption, greenhouse gas emissions, and socio-environmental mitigation plans, an important step toward transparency and public control (Diário do Nordeste, 2025). In parallel, the National Grid Operator (ONS) has authorized the connection of two large data centers to the *Pecém Complex*, with operations planned to begin in 2027 through the Pecém II and III substations (CNN Brasil, 2025). These movements highlight both the state's ambition in leveraging its favorable climate and renewable energy sources, and the need for this growth to be supported by a robust regulatory framework.

Despite the prospect of up to R$50 billion in investments, a critical regulatory gap persists: the absence of technical requirements such as PUE (Power Usage Effectiveness) and WUE (Water Usage Effectiveness) indicators, as well as the lack of independent auditing and community participation mechanisms (Diário do Nordeste, 2025). The legislative proposal represents an initial step forward, but its effectiveness will depend on oversight capacity and political commitment to implementing clear and verifiable standards. Without this, data centers risk operating as technological islands, highly intensive in natural resources and disconnected from the local economy and the well-being of neighboring communities.

While the legislative debate in Brasília reveals a lack of preparation, the impacts of a deregulated expansion are materializing severely in the territories. No case is more emblematic and alarming than that of Eldorado do Sul (RS), where the construction of the Scala AI City complex is planned. Representing a multi-billion-dollar investment, the project has the potential to reach 4.75 GW of energy demand, a value exceeding the combined capacity of major national hydroelectric plants like Jirau and Santo Antônio. With legislative support through Municipal Law No. 5,949/2024, which created a "*Data Center Technology Hub*" (LAPIN, 2025) with simplified licensing for the Scala AI City project, streamlining procedures and eliminating specific environmental assessment requirements (LAPIN, 2025). The initial phase of the project already represents 7% of the installed data center capacity in Brazil, pressuring the local power grid and intensifying environmental impacts in a region marked by extreme events, such as the 2024 flood that submerged over 80% of the municipality

(Folha de S. Paulo, 2024), that affected 25 hydroelectric plants, interrupting the power supply and requiring the activation of thermoelectric plants and emergency energy purchases (Brasil, 2024). Amid environmental vulnerabilities, the viability of a megaproject of this size requires increased attention (LAPIN, 2025).

Beyond the energy and water impacts, this expansion model raises concerns about intellectual property and digital sovereignty, as such structures concentrate the massive storage and processing of data, including public, scientific, and behavioral data, without any guarantee that the benefits derived from the use of this information will return to society. Furthermore, the project's approval occurred without public consultation and relaxed urban and environmental rules, thereby ignoring the Mbyá-Guarani Indigenous communities and displaced residents (Martins, 2025).

Framed as an emblem of 'progress,' the project stands at the epicenter of a serious conflict with the Mbyá-Guarani Indigenous community of Tekoa Pekuruty (Sperafico, 2024). The community, which has resided in the area for over 15 years, saw its already precarious situation drastically worsen in 2024. After being displaced by devastating floods, its members witnessed the destruction of their village by tractors from the National Department of Transport Infrastructure (DNIT), which acted without prior notice to build an emergency road access (Martins, 2025).

This act of destruction occurred while the community had been waiting for years for the fulfillment of a resettlement agreement, compensation owed for the duplication of the BR 290 highway (Sperafico, 2024). This right, systematically ignored, was only recognized by the Federal Court in January 2025, which ordered DNIT to purchase land and build housing and schools for the community (Martins, 2025). Crucially, the Mbyá-Guarani community was never consulted about the data center project that now threatens its territory, in a clear violation of Convention 169 of the International Labour Organization (ILO), to which Brazil is a signatory (Martins, 2025). While real estate speculation and the approval of municipal laws favorable to the data center advance at an accelerated pace, the community's ancestral rights are marginalized (Martins, 2025).

