PLANETARY BOUNDARIES AND INTERNATIONAL ENVIRONMENTAL LAW: TOWARDS EARTH SYSTEM GOVERNANCE

by

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International Environmental Law stands at a crossroad, where its basic ideas and principles are massively coming at odds with the depth and demand of universal environmental catastrophe. Greatly based upon notions of state control, assent, and fragmented international agreement, the discipline has failed to respond to massive environmental degradation and biodiversity failure. The formation of the scientific notion of the ecological boundaries and limits has elevated the constraint by introducing a bunch of environmental thresholds and limits within which the humankind can remain secure. Developed by the Stockholm Resilience Centre, this framework uncovers crucial biodiversity dynamics like the massive ecological destruction, ecological threshold, poor land usage and change, and bio-geochemical cycles and hence introduces a novice standard beyond which the irreparable environmental damage sharply increases and spikes. While this model has gained impeccable speed and admiration among scientific and policy stakeholders, its ethical interpretation and application for international law remains questionable. This paper argues that adopting environmental limits within the scope and ambit of international environmental law calls for a thorough transformation from fragmented governance towards an obligatory structure of earth system governance.

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Empirical support for this crossroad is considerable. A 2023 update to the planetary boundaries framework found that six of the nine boundaries, including climate change, biosphere integrity, land system change and novel entities, have now been transgressed, placing the Earth system well outside the safe operating space identified by the original 2009 study.[1]

The systematic architecture of International Environmental Law is identified by gradual support and domain specific rules and regulations. Treaties like the Paris Agreement and the

[1] Katherine Richardson and others, 'Earth Beyond Six of Nine Planetary Boundaries' (2023) 9(37) Science Advances eadh2458 <https://doi.org/10.1126/sciadv.adh2458> accessed 24 September 2026.

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Convention on Biological Diversity[2] illustrate this approach, addressing isolated ecological problems through settled obligations and showing political acceptability rather than ecological prerequisites. These instruments reveal structural constraints when weighed against ecological limits. The Paris Agreement[3], for example, aims to control global heating to well below 2 degree Celsius, yet its dependency on nationally determined contributions results in a cumulative target deficit that threatens to overstep the thermal boundary. This gap is not merely theoretical. The United Nations Environment Programme has reported that full implementation of existing nationally determined contributions would still leave the world on course for warming of between 2.3 and 2.5 degrees Celsius by the end of the century, well above the thermal boundary the Paris Agreement was designed to prevent. [4]Likewise, the Convention on Biological Diversity outlines targets for responsible and sustainable stewardship, but lacks compliance procedures to conserve biodiversity at a rate that already violates the environmental threshold. This disconnect emphasises an underlying issue: international environmental law remains sensitive and homocentric, whereas ecological limits demand proactive and global environmental governance.

At the heart of this dispute lies the absolute dominance of state members and stakeholders. International Law pictures environmental responsibilities as bilateral treaties and agreements between states, subject to adherence and restricted by territorial domination. However, environmental boundaries and limits are transnational in nature; they focus on the interdependence of planetary structures that operate across jurisdictions. This leads to creation of mind-boggling queries and questions about the wholeness of economy as a guiding light and principle. If the non-adherence of the defined boundary, like greenhouse gas emission or eutrophication, ruins the balance of the entire ecosystem, then the caused damaged cannot be restricted to disputes of territorial nature and essence. Instead, it evidences the collective interest of the international groups and members, reflecting and highlighting the demise of universal adherence of these obligations. The transboundary character of environmental harm is not confined to greenhouse gases. The World Health Organization has reported that 99 per cent of the global population breathes air that exceeds its guideline limits, with the pollutants concerned routinely crossing national borders, which illustrates why confining regulatory responsibility to the territorial state is increasingly

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[2] Convention on Biological Diversity, June 5, 1992, 1760 U.N.T.S. 79, 31 I.L.M. 818

