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RISK, RESPONSIBILITY AND THE ALGORITHM: DESIGNING LIABILITY REGIMES FOR AI-DRIVEN ENVIRONMENTAL DAMAGE

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ABSTRACT

Artificial intelligence has saturated environmentally relevant processes – from data-intensive training pipelines to AI-mediated industrial and resource management decisions – while liability frameworks remain predominantly anthropocentric and technologically outdated. This paper challenges existing civil and regulatory liability regimes to address environmental damage caused by AI systems across two principal registers: civil harms resulting from AI-controlled physical systems, and systemic environmental externalities of AI-based infrastructures, including elevated energy consumption, greenhouse gas emissions, water usage, and electronic waste.

Employing a doctrinal and comparative methodology, the paper maps the contours of environmental liability – fault, strict and absolute liability, the polluter pays and precautionary principles – and evaluates their capacity to absorb new AI-associated risks under both European and Indian legal frameworks.

It critically examines emerging AI-specific instruments, concluding that the EU AI Act, the revised Product Liability Directive, and the proposed AI Liability Directive share a structural blind spot: the treatment of environmental damage as a separate, standalone category of compensable harm.

Building on a typology of AI-related environmental harms and an AI Environmental Liability Matrix cross-tabulating damage categories against actors across the AI value chain.

The paper proposes a hybrid liability regime that combines strict or absolute liability for high-risk AI applications with rebuttable presumptions in other high-impact systems, supplemented by residual fault-based regimes and ex ante obligations including AI-specific environmental impact

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assessments and sustainability-by-design requirements. EU and Indian case studies demonstrate the normative and practical value of this model in internalising environmental externalities, operationalising ecological legal principles, and informing legislative reform.

Keywords: *Artificial Intelligence; Environmental Damage; Liability Frameworks; Polluter Pays Principle; Strict Liability; EU AI Act; Environmental Governance.*

Introduction

Artificial intelligence has ceased to be peripheral to environmentally significant activity. AI systems now govern industrial emissions controls, optimise energy dispatch across power grids, automate resource extraction, and determine compliance with environmental regulations.[3] The scale and pace of AI deployment have generated a pronounced governance paradox: the very systems projected to enhance environmental management simultaneously produce environmental externalities that existing liability frameworks were never designed to address. Global data centre electricity consumption is projected to double between 2022 and 2026,[4] and the energy required to train a single large language model has been estimated to produce carbon emissions equivalent to the lifetime output of five gasoline-powered automobiles.[5] These are not marginal costs but systemic ones – embedded in the infrastructure of an AI-dependent economy.

Yet environmental liability law – whether founded on fault, strict liability, or the polluter pays principle – was crafted in an era of anthropocentric, physically discrete, and technologically transparent causation.[6] When an AI system developed in one jurisdiction, deployed through cloud infrastructure in another, and operating autonomously within a transnational industrial complex causes or contributes to environmental harm, the doctrinal tools calibrated for the factory owner who knowingly discharged effluent into a river are strained beyond their functional limits.[7] This paper examines how that structural strain can be most coherently resolved.

Three research questions organise the analysis. First, how should civil and regulatory liability frameworks be designed or re-interpreted to address environmental damage caused or aggravated by AI systems? Second, to what extent can traditional environmental liability doctrines accommodate AI-induced harms? Third, what gaps persist in the EU's AI regulatory package – the EU AI Act,[8] the revised Product Liability Directive (Revised PLD),[9] and the proposed AI

3Ryan Calo, Artificial Intelligence Policy: A Primer and Roadmap, 51 U.C. Davis L. Rev. 399, 403 (2017).

4Int'l Energy Agency, Electricity 2024: Analysis and Forecast to 2026, at 96–97 (2024) [hereinafter IEA, Electricity 2024].

5Emma Strubell et al., Energy and Policy Considerations for Deep Learning in NLP, Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics 3645, 3648 (2019).

6Shyam Divan & Armin Rosencranz, Environmental Law and Policy in India 58–62 (2d ed. 2001).

7Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on Environmental Liability with Regard to the Prevention and Remedying of Environmental Damage, 2004 O.J. (L 143) 56 [hereinafter ELD].

8Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 Laying Down Harmonised Rules on Artificial Intelligence, 2024 O.J. (L) [hereinafter EU AI Act].