Companies like Elea Data Centers, in promoting their "*Rio AI City*" project, promise "zero water consumption" cooling technologies, but, as the LAPIN (2025) report points out, they provide no technical methodology to substantiate this claim, nor do they disclose environmental monitoring plans or governance mechanisms for the project. Scala, in turn, claims to have the lowest PUE in Latin America but provides no data to support this assertion and creates barriers to information access by requiring personal data to download its sustainability report. Ascenty, another major operator in Brazil, presents its data in such a fragmented and methodologically confusing manner that it is impossible

to conduct a historical analysis of its water or energy impacts (LAPIN, 2025).

These cases offer a unique opportunity to think about the regulation of data centers in Brazil holistically. It is not a matter of attracting investments or modernizing infrastructure, but of building a policy that integrates rigorous environmental assessment, territorial justice, social participation, and digital protection: Themes that are intertwined with the discussion on technological sovereignty and intellectual property. The experience of Eldorado do Sul, where technical standards, public control, and any form of democratic consultation were lacking, serves as a warning. In Ceará, there is still room to avoid similar mistakes, but this will require social vigilance and political will to transform legislative promises into effective practices.

In the absence of specific regulation, Brazil runs the risk of becoming merely a support territory for the computational infrastructure of large corporations, which appropriate local knowledge and collective data without fair redistribution or transparency. The lack of regulations that impose technical, environmental, and digital governance limits reveals the urgency of building a public policy that integrates sustainability, territorial justice, and also the defense of collective intellectual property and knowledge as a common good, combating the digital extractivism that advances silently through these infrastructures.

Given the scale and complexity of data center expansion in Brazil, the formulation of a national regulatory framework that integrates, in a coordinated manner, the environmental, energy, territorial, and digital dimensions become imperative. The absence of bodies like the ANA and the National Water Resources Council in policy-making spaces is not just an isolated failure but reveals an institutional fragmentation that compromises the construction of a systemic, transparent, and technically qualified governance.

The gravity of such regulatory absence is compounded by the growing centrality of data as a strategic resource. Data centers concentrate the infrastructure enabling the storage, processing, and monetization of public, scientific, cultural, and behavioral data—assets often derived from collective practices and state information systems. In the absence of guarantees regarding traceability, social control, or fair redistribution of the value generated, the nation risks deepening a model of digital extractivism, wherein national intangible assets are appropriated by large technology platforms without a proportional return to society. Simultaneously, the prevailing regulatory ambiguity discourages responsible investors seeking environments characterized by institutional predictability, regulatory certainty, and clear socio-environmental obligations. Consequently, to ensure that the ongoing technological transformation neither aggravates historical inequalities nor produces new cycles of exploitation in vulnerable territories, Brazil must urgently construct a public policy for data

centers that is technically robust, legally coherent, and politically committed to territorial justice, informational sovereignty, and the protection of knowledge as a common good.

OVERCOMING THE EXTRACTIVIST PARADIGM: PROPOSAL FOR AN INTEGRATED REGULATORY FRAMEWORK BASED ON THE CONCEPT OF SYSTEMIC GOVERNANCE

The intersection of the exponential expansion of the digital economy and the growing scarcity of water and energy resources, exacerbated by climate change, constitutes one of the most critical and dangerously mismanaged challenges in contemporary Latin America. The prevailing development paradigm, oriented toward the unrestricted attraction of investments, *proves to be not only insufficient but also an active catalyst* for socio-environmental conflicts and a systematic displacement of harm onto the most vulnerable communities and ecosystems (Garcia, 2025).

Instances of conflict analyzed in Chile (Martins, 2025), Mexico, and even in Global North jurisdictions like the United States and Spain, should not be interpreted as isolated anomalies, as they represent the predictable result of a systemic model that allows the privatization of profits from the digital economy while socializing its infrastructure costs and environmental liabilities (Penn, 2025). The solution to this impasse cannot be found in voluntary corporate commitments or in regulatory frameworks focused on isolated metrics, which often generate adverse trade-offs, such as substituting water efficiency for greater energy expenditure (Commins, 2025). What is required is a fundamental reorientation toward a new regulatory paradigm that is integrated, geographically informed, transparent, and socially just.