[3]United Nations. (2015). *Paris agreement*. United Nations Treaty Collection. \url{https://treaties.un.org/pages/viewdetails.aspx?src=treaty&mtdsg_no=xxvii-7-d&chapter=27&clang=_en}

[4] United Nations Environment Programme, Emissions Gap Report 2025: Off Target (UNEP 2025) <https://www.unep.org/resources/emissions-gap-report-2025> accessed 24 September 2026.

difficult to sustain. [5]In this reference, the duty to avoid harm and the duty of taking due care gain found new relevance. States may be under a duty not just to prevent transnational ecological damage in a conventional lens, but to consolidate and confirm that their efforts in totality do not overpressure global infrastructure beyond a point.

The regulatory capacity of environmental boundaries actually calls for a thorough evaluation of multiple sources of international law. While international rules, obligations and procedures remain most important and fundamental, the increasing influence of scientific facts actually blurs this hierarchical setup. The environmental boundary framework, though not legally functional and operational, still holds an evidentiary value and worth that questions the principle of free will within the scope of international law. It supplies various indicative protocols and limits that could let the world take a sneak peek in the fragmented content and syllabus of legal liabilities, using abstract protocols such as sustainable usage of developmental means into performance mechanism. For example, the precautionary principle, frequently slammed for its vagueness, could be tailored and altered to require states to respond accordingly whenever there is an uncalled intrudence and intersection of a definitive and concrete boundary even in a scientific uncertainty.

The role of international courts and tribunals in this change is profound and pivotal. The International Court of Justice has, in its consultative opinions and disputed cases, progressively enlarged the extent of environmental liability, prioritising thorough review, environmental impact study, and environmental policy integration into strategic planning. While the court has overlooked environmental thresholds, its jurisprudence underpins the legal system for doing so. An advisory report recognising the legal significance of environmental boundaries could accelerate the development of conventional practices, particularly if supported by uniform practice and a sense of legal obligation. Nonetheless, the growing reliance on international legal proceedings and climate litigation in municipal courts suggests an expanded judicial activism to utilise scientific research and contagion risk.The scale of this trend is notable. By the end of 2025, more than 3,600 climate related cases had been filed before courts and tribunals across 62 countries since the first such case in 1986, with claimants increasingly relying on scientific thresholds and government obligations rather than conventional tort principles alone. This proliferation lends weight to the view that

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[5] World Health Organization, 'Almost Everyone Now Breathing Polluted Air, Warns WHO' (WHO, 4 April 2022) <https://operationalsupport.un.org/en/almost-everyone-now-breathing-polluted-air-warns-who> accessed 24 September 2026.

domestic and regional courts are, in practice, operationalising the evidentiary role that environmental boundaries occupy in international law.[6]

This potential has since moved from possibility to reality. On 23 July 2025, the International Court of Justice delivered a unanimous advisory opinion on the Obligations of States in Respect of Climate Change, holding that a failure to take adequate measures to protect the climate system may constitute an internationally wrongful act attributable to the state concerned. The request that led to this opinion was itself driven by a coalition led by Vanuatu and other small island developing states, illustrating how states most exposed to the transgression of planetary boundaries have used the advisory jurisdiction of the Court to press for a more obligatory reading of state responsibility than the treaty architecture discussed above provides.[7]

Regardless of these possibilities, formidable obstacles exist. Downscaling planetary boundaries into mandatory rules grapples with concepts of fair allocation and social justice. The historical accountability of developed nations for ecological damage differs significantly from the growth requirements of developing countries. A non-negotiable ecological constraint could unduly restrict the discretionary authority of the global south, expressing reservations about equity and neo-imperialism. This tension is highly visible when seen through sceptical outlooks such as Third World Approaches to International Law (TWAIL), which analyse the power structure integrated into global legal frameworks. From this perspective, ecological limits can be interpreted as an expert-driven system that centres on scientific expertise from the developed nations while devaluing alternative epistemologies and developmental goals. Resolving these issues requires a subtle strategy that embodies shared tenets but differentiated responsibilities, capacity development, and fair distribution of resources into any propelling global environmental governance.