9Directive (EU) 2024/2853 of the European Parliament and of the Council of 23 October 2024 on Liability for Defective Products, 2024 O.J. (L) [hereinafter Revised PLD].

Liability Directive (AILD) – [10]when the damage in question is environmental rather than personal or purely economic?

The thesis advanced is that existing environmental liability principles – particularly strict and absolute liability, the polluter pays principle, and the precautionary principle – provide a robust normative foundation for addressing AI-induced environmental harm, but require targeted supplementation through AI-specific attribution rules, burden-shifting presumptions, and multi-actor responsibility mechanisms to avoid significant accountability gaps. A hybrid liability regime, complemented by mandatory environmental impact obligations, represents the most doctrinally coherent and practically feasible response.

The methodology is primarily doctrinal and comparative, drawing on international environmental law principles, European AI and environmental liability developments, and Indian environmental jurisprudence, including the absolute liability doctrine and National Green Tribunal practice.[11] Criminal liability and data protection dimensions fall outside the paper's scope.

Conceptualising AI-Induced Environmental Damage

Meaningful liability analysis requires precise identification of the harm to be governed. Under the EU Environmental Liability Directive (ELD), "environmental damage" encompasses damage to protected species and natural habitats, water damage meeting defined significance thresholds, and land contamination posing risks to human health.[12] This definition, serviceable within its designed context, was not crafted to encompass the distinctive harm profiles generated by AI systems. A conceptual typology along three analytical axes is therefore required.

The first axis concerns causation mode. Direct physical causation arises where an AI-controlled physical system – an autonomous industrial facility, AI-managed extraction equipment, or an algorithmic emissions control mechanism – malfunctions or is misconfigured, causing pollution of a conventional kind.[13] Indirect digital causation arises where an AI optimisation algorithm, without any discrete system failure, lawfully increases aggregate resource throughput, energy demand, or emissions intensity across a connected system beyond environmentally permissible

[10]Proposal for a Directive of the European Parliament and of the Council on Adapting Non-Contractual Civil Liability Rules to Artificial Intelligence, COM (2022) 496 final (Sept. 28, 2022) [hereinafter AILD].

[11]M.C. Mehta v. Union of India, (1987) 1 SCC 395 (India); Vellore Citizens' Welfare Forum v. Union of India, (1996) 5 SCC 647 (India).

[12]ELD, supra note 5, art. 2(1).

[13]See Wendell Wallach & Colin Allen, Moral Machines: Teaching Robots Right from Wrong 175–80 (2009) (discussing machine-caused physical harm in automated industrial contexts).

thresholds.[14] Purely infrastructural impacts constitute the third and most voluminous category: the energy consumed in AI model training and inference, the water used for data centre cooling, and the e-waste generated by AI-accelerated hardware obsolescence cycles.

The empirical dimensions of this third category are particularly striking. Training GPT-3 was estimated to have consumed approximately 1,287 megawatt-hours of electricity, emitting approximately 552 metric tonnes of carbon dioxide equivalent –[15]a figure that understates the full lifecycle environmental cost of model deployment and iterative fine-tuning.[16] Google reported consuming approximately 5.6 billion gallons of water globally for data centre cooling in 2022 alone.[17] Global e-waste generation reached a record 62 million metric tonnes in 2022, with AI-accelerated hardware upgrade cycles materially contributing to this trajectory.[18] The International Energy Agency projects that data centre electricity demand could reach between 800 and 1,050 TWh globally by 2026.[19] These figures are not merely empirical curiosities; they constitute the evidentiary foundation upon which the legal characterisation of "damage" and "risk" in liability doctrine must be revisited.

The second axis concerns temporal and spatial characteristics. AI-induced environmental harms range from acute, spatially localised events to diffuse, transboundary, and intergenerational harms – such as the cumulative contribution of global AI infrastructure to atmospheric greenhouse gas concentrations.[20] The third axis concerns attribution complexity, distinguishing single-actor scenarios, multi-actor configurations, and fully networked socio-technical systems in which environmental harm cannot be disaggregated into individual contributions without extensive and often unavailable technical information.[21] This typology directly informs the appropriate liability standard and the allocation of responsibility among developers, deployers, infrastructure operators, and financiers, as addressed below.

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[14]See Kate Crawford, Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence 33–41 (2021) (documenting how algorithmic optimisation reshapes resource throughput and environmental load).