An essential starting point for effective governance is a legal and political redefinition of the status of data centers. Due to their systemic importance for the functioning of the digital economy and their massive consumption of scarce public resources, data centers must be legally classified as critical infrastructure of public interest (Eidissen *et al.*, 2025). This reclassification is not merely semantic; it provides the legal foundation that justifies a more intense state regulatory intervention, overcoming the logic that they are merely private enterprises operating in a free market (Zhang, 2025).

The development model currently prevailing in the Latin American region, focused on the unrestricted attraction of investments through fiscal incentives and lax regulation, has proven to be flawed. It allows companies to internalize the profits of digital operations while externalizing and socializing the stress on the power grid, which requires multi-billion-dollar investments for reinforcement; the

depletion of aquifers in drought-prone areas; and the potential dependence on fossil fuels to ensure system stability. Therefore, the State must pivot from its passive role as an investment facilitator to become an active strategic orchestrator. This implies conditioning the authorization and operation of these ventures to their alignment with national goals of sustainable development, water, grid stability, and climate resilience.

This study advocates for the construction of an integrated regulatory framework for data center infrastructure, drawing upon the Brazilian scenario, grounded in a critical analysis of the ongoing legal and legislative developments in the country. It finds support in the constitutional principle of the supremacy of the public interest over the private one and in the socio-environmental function of property (Article 5, XXIII, and Art. 170, III, of the Brazilian Federal Constitution), justifying that the State should impose strict conditions to ensure that the use of natural resources serves the collective well-being.

Brazil finds itself at a simultaneously crucial and paradoxical moment. Although the legislative debate on the matter has begun, the initial initiatives demonstrate a notable technical and conceptual fragility, revealing a governance vacuum that urgently needs to be filled by robust and technically grounded legislative proposals, under the risk of consolidating a neocolonial and extractivist development model beneath a facade of technological modernity.

It is in this scenario of institutional disarticulation that a fragmented and technically deficient legislative debate intensifies, materializing in what can be called the sector's "regulatory labyrinth" or "complex regulatory landscape". The proposals currently before the National Congress reflect this absence of a systemic vision. Bill No. 2.238/2023, currently pending in the Chamber of Deputies, seeks to establish a regulatory framework for the use of artificial intelligence in Brazil.

At the same time, when the debate shifts to the physical infrastructure that underpins Artificial Intelligence, the initial forays reveal a profound technical unpreparedness. While the Bill No. 3.018/2024 (Senado Federal, 2024), is meritorious for initiating the debate, it constitutes an example of regulatory deficiency. The legislative text lacks precise technical criteria, refrains from establishing quantifiable efficiency goals, and, critically, fails to integrate the operational licensing of data centers with impact-based environmental licensing, an indispensable requirement for any systemic and cumulative analysis of their effects on the territory (Maranhão *et al.*, 2025).

More critically, the Bill is predicated on a flawed conceptual premise that compromises its entire legal structure: the confusion between the figure of the data center operator (responsible for the physical infrastructure, or hardware) and that of the data manager (responsible for the logical programming layer, or software), as pointed out by Maranhão *et al.* (2025).By imposing responsibilities

intrinsic to AI system developers onto physical infrastructure operators, such as conducting audits on the purpose of data use, ensuring portability, or appointing a Data Protection Officer (DPO), the Bill becomes legally incoherent and technically immature. Such obligations are already duly allocated under the General Data Protection Law (LGPD) to the figure of the data controller. This conceptual imprecision results in legislative overlap, creates legal uncertainty for infrastructure operators, and, more importantly, diverts the regulatory focus from its essential object: the mitigation of physical, energy, and water impacts.