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The equity concerns raised by TWAIL scholarship are borne out by the empirical record of historical emissions. Analysis of cumulative carbon dioxide emissions since 1850 shows that countries classified as developed under the UNFCCC's Annex I, representing a small minority of the global population, account for roughly half of all historical emissions, with the United States alone responsible for close to a fifth of the global total. This disparity

[6] Joana Setzer and Catherine Higham, Global Trends in Climate Change Litigation: 2026 Snapshot (Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science 2026) <https://www.lse.ac.uk/granthaminstitute/publication/global-trends-in-climate-change-litigation-2026-snapshot/> accessed 24 September 2026.

[7] International Court of Justice, 'Obligations of States in Respect of Climate Change' (Advisory Opinion, 23 July 2025) <https://www.icj-cij.org/case/187> accessed 24 September 2026.

between historical contribution and present day vulnerability lends empirical weight to the argument that a uniform ecological ceiling, imposed without regard to differentiated responsibility, risks reproducing rather than remedying existing inequities.[8]

A further issue exists in the organisational spread and setup of global governance in the field of environment. Numerous protocols, treaties, conventions and adjudicatory authorities operate with clashing and overlapping responsibilities and disoriented team effort, inviting more deficiencies, errors and problems in the proper implementation. The extent of this fragmentation is considerable in practice. The International Environmental Agreements Database maintained at the University of Oregon currently records more than 1,300 multilateral environmental agreements alongside over 2,200 bilateral arrangements, most concluded without systematic reference to one another. Such proliferation makes the coordinated ratchet mechanism that a genuine Earth System Treaty would require considerably more difficult to negotiate than the existing sectoral model. [9]The power struggle, which is likely to affirm adherence and obligation to ecosystem thresholds and limits, further intensifies the situation. Reformative measures have included organisational strengthing, formulation of global environmental threshold standards for efficient governance, and incorporating expert opinions into proper decision making process and mechanism. A more high-flying strategy would include structuring a comprehensive Earth System Treaty that solidifies existing commitments and sets mandatory limits based on ecological limits. Such a treaty could merge oversight procedures, surveillance systems, and conflict resolution methods, hence advancing transparency and symmetry. Ideally, an attempt to incorporate ecological limits and boundaries into international environment law requires both regulative restructuring and legislative means and measures. It reiterates for structural reorientation that has recognise the field and an enthusiastic acceptance of switching to more ground moving methodology to governance. That though does not mean an absolute abandonment of legal provisions and mechanisms, but rather a very swift switch to fact-based revision of ecological truths. The smooth switch from ownership to preservation, from fragmentation to unification, and from lose to solid precautionary principles and protocols, reflects and carries a very radical restructuring of international governance in dealing with ecological crisis. The idea of ecological boundaries has helped in creating a generous amount

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[8] Carbon Brief, 'Analysis: Which Countries Are Historically Responsible for Climate Change?' (Carbon Brief, 5 October 2021) <https://www.carbonbrief.org/analysis-which-countries-are-historically-responsible-for-climate-change/> accessed 24 September 2026.

[9] International Environmental Agreements Database Project, 'Home' (University of Oregon) <https://iea.uoregon.edu> accessed 24 September 2026.

of integrative scholarship that critically assess the loopholes and drawbacks of international environmental law in catering to environmental maintainenece. John Rockstrom and the Stockholm Resilience Centre[10] first envisioned ecological boundaries in 2009, identifying the environmental limit which governs the planetary balance. Their work ideally revolutionised the environmental perception and interpretation by diverting attention from environmental impact to polycrisis.