[15]David Patterson et al., Carbon Emissions and Large Neural Network Training 5 (Apr. 21, 2021) (arXiv preprint arXiv:2104.10350).

[16]Strubell et al., supra note 3, at 3649 (estimating that continuous model retraining and fine-tuning multiplies initial training emissions severalfold).

[17]Google, 2023 Environmental Report 12 (2023).

[18]United Nations University, Global E-Waste Monitor 2024, at 14–15 (2024) [hereinafter Global E-Waste Monitor].

[19]IEA, Electricity 2024, supra note 2, at 96 (projecting data centre electricity demand reaching 800–1,050 TWh globally by 2026).

[20]See Philippe Sands et al., Principles of International Environmental Law 723–30 (4th ed. 2018).

[21]See generally Luciano Floridi et al., An Ethical Framework for a Good AI Society: Opportunities, Risks, Principles, and Recommendations, 28 Minds & Machines 689, 700–03 (2018).

Existing Environmental Liability Frameworks

Environmental liability doctrine has evolved across common and civil law systems towards increasingly stringent standards, reflecting the structural features of environmental harm: information asymmetries between polluters and victims, long latency periods, scientific uncertainty, and high social costs.[22] Three principal models are analytically relevant.

Fault-based liability requires proof that a defendant breached a duty of care and that this breach caused identifiable harm to an identified plaintiff.[23] In practice, environmental claims are defeated with disproportionate frequency by diffuse causation, long latency, and scientific complexity characteristic of ecological damage.[24] Strict liability for hazardous activities dispenses with fault, imposing liability upon any operator who introduces an exceptionally dangerous activity into an environment from which an escape causes harm.[25] Cambridge Water Co v Eastern Counties Leather plc confirmed that the rule in Rylands v. Fletcher requires foreseeability of the damage type,[26] a qualification that diminishes the doctrine's utility when AI systems generate harm through emergent, unpredicted behaviours not contemplated at the point of design or deployment.

Indian environmental jurisprudence made its most distinctive contribution in departing from Rylands to articulate an unqualified absolute liability standard. In M.C. Mehta v. Union of India, the Supreme Court held that any enterprise engaged in a hazardous or inherently dangerous activity bears an absolute, non-delegable duty to compensate all who suffer harm – without exception, without defences.[27] The Court explicitly rejected Rylands on the ground that a modern industrial economy demands that the full cost of technological risk be borne by those who profit from it.[28] The principle was reinforced in Indian Council for Enviro-Legal Action v. Union of India, where the Court affirmed the polluter pays principle as a binding rule of Indian law, holding that the

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[22]See Nicolas de Sadeleer, Environmental Principles: From Political Slogans to Legal Rules 246 (2002) (critiquing structural limitations of fault-based liability for diffuse environmental harm).

[23]Donoghue v. Stevenson, [1932] AC 562, 580 (UK) (articulating the neighbour principle that became foundational to negligence liability).

[24]See de Sadeleer, supra note 20, at 248–50 (noting that diffuse causation and long latency systematically defeat fault-based environmental claims at the evidentiary stage).

[25]Rylands v. Fletcher, (1868) LR 3 HL 330, 339–40 (UK) (establishing that persons who bring dangerous things onto their land are strictly liable for all damage caused by an escape).

[26]Cambridge Water Co. v. E. Counties Leather plc, [1994] 2 AC 264, 303–05 (UK) (confirming that the rule in Rylands requires foreseeability of damage type).

[27]M.C. Mehta v. Union of India, (1987) 1 SCC 395, 420–21 (India).

[28]Id. at 421.

polluter – not the affected community – must bear the cost of remediation and compensation alike.[29]

The polluter pays principle received its canonical international articulation in Principle 16 of the Rio Declaration, which promotes the internalisation of environmental costs by polluters.[30] In Vellore Citizens' Welfare Forum v. Union of India, the Supreme Court grounded the polluter pays and precautionary principles in Articles 21, 47, 48A, and 51A(g) of the Indian Constitution, elevating them from international commitments to constitutionally-backed obligations.[31] The precautionary principle – Principle 15 of the Rio Declaration –[32]has particular salience for AI-induced environmental harm, given the scientific uncertainty surrounding the aggregate climate impact of AI infrastructure at scale.