The Bill No 3.018/2024 presents two other structural weaknesses. First, it makes a mistake by attempting to regulate a nascent market without establishing clear applicability thresholds. By targeting "AI-dedicated data centers," a category of infrastructure that, according to experts, will only reach technical and commercial maturity in Brazil in three to five years, and by doing so without stipulating any parameters for volume, energy density, or operational criticality, such as the international Tier 3 standard (an international standard that defines a level of quality and reliability for data centers, focused on high availability and security) (Zurich Airport Brasil, 2024), the Bill creates a tangible risk of imposing a disproportionate regulatory burden on small-scale operators, while at the same time failing to regulate the hyperscale projects that constitute the true socio-environmental challenge (Maranhão *et al.*, 2025). Second, the Bill can be characterized as a legislative act devoid of enforcement mechanisms. The text does not establish a clear and specific sanctions regime for non-compliance with its provisions, limiting itself to a generic reference to "current legislation" (Maranhão *et al.*, 2025). Nor does it designate the competent authority for oversight, which foretells conflicts of competence between regulatory agencies and a probable administrative inertia (Maranhão *et al*., 2025).

Parallel to this deficient legislative initiative, the dispute for effective regulation is unfolding in other institutional arenas. On the one hand, an articulation of civil society and the academic community is exerting pressure on the National Environmental Council (CONAMA) to include data centers in the list of activities subject to specific and robust environmental licensing, basing its claim on the constitutional precautionary principle and the need for cumulative impact assessment (Soares, 2024; Bucco, 2024). In the opposite direction, the federal Executive Branch is signaling its intention to issue a Provisional Measure centered on a package of fiscal incentives, mentioning "sustainability rules" as a generic trade-off but maintaining an unequivocal focus on economic promotion (Martins, 2025). The manifest risk is that the logic of promotion will override that of control, resulting in a weak regulation that perpetuates the model of socializing costs and consolidates Brazil as a digital sacrifice territory.

Amid this scenario of uncertainty and regulatory inadequacy, a legislative

alternative emerges that represents a significant qualitative advance. Bill No. 2.080/2025 authored by Congresswoman Duda Salabert (Câmara dos Deputados, 2025), offers a technically sound path aligned with the best international practices for regulating the sector. Distinguishing itself from previous proposals, this Bill is correct in its diagnosis of the problems and in its selection of legal instruments, and can serve as a basis for the construction of a truly effective and sustainable regulatory framework.

The merits of Bill No. 2.080/2025 are notable for its technical precision and its integrated approach. The Bill correctly focuses on the energy efficiency and socio-environmental sustainability of the infrastructure, defining clearly and objectively, in its Art. 2, the essential metrics such as Power and Water Usage Effectiveness, which constitute the universal technical language for measuring the sector's efficiency (Câmara dos Deputados, 2025).

Article 5 of the Bill establishes a mandatory efficiency standard, requiring data centers to maintain a PUE equal to or less than 1.3. This means that legislative proposed establishes that the consumption for cooling and auxiliary services cannot be greater than 30% of the total consumed[5]. In other words, the closer the number is to 1, the more efficient the operation is, or meaning less energy is 'spent' on cooling, for example. The industry average, according to Google itself, is 1.55 (BNamericas, 2024). The established limit is not an arbitrary target, but rather a high-efficiency standard that aligns with the most advanced regulations worldwide. In Germany, the 2023 Energy Efficiency Act requires a PUE of 1.3 for new facilities, while existing ones must reach 1.5 by 2027 and 1.3 by 2030. In California, a policy since 2014 has required facilities with a PUE above 1.5 to reduce it by 10% annually (Aguirre *et al*., 2025). The adoption of such a standard would position Brazil at the forefront of global regulation in the sector.

Art. 12 of the aforementioned Bill proposes the creation of a National Data Center Transparency Portal, a public platform (Câmara dos Deputados, 2025) where monthly performance reports would be disclosed (including PUE, WUE, energy and water consumption, and use of renewable sources, as detailed in its Art. 10). This transparency mechanism is fundamental for social and market control, allowing civil society, investors, and researchers to monitor the sector's performance and demand accountability. The Bill seeks to act on fronts that are concerned not only with the energy issue, but also by creating an Economic Instrument for Sustainability, instituting an aliquot for the use of the country's electrical infrastructure by data centers with a demand equal to or greater than 100 kWh per month. For this, Art. 7 establishes the Energy Efficiency Tax for Data Centers (TEED), with a progressive rate based on performance (PUE and WUE). Crucially, the revenue from this tax would be allocated to the Sectoral Energy

[5] That is why the value is set at 1.3, because if it were 20%, it would be 1.2, for example.