The EU Environmental Liability Directive operationalises these principles within a public law framework, imposing strict liability on operators of scheduled occupational activities for environmental damage caused thereby,[33] and fault-based liability for damage to protected habitats and species.[34] The ELD's insistence that operators bear the cost of preventive and remedial measures directly embodies the polluter pays principle.[35] However, the ELD's definitions of "operator" and "occupational activity" were not designed to capture the distributed, software-mediated AI value chain—a gap that becomes acute when the entity causing environmental harm operates at several removes from the entity responsible for the AI system's design.

Emerging AI-Specific Liability Instruments and Their Environmental Gaps

The EU's tripartite AI regulatory package constitutes the most comprehensive legislative response to AI liability yet enacted, yet it exhibits a structural blind spot regarding environmental harm.

The EU AI Act, which entered into force on 1 August 2024, establishes a risk-based classification system under which providers and deployers of "high-risk" AI systems are subject to graduated obligations including conformity assessments, risk management systems, and post-market

[29]Indian Council for Enviro-Legal Action v. Union of India, (1996) 3 SCC 212, 246–48 (India).

[30]Rio Declaration on Environment and Development, Principle 16, June 14, 1992, U.N. Doc. A/CONF.151/26/Rev.1(vol.1), annex I [hereinafter Rio Declaration].

[31]Vellore Citizens' Welfare Forum v. Union of India, (1996) 5 SCC 647, 658–60 (India) (grounding the polluter pays and precautionary principles in Articles 21, 47, 48A, and 51A(g) of the Indian Constitution).

[32]Rio Declaration, supra note 28, Principle 15.

[33]ELD, supra note 5, art. 3(1)(a).

[34]ELD, supra note 5, art. 3(1)(b).

[35]ELD, supra note 5, recital 2; see also Ludwig Krämer, EU Environmental Law 381–83 (8th ed. 2016).

monitoring obligations.[36] Annex III designates AI systems deployed in critical infrastructure as high-risk,[37] encompassing, in principle, AI managing energy grids and industrial environmental controls. Critically, however, the AI Act does not create standalone civil liability for environmental harm: it establishes ex ante regulatory obligations whose breach may inform ex post liability under separate instruments, but generates no right to compensation for ecological damage.[38] The Act requires providers of general-purpose AI models with systemic risk to document energy consumption,[39] but this disclosure obligation does not constitute or generate liability for the environmental consequences of that consumption.

The Revised Product Liability Directive of 2024 modernises the defective products regime by expanding the definition of "product" to encompass software and AI systems,[40] introducing rebuttable presumptions of defectiveness and causation where defendants withhold necessary information,[41] and extending manufacturer liability to entities that substantially modify AI models.[42] These are significant advances. However, compensable "damage" under the Revised PLD remains tethered to personal injury, death, psychological harm, and property damage to consumer goods –[43]environmental damage to natural resources, protected habitats, and the global climate does not qualify as compensable harm within the Directive's operative provisions.[44]

The proposed AI Liability Directive adopts a complementary approach, introducing a rebuttable presumption of causation in favour of claimants who establish that a defendant breached a relevant duty of care and that a plausible causal link exists between the AI system's output and the harm suffered.[45] The AILD explicitly preserves national fault-based liability regimes[46] but does not designate environmental damage as a distinct compensable category, nor does it engage with the evidentiary problems – diffuse causation, long latency, collective harm – that distinguish ecological

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[36]EU AI Act, supra note 6, arts. 9–17.

[37]EU AI Act, supra note 6, Annex III, para. 2.

[38]See European Commission, Explanatory Memorandum to the Proposal for the AI Act, COM(2021) 206 final, at 24 (Apr. 21, 2021).

[39]EU AI Act, supra note 6, art. 55(1)(c).

[40]Revised PLD, supra note 7, art. 4(1).

[41]Revised PLD, supra note 7, arts. 9–10.

[42]Revised PLD, supra note 7, art. 7(4).

[43]Revised PLD, supra note 7, art. 4(6).

[44]See European Commission, Impact Assessment Accompanying the Proposal for a Revised Product Liability Directive, SWD(2022) 316 final, at 28 (Sept. 28, 2022) (acknowledging that purely ecological damage falls outside the traditional product liability framework and the revised Directive's operative scope).

[45]AILD, supra note 8, art. 4(1).