Fund, with the specific purpose of financing the expansion and modernization of the electrical transmission infrastructure. The Bill creates a mechanism by which the industry itself, particularly the less efficient operators, contributes to solving the bottleneck that its activity helps to create, revealing itself as an instrument that internalizes systemic costs (Câmara dos Deputados, 2025).

Beyond the obligations, Articles 13 and 14 (Câmara dos Deputados, 2025) create promotion mechanisms, such as the Sustainable Data Center Seal and specific credit lines, which advocates for companies to exceed the minimum targets. This responsive regulation approach, which combines coercion with incentives, is similar to the European Union's voluntary Code of Conduct, which also provides benefits for participants who demonstrate a significant reduction in their energy consumption (Maranhão *et al.*, 2025). The Seal would function as an important market differentiator, rewarding the technological vanguard and encouraging the continuous improvement of the entire sector.

Furthermore, the Bill also manages to address water resource management, even though superficially, in Articles 8 and 9 (Câmara dos Deputados, 2025), by encouraging the use of reused water, and electronic waste management, aligning with the National Solid Waste Policy and promoting the circular economy. This holistic vision demonstrates a systemic understanding of environmental impacts, avoiding the "leakage effect," in which the solution to one problem (energy) ends up aggravating another (water or waste) (Câmara dos Deputados, 2025).

By combining clear obligations, economic instruments, and incentives for innovation, Bill No 2.080/2025 offers the structure of a contemporary, technically informed public policy capable of outlining the beginning of how to confront the complex challenges associated with the expansion of AI in Brazil.

In contrast to the slowness and complexity of the federal debate, subnational initiatives are beginning to emerge as more agile responses to the regulatory vacuum. The state of Goiás, notably, became a pioneer by becoming the first in the country to sanction comprehensive legislation for the use of Artificial Intelligence in May 2025 (Assembleia Legislativa do Estado de Goiás, 2025). The Goiás state law advances by establishing clear guidelines with a focus on ethics, transparency, and responsibility. Among its central points, the law requires companies to be transparent about the functioning of their algorithms and the data used, in addition to ensuring human accountability for decisions made by AI systems, with the requirement of direct supervision in critical sectors such as health and public safety. By creating a safe and predictable legal environment, the state seeks to consolidate itself as a national hub of technological innovation and serves as an important case study and a potential model for the formulation of a cohesive and effective national regulatory framework (Barbosa, 2025).

This pioneering approach from Goiás is notable for integrating both the

promotion and the regulation of artificial intelligence within a single, comprehensive legislative framework. The complementary Bill, forwarded in May 2025, establishes the State Policy for Fostering Innovation in Artificial Intelligence. Its objectives include stimulating sustainable technological development, research, and technical training, attracting strategic investments in digital infrastructure, and promoting public-private partnerships (Assembleia Legislativa do Estado de Goiás, 2025).

Simultaneously, the Bill meticulously builds a governance structure to ensure this development is responsible. It provides for the creation of the Nucleus for Ethics and Innovation in Artificial Intelligence (NEI-IA), institutes regulatory sandboxes for safe experimentation, and protects fundamental citizen rights in the face of automated decisions, ensuring transparency and mechanisms for human review (Assembleia Legislativa do Estado de Goiás, 2025). Therefore, Goiás's strategy is not sequential; rather, it's a unified vision that understands fostering innovation and establishing responsible regulation as two sides of the same coin, demonstrating a high level of governance maturity.