[46]AILD, supra note 8, art. 1(2).

damage from personal and economic injury.[47] The AILD's presumption of causation operates within national tort frameworks that generally require an identifiable claimant and a quantifiable, individual harm—criteria that diffuse ecological damage frequently fails to satisfy.[48] The combined effect is a regulatory architecture that addresses personal and economic AI-induced harm with growing sophistication while leaving the environmental dimension systematically unaddressed.

Structural Challenges in Attributing Liability for AI-Induced Environmental Harm

The attribution of AI-induced environmental liability confronts two compounding layers of causal complexity that together defeat most conventional liability frameworks before they can be engaged.

The first arises from the intrinsic characteristics of environmental causation. Where harm results from the cumulative contributions of multiple independent AI infrastructure operators – as with the aggregate contribution of global data centres to atmospheric greenhouse gas concentrations – courts confront overdetermined causation: no single actor's output was strictly necessary for the harm, yet each materially contributed.[49] Legal scholarship has proposed the NESS test – Necessary Element of a Sufficient Set – as a means of navigating this problem. Under Wright's formulation, a defendant's conduct is causally relevant if it constitutes a necessary element of a set of antecedent conditions jointly sufficient to produce the harm.[50] Proportional liability – allocating responsibility among contributors in proportion to their causal share – offers a complementary mechanism[51] with some precedent in environmental mass-tort contexts, though both approaches remain underutilised in environmental litigation.

The second layer of complexity arises from the opacity of AI systems themselves. Deep learning models process inputs through billions of parameters in ways that even their developers cannot fully reconstruct or explain.[52] This opacity defeats fault-based environmental claims at both the breach and causation stages: a claimant cannot ordinarily demonstrate that a specific design choice constituted a breach of the applicable standard of care, nor that a specific algorithmic decision

47See European Parliament, Study on Civil Liability Regime for Artificial Intelligence 42–45 (2020) [hereinafter EP AI Liability Study] (noting the absence of environmental harm as a standalone category in emerging AI liability proposals).

48Id. at 47.

49On overdetermination in environmental causation, see Michael D. Green et al., Reference Guide on Epidemiology, in Reference Manual on Scientific Evidence 549, 608 (Fed. Jud. Ctr., 3d ed. 2011).

50Richard W. Wright, Causation in Tort Law, 73 Cal. L. Rev. 1735, 1788–90 (1985) (formulating the Necessary Element of a Sufficient Set test as a means of resolving overdetermination).

51See Sindell v. Abbott Labs., 26 Cal. 3d 588, 607–10 (1980) (introducing market-share liability as a proportional causation mechanism in complex, multi-actor mass tort scenarios).

52Frank Pasquale, The Black Box Society: The Secret Algorithms That Control Money and Information 3–8 (2015).

caused a specific environmental outcome, without access to proprietary model architecture and training data that defendants have strong incentives not to disclose.[53] The EU AI Act's transparency obligations for high-risk systems[54] partially address the disclosure problem, but they do not translate directly into evidentiary disclosure mechanisms in tort or environmental liability proceedings.

The multi-actor structure of the AI value chain further fragments responsibility. A single AI-induced environmental harm may implicate: hardware manufacturers whose energy-inefficient accelerators increase total consumption;[55] cloud infrastructure providers whose data centre siting and cooling choices drive water depletion;[56] AI model developers whose architectural choices maximise performance at the cost of energy efficiency;[57] and deployers whose operational configurations determine actual emissions profiles.[58] Existing tort doctrines of joint and several liability address certain multi-party scenarios but do not accommodate the highly differentiated information advantages of actors distributed across a global digital supply chain.[59] The transboundary character of AI infrastructure adds acute jurisdictional complexity: data centres contributing to climate-relevant emissions are frequently located in different jurisdictions from those where environmental harm is experienced, creating choice-of-law difficulties and collective action problems for effective enforcement.[60]

Towards a Hybrid Liability Model

The foregoing analysis reveals a structural mismatch between the demands of AI-induced environmental harm and the supply of available liability doctrine. The paper proposes a three-tier hybrid liability regime, anchored in established environmental law principles but structurally adapted to the distinctive challenges of AI-induced environmental harm.

A. First Tier: Strict or Absolute Liability for High-Risk AI Applications

[53]See Joshua A. Kroll et al., Accountable Algorithms, 165 U. Pa. L. Rev. 633, 685–90 (2017) (identifying structural barriers to algorithmic accountability, including the inaccessibility of model architecture and training data).