Even with the potential that Bill Nº. 2.080/2025 holds for addressing the issue, it is still necessary to propose a regulatory framework for Brazil that definitively redefines the role of the State from that of a facilitator of investments to a strategic planner. The first step consists of the legal reclassification of data centers as critical infrastructure of public interest, by virtue of their systemic impact on the economy and the consumption of natural resources.Underpinned by this premise, the licensing process must be specific and robust. This aligns with civil society recommendations, such as creating a public portal for the continuous monitoring of auditable and territorialized environmental data from data centers. Furthermore, environmental licensing should be conditioned on the presentation of socioeconomic return and environmental compensation plans, with the express legal prohibition of installing data centers in territories already under water stress without prior public consultation and robust impact assessments (LAPIN, 2025). Making it mandatory to conduct an Environmental Impact Assessment (EIA) for all data centers that exceed a certain size (e.g., 1 MW of IT load). Inspired by the demands of Brazilian civil society and the Chilean judicial precedent, the scope of the EIA must be holistic, evaluating not only the local impact of the project but also its cumulative and synergistic impacts on the regional power grid, the water resources of the river basin (including the accounting of 'embedded water' in the consumed energy), and the electronic waste management chain. The issuance of the Operating License must be strictly conditioned on the fulfillment of mandatory and auditable goals for PUE (with a reference value below 1.3) and WUE, adjusted to local climatic and hydrological conditions, in addition to contractual proof of renewable energy use.

To combat the concentration of data centers in ecologically vulnerable areas or those with overloaded infrastructure, such as the Tamboré region (SP) or municipalities with a history of drought, the implementation of a territorial planning policy is proposed, called Ecological-Digital Zoning (ZE-D). This instrument would map the national territory, identifying preferential zones, restricted zones, and prohibited zones for the installation of data centers, based on technical criteria. The criteria for defining preferential zones would include: 1) Proximity to transmission grid substations with idle capacity; 2) Low level of water stress and availability of alternative water sources (such as treated effluents); 3) Climatic conditions that favor the use of high-efficiency cooling technologies; and 4) Potential for industrial synergies, such as the reuse of residual heat generated by servers for district heating, agricultural greenhouses, or other industrial processes. This approach, inspired by the digital platform model proposed in Chile's National Data Center Plan (Associated Press, 2024), would shift siting decisions from purely market-driven logic to strategic state planning. This proposal is not a radical invention, rather, it is an adaptation of the already consolidated instrument of Ecological-Economic Zoning (ZEE), provided for in the National Environmental Policy, applying its logic of territorial planning to the new realities of the digital economy.

For the insertion of these hyper-energy-consuming technological mechanisms to be possible, a paradigm shift is crucial in the regulation of the electricity sector, which currently views data centers merely as passive "loads" on the grid. They must be seen and regulated as potential "grid assets" (DiSanto, 2025). Regulations from the National Electric Energy Agency (ANEEL) should require that new large-scale data centers be technically capable of participating in demand response programs, that is, to modulate their consumption in a controlled and rapid manner when requested by the system operator, thus helping to relieve the grid during peak times and increase overall stability. Additionally, "regulatory corridors" (fast-tracks) should be created for the connection of projects that demonstrate a high degree of sustainability, such as those that commit to 24/7 renewable energy supply contracts, guaranteed by battery energy storage systems (BESS) (Iberdrola, 2025). The agreement signed between Atlas Renewable Energy and Codelco in Chile for the continuous supply of solar energy (Press Releases, 2024) serves as a concrete and viable model, demonstrating that the intermittency of renewable sources can be overcome with innovative technology and business models.

Corroborating with the suggested regulatory framework, the policy of fiscal incentives, such as the one under discussion in Brazil, should not be granted as a "blank check" to the industry. The benefits must be transformed into smart incentives, strictly linked to sustainability performance metrics that are rigorous,

transparent, and auditable. This means linking public financing and tax benefits to verifiable environmental targets through results-based financing instruments, ensuring a concrete socio-environmental return for state support (LAPIN, 2025).

The granting of tax exemptions on investments or imports should be conditioned on proof that the project: 1) Achieves and maintains ambitious PUE and WUE targets; 2) Is installed in a preferential zone defined by the ZE-D; 3) Proves the use of 24/7 renewable energy, preferably through PPAs (power purchase agreements) with storage; and 4) Invests in local talent development programs and the regional supply chain. This approach ensures that state support generates a concrete socio-environmental return and not just private profit at the expense of public resources, guaranteeing that the economic benefits are shared with the community (Aerodoc, 2025).

From the analysis of the cases that underscores the impacts of data centers on Latin American territories, as well as the legislative proposals currently underway in Brazil, it is clear that the complexity and interdependence of the effects triggered by the expansion of digital infrastructure, especially on the electrical, water, and environmental systems, highlights the structural insufficiency of fragmented and sectoral solutions to face the problem increasingly evident. These impacts are not restricted to isolated technical spheres but unfold into territorial conflicts, an overload of the public administration, socio-environmental inequalities, and risks to energy and water security, as demonstrated by the cases in Latin America.

To face the challenges identified in the analysis of Brazilian (mis)governance and the impacts observed in Latin American experiences, the adoption of systemic governance is proposed, understood as a multi-scalar, intersectoral, and technically informed regulatory model (Olivieri *et al*., 2018, apud Levi-Faur, 2012), capable of articulating different environmental, energy, technological, urban, and fiscal public policies under a logic of integrated planning and socio-environmental justice. The recent experience in Brazil, added to the conflicts arising from the installation of data centers in Chile and Mexico, reveals that the socio-environmental impacts of this digital infrastructure are cumulative, interdependent, and unequally distributed, making fragmented regulatory approaches, such as those contained in Bills 3.018/2024 and 2.238/2023, ineffective. Thus, *systemic governance* can be understood as an integrated and adaptive approach to addressing contemporary challenges, characterized by high complexity, interdependence, and unpredictability. This perspective recognizes that effective public policies require not only coordination between different sectors and levels of government but also the capacity to incorporate multiple perspectives and continuous feedback. According to the Organisation for Economic Co-operation and Development (OECD), systemic

thinking offers conceptual and operational tools to manage this type of complexity, promoting a more reflexive, collaborative, and learning-oriented governance (Hynes *et al.*, 2020; Staw *et al.*, 2020). Practical experiences of applying this model reveals that systemic approaches can transform the way governments understand public problems and redesign their decision-making structures (Hynes *et al.*, 2020, Staw *et al.*, 2020).

Governance in the realm of technology, especially in AI data centers, therefore, cannot be restricted to market logic or immediate economic goals, since its operation depends intensely on critical public resources, such as water and energy, and imposes direct pressures on already vulnerable territories. Given this, a coordinated action between the State, civil society, and the productive sector becomes indispensable, capable of internalizing the systemic costs of the digital economy and guiding its expansion based on criteria of sustainability, territorial equity, and environmental security. Recognizing that data centers are, at the same time, vectors of innovation and producers of structural risks, the regulatory model proposed here starts from the premise that this infrastructure must be treated as a strategic asset, whose governance requires legal, technical, and institutional instruments compatible with its complexity and centrality in the territorial and economic reconfiguration of Latin America.

Adopting a perspective of systemic governance means recognizing that the regulation of data centers cannot be fragmented or reactive, but must articulate cross-cutting public policies - environmental, energy, technological, urban, and territorial planning, in an integrated and long-term approach. This implies overcoming sectoral institutional arrangements and fostering multi-scalar deliberation mechanisms capable of incorporating both the global dynamics of the digital economy and the local specificities of the affected territories. As Schweizer and Juhola (2024) point out, the governance of systemic risks requires reflexive, iterative, and inclusive processes capable of addressing the complexity, uncertainty, and ambiguity that characterize critical infrastructures in the digital era. Thus, the design of regulatory policies for data centers must be anchored in governance models that combine interdisciplinary analysis with institutional devices that ensure social participation, transparency, and accountability, especially given the risks of systemic collapse that such infrastructures can generate. The proposed governance, therefore, not only regulates but also learns, adapts, and co-evolves with the systems it strives to guide.