[54]EU AI Act, supra note 6, art. 13.

[55]See Int'l Energy Agency, Data Centres and Data Transmission Networks 8–10 (Sept. 2023) [hereinafter IEA, Data Centres].

[56]Google, supra note 15, at 12.

[57]Patterson et al., supra note 13, at 6–7 (finding that architectural choices can reduce training energy consumption by an order of magnitude without equivalent performance loss).

[58]Crawford, supra note 12, at 47.

[59]See Restatement (Third) of Torts: Apportionment of Liability § 10 cmt. a (Am. L. Inst. 2000) (noting that joint and several liability does not adequately address differentiated contributions in complex industrial supply chains).

[60]Sands et al., supra note 18, at 723–27.

The first tier imposes strict or absolute liability for AI-enabled activities that are environmentally high-risk. Drawing on the absolute liability doctrine affirmed in M.C. Mehta[61] and the strict liability framework of the ELD,[62] this tier would apply to AI systems exercising operational control over hazardous industrial emissions, large-scale resource extraction, critical energy infrastructure, or other activities where the potential for irreversible or large-scale environmental harm is analogous to the hazardous activity scenarios that have historically grounded strict liability.[63] Primary liability attaches to the deployer as the party introducing the AI system into the hazardous operational context; secondary liability reaches developers whose design choices foreseeably created the conditions for harm.[64]

The rationale mirrors the environmental law foundations of strict liability. AI systems deployed in high-risk environmental contexts generate profound information asymmetries: developers possess detailed knowledge of model behaviour that deployers and affected communities cannot independently access.[65] Requiring fault proof exploits this asymmetry and insulates AI actors from liability through opacity – an outcome directly contrary to the polluter pays principle, which demands that causative actors, not society, internalise the cost of environmental harm.[66] Absolute liability, following the M.C. Mehta logic, is warranted in intrinsically hazardous sectors precisely because no exception or defence can be permitted to substitute technological inscrutability for accountability.

B. Second Tier: Rebuttable Presumptions for High-Impact AI Systems

The second tier applies to other high-impact AI systems – those whose aggregate environmental footprint is significant but whose outputs are not immediately and directly destructive. Modelled on the mechanisms of the Revised PLD[67] and the AILD,[68] but explicitly extended to environmental damage, this tier operates as follows: a claimant establishing that (a) an AI system deviated from applicable environmental performance standards, and (b) a plausible causal link exists between that deviation and the harm suffered, triggers a presumption that the defendant's system caused the

[61]M.C. Mehta v. Union of India, supra note 25, at 420–21.

[62]ELD, supra note 5, art. 3(1)(a).

[63]See Cambridge Water Co., supra note 24, at 305–06 (identifying non-natural use and exceptional risk as criteria for activating strict liability under Rylands).

[64]See EP AI Liability Study, supra note 45, at 52 (recommending a primary-secondary liability structure for AI systems to reflect differentiated contributions to harm).

[65]See Kroll et al., supra note 51, at 685.

[66]See Vellore Citizens' Welfare Forum, supra note 29, at 659 (holding that the polluter pays principle requires the causative actor, not the state, to internalise the full cost of environmental harm).

[67]Revised PLD, supra note 7, arts. 9–10.

[68]AILD, supra note 8, art. 4.

harm – rebuttable only by demonstrating the absence of the operational deviation or the existence of an independent superseding cause.[69] The presumption is calibrated to the evidentiary disability imposed by AI opacity: it does not eliminate the causation requirement, but shifts the cost of establishing non-causation to the party best positioned to access and disclose the relevant evidence.

C. Third Tier: Residual Fault-Based Liability with Ex Ante Obligations

The third tier preserves residual fault-based liability for lower-impact AI uses, supplemented by mandatory environmental transparency obligations. Critically, AI systems whose projected energy and resource consumption exceeds defined computational thresholds should be subject to AI-specific Environmental Impact Assessments (EIAs),[70] modelled on established EIA frameworks and combining lifecycle analysis of energy consumption, water use, and hardware obsolescence. Such assessments would serve both ex ante deterrence and ex post evidentiary functions – establishing baseline performance standards against which deviations can subsequently be measured for the purposes of the second-tier presumption.

D. The AI Environmental Liability Matrix

An "AI Environmental Liability Matrix" cross-tabulates actors (developer, deployer, data centre operator, infrastructure financier, state regulator) against harm categories (direct physical, indirect digital, infrastructural) to assign primary, secondary, and residual liability shares to each actor-harm pair. Extended producer liability principles – adapted from the WEEE Directive's hardware lifecycle obligations[71] - enable contribution and indemnity mechanisms between private parties,[72] preventing actors who design energy-inefficient AI systems from insulating themselves from downstream environmental liability through the interposition of operators or deployers.

The hybrid model must operate not in isolation but as part of an integrated governance architecture. Mandatory sustainability-by-design requirements in AI legislation,[73] AI-

[69]This structure is analogous to the evidentiary presumptions applicable to scheduled occupational activities under the ELD. See ELD, supra note 5, Annex III.

[70]See Council Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the Assessment of the Effects of Certain Public and Private Projects on the Environment, 2012 O.J. (L 26) 1 [hereinafter EIA Directive] (providing the established framework for proportionate environmental impact assessment in EU law).

[71]See Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on Waste Electrical and Electronic Equipment, 2012 O.J. (L 197) 38 [hereinafter WEEE Directive] (extending producer responsibility obligations across the hardware lifecycle).

[72]WEEE Directive, supra note 69, arts. 12–13.

[73]See EU AI Act, supra note 6, art. 55(1)(c) (requiring providers of general-purpose AI models with systemic risk to prepare and maintain documentation on energy consumption).

environmental compensation funds financed by levies on high-impact AI services,[74] and the application of the precautionary principle to AI infrastructure authorisation[75] complete the framework. Inter-generational equity considerations – given the long latency of AI-related greenhouse gas emissions – further justify stricter liability standards and extended limitation periods for AI-related environmental harms.

Jurisdiction-Specific Applications and Case Studies

A. The EU Case Study

Consider a scenario in which an AI-optimised energy management system deployed across a transnational electricity grid generates unanticipated load-shifting patterns, causing emissions spikes at fossil-fuel peaker plants that exceed national emissions limits and damage protected natural habitats. Under the current EU framework, the AI Act's high-risk designation for critical infrastructure AI[76] imposes ex ante obligations on the provider but generates no environmental liability. The ELD applies strict liability to the emitting plant operator,[77] but does not readily extend to the AI developer or deployer whose system caused the operational deviation. The Revised PLD covers the AI system as a defective product but excludes purely ecological harm from its compensable damage categories.[78] The AILD's presumptions benefit individual claimants in personal injury proceedings but provide no mechanism for addressing diffuse habitat damage suffered collectively by communities or protected ecosystems.

The proposed hybrid model directly addresses each of these gaps. The AI developer and deployer of a critical infrastructure AI system face first-tier strict liability for the resulting environmental damage without the need to establish fault, breach, or navigate opaque model architecture. The EIA obligation ensures that baseline performance standards exist against which the deviation can be measured for other claims. The liability matrix allocates primary liability to the deployer and secondary liability to the developer whose architectural choices foreseeably increased emissions risk.

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[74] Cf. Directive 94/62/EC of the European Parliament and of the Council of 20 December 1994 on Packaging and Packaging Waste, 1994 O.J. (L 365) 10 (establishing the model of industry-financed environmental compensation through extended producer responsibility).

[75] Rio Declaration, supra note 28, Principle 15; Treaty on the Functioning of the European Union art. 191(2), 2012 O.J. (C 326) 132 [hereinafter TFEU] (codifying the precautionary principle as a foundational obligation of EU environmental law).

[76] EU AI Act, supra note 6, Annex III, para. 2.

[77] ELD, supra note 5, art. 3(1)(a).

[78] Revised PLD, supra note 7, art. 4(6).

B. The Indian Case Study

In India, consider an AI-driven industrial monitoring system whose outputs are used to certify regulatory compliance with emission norms, but which systematically under-reports discharge data, enabling a manufacturing facility to pollute beyond permissible limits. Indian courts could apply absolute liability under M.C. Mehta[79] to the facility operator and, by extension, to the AI system's deployer as the enabling party. The polluter pays principle, as elaborated in Indian Council for Enviro-Legal Action,[80] grounds a comprehensive remediation obligation. The National Green Tribunal, with its broad jurisdiction over substantial questions relating to the environment,[81] possesses both the mandate and institutional capacity to develop AI-specific evidentiary protocols for assessing algorithmic contributions to harm. An Indian AI liability statute, informed by the hybrid model, could graft these principles onto a structured legislative framework, offering a model for other developing jurisdictions with robust environmental law traditions and nascent AI governance regimes.