CONCLUSION

This study focused on the central paradox of the digital era in Latin America: the collision between the promise of modernization, driven by the expansion of Artificial Intelligence infrastructure, and the reality of a new

extractive logic that threatens socio-environmental sustainability and regional sovereignty, addressing the research problem: how can the expansion of AI data centers in Latin America, promoted under the discourse of economic development, be effectively reconciled with socio-environmental sustainability and the resilience of local infrastructures, avoiding the perpetuation of an extractivist model? The guiding question was not whether digital development should occur, but how it could be reconciled with the principles of environmental justice and the resilience of local infrastructures. The research concludes that this reconciliation is feasible but requires a paradigm shift from the current governance model. This study concludes that the solution lies not in marginal adjustments, but in a paradigm shift regarding the State's role: transitioning from a passive facilitator of investment to a strategic architect of the digital transition. Thus, the hypothesis is that the unsustainability of the current model is not an inevitable technological byproduct but a direct consequence of a political and regulatory vacuum that allows for the internalization of profits and the externalization of socio-environmental costs.

This reasoning was based on a qualitative and interdisciplinary methodology, deliberately designed to connect theory with practice and the global scale with local impact. The analysis of documents and technical literature was essential to provide a macro view, quantifying the magnitude of water and energy impacts and demystifying the corporate narrative of "green sustainability." It was, in fact, the case studies of impacts generated by data centers in peripheral countries that provided the micro view, revealing the concrete mechanisms of governance failure: fragmented licensing, fiscal incentives devoid of counterparts, and the absence of integrated territorial planning. The triangulation of these sources allowed not only for the identification of the problem but also for the dissection of it, demonstrating how political decisions and legal gaps create the conditions for "data colonialism" to manifest in its most tangible form: the appropriation of water, energy, and territory.

The responsibility to reverse this trajectory, therefore, is transferred to the public authorities. The diagnosis of a governance vacuum should not be a pessimistic end point, but the starting point for transformative political action. The fundamental issue for Latin America is not to reject the digital economy, but to have the capacity to actively shape it to serve the interests of the community in the long term. As detailed in this research, based on the main social, legal, and legislative events in Brazil, as well as on the exemplary cases involving other Latin American countries, the path to this is the implementation of an integrated and robust regulatory framework, whose pillars include strategic environmental licensing, ecological-digital zoning, the modernization of the electricity sector regulation, and, crucially, smart fiscal incentives, strictly conditioned on rigorous

metrics of socio-environmental performance and contribution to public infrastructure.

This choice requires more than legal adjustments or specific policies; it demands a strategic redirection of the region's political, economic, and institutional priorities. It means recognizing digital infrastructure not as a mere vector of economic growth, but as a strategic public good, deeply connected to national sovereignty, social justice, and ecological integrity. It is necessary to build a systemic governance model, which SEEKS to integrate the emblematic dimensions in the development of data centers, such as aspects in the energy, environmental, technological, and territorial aspects, as well as robust regulation mechanisms, mandatory transparency, and qualified social participation. To assume the premises of robust regulation based on systemic governance implies breaking with the extractive logic that has historically subordinated Latin American countries to a peripheral role in the international division of labor and technology. It means, as Regattieri (2025) argues, going beyond the passive attraction of foreign capital and fiscal incentives, establishing safeguards for energy, water, and minerals. The construction of a digital and sustainable sovereignty is not just a technical or legal imperative, but a long-term political project that requires vision, institutional courage, and regional articulation. On the horizon of COP30, to be held in Brazil, this strategy can reposition the country as a policy formulator, integrating digital sovereignty, socio-environmental justice, and a qualified insertion into global value chains (Regattieri, 2025), ultimately deciding whether Latin America will be a territory of inclusive and environmentally responsible innovation, or will continue to be a digital sacrifice zone".

It also implies challenging the innovation frameworks and efficiency criteria imposed by large corporations, asserting that digitalization cannot occur at the expense of vulnerable communities, environmental erosion, or institutional opacity. It is a matter of disputing not only the means but the ends of the digital transformation, ensuring that its benefits are equitably distributed and its impacts fully considered.

It is, ultimately, about deciding whether Latin America will be a territory of inclusive and environmentally responsible innovation, or will continue to be a digital sacrifice zone, on the margins of the decisions that shape the global future.

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