Policy and Legislative Recommendations

The foregoing analysis generates four concrete legislative recommendations for policymakers at both national and supranational levels.

First, AI-specific liability instruments – including any successor to the proposed AILD – should expressly designate "environmental damage" as a compensable category of harm, with tailored presumptions and evidentiary rules designed to address diffuse causation, long latency, and attribution complexity.[82] The current exclusion of purely ecological damage from both the Revised PLD and the AILD is a doctrinal anachronism that will, as AI infrastructure scales, generate increasingly severe accountability gaps.

Second, strict liability provisions should be extended to environmentally high-risk AI applications, with quantified risk thresholds developed through collaboration among environmental regulators, technical standards bodies, and judicial institutions. Third, mandatory AI-specific EIAs should be introduced for computational projects exceeding defined energy thresholds, modelled on

[79]M.C. Mehta v. Union of India, supra note 25, at 420–21.

[80]Indian Council for Enviro-Legal Action, supra note 27, at 246–47.

[81]National Green Tribunal Act, 2010, § 14 (India) (conferring original jurisdiction over 'substantial questions relating to the environment').

[82]See EP AI Liability Study, supra note 45, at 55 (recommending that expanded harm categories, including environmental damage, be incorporated into AI liability legislation at the EU level).

established EIA frameworks and calibrated to the scale and risk profile of each application.[83] Fourth, AI-environmental compensation funds, financed by progressive levies on data centre energy consumption and large-scale model training operations, should be established to provide collective redress where individual defendants are unidentifiable or insolvent.

At the governance level, mandatory carbon and water footprint disclosures for high-impact AI systems, binding technical standards on energy and resource efficiency for high-risk AI systems and data centres, and capacity-building programmes equipping judicial and administrative bodies with the scientific and technical expertise needed to adjudicate AI-induced environmental claims are indispensable complements to the proposed liability regime.

Conclusion

This paper has argued that the environmental dimensions of AI governance have been systematically neglected in the design of emerging AI-specific liability instruments – an omission that is doctrinally unjustifiable and ecologically hazardous. The conceptual typology of AI-induced environmental harms – distinguishing direct physical, indirect digital, and infrastructural damage along axes of causation mode, temporal and spatial character, and attribution complexity – provides the analytical foundation for more precise doctrinal and legislative responses. The hybrid liability model operationalises the polluter pays and precautionary principles in the AI context, integrating strict or absolute liability for high-risk applications with rebuttable presumptions and residual fault-based regimes, without imposing evidentiary demands that affected communities cannot realistically meet. The AI Environmental Liability Matrix ensures proportional allocation of responsibility across the value chain, preventing accountability from being diffused through the interposition of intermediaries.

The EU–India comparative dimension of this paper is itself instructive. In the EU, legislative sophistication and institutional capacity create the conditions for a comprehensive codified response; what is missing is the political will to treat the environmental externalities of AI as a primary, rather than incidental, governance objective. In India, a rich jurisprudential tradition of absolute liability and constitutional environmental obligation provides a doctrinal infrastructure capable of reaching AI-induced harm; what is required is AI-specific procedural and evidentiary adaptation. Each jurisdiction has something to learn from the other.

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[83]EIA Directive, supra note 68, Annexes I–II (providing templates for calibrating proportionate assessment requirements to the scale and risk profile of the proposed activity).

The deepest challenge is ultimately political rather than doctrinal: whether the jurisdictions most invested in AI development have the will to internalise its environmental costs. Environmental law's jurisprudential history offers cautious optimism – liability, appropriately designed, has proven among the most durable instruments available for aligning private incentives with the public interest in a healthy and sustainable environment. That lesson is no less applicable in the age of the algorithm.[84]

[84]See generally Cass R. Sunstein, Laws of Fear: Beyond the Precautionary Principle 4–10 (2005) (arguing for carefully calibrated regulatory responses to emerging technological risk that avoid both paralysis and recklessness).