The impactful research work by Will Steffen and colleagues ideally expanded this framework and identified that multiple restrictions, including ecological degradation, climate chaos, and nitrogen cycles had already been stretched beyond a level. Scholars in academia later started interrogating if international law, primarily settled around equal stature and amicable adherence to treaties, holds the organisational capacity to regulate the interconnected relationships at a planet wide scale. Renowned scholars like Frank Biermann[11] have contended that the human civilisation needs an alternative shift from fragmented environmental governance structure towards governance rooted in sustainability. He further argues that the commercial composition of international environmental law like climate management treaties, environmental conventions and protocols, ocean conservation accords and other commercial rules and mandates largely operate in exclusive capacity despite having connected ecological statistics.

His contribution in the earth governance framework explicitly mention about responsible governance structure, cooperative approach towards inter-departmental work ethics and community participation well equipped to respond to environmental integrity. Likewise, Louis Kotze has argued that environmental boundaries are a very primary mandate for a sustainable ecosystem to survive. He also highlights how the present legal mechanism is insanely centralised and overly motivated in finances and generating wealth, hence miserably failing to safeguard planetary boundaries as mandatory and enforceable agreements. Illustrative examples from global ecological conservation mechanism further accentuate these dialogues and debates. The Trail Smelter Arbitration[12] between the United States and Canada identified the fundamental doctrine that the states are obliged and must put a stop to any

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[10] Johan Rockstrom and others, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472 <https://doi.org/10.1038/461472a> accessed 24 September 2026.

[11] Frank Biermann, *Planetary Boundaries and Earth System Governance*, Ecological Economics, September 2012, V 81, pp-4-9 https://doi.org/10.1016/j.ecolecon.2012.02.016

[12] Trail Smelter Arbitration(United States vs Canada) Awards of April 16, 1938, and March 11, 1941, 3 U.N. Rep. Int'l Arb. Awards 1905 (1941) [1, 2]https://studybuddypro.com/topic/trail-smelter-

activity causing Trans boundary ecological harm within their jurisdiction. Although predetermined before the appearance of planetary limit theory, the case helped carve a pathway for identifying ecological obligations that are global and multifaceted in nature and application. Academicians of this generation resort to the Trail Smelter as a leading judgement identifying communal ecological duties and activities.

The advisory opinion of the ICJ on the usage of nuclear weapons also helped shape the environmental jurisprudence by highlighting that preserving the ecology and resources are a bare minimum activity that all states should and must adhere to. The Court also stated that environmental degradation harms the genetic lineage and national boundaries, hence expanding the need for environmental management and stewardship. Likewise, the Gabčíkovo-Nagymaros Project case[13] between Hungary and Slovakia reflected a major point of contention by vouching for sustainability as a tenet of harmonisation between ecological protection and financial growth.

More immediate issue centric climate case studies have massively extended the weightage of empirical data and facts. In the Urgenda Foundations v. State of the Netherlands case[14], the Dutch Courts relied massively on IPCC findings to hold that the government was lawfully obliged to establish and apply emission reduction strategies and mechanisms. The decision highlighted how local tribunals can adopt established scientific data and researches to clarify legal standing of a state party under environmental human rights. Similarly, in Neubauer v. Germany[15], the German constitutional court held that the failure to take any environmental action violated and damaged the concept of generational liberty by inappropriately passing the burden and trouble to future generations. These studies focus on a growing judicial indication to measure mandatory legal obligations through environmental studies and earth system stability. Another key precedent is the Inter-American Court of Human Rights Advisory Opinion OC-23/17 on the Environment and Human Rights. The Courts recognised the right to have a clean environment and insisted that's it's the prime duty of state parties to not just prevent ecological degradation, but to further help mitigate the after effects of severe environmental damage already done. The Shell climate litigation in the Netherlands also

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[13] Gabčíkovo-Nagymaros Project **is** Gabčíkovo-Nagymaros Project (Hungary/Slovakia), Judgment, I.C.J. Reports
1997, p.
[14] State of the Netherlands v. Urgenda Foundation, ECLI:NL:HR:2019:2007 (Judgment of December 20, 2019)
[15] *Neubauer v. Germany*, 1 BvR 2656/18 (along with joined cases 1 BvR 78/20, 1 BvR 96/20, 1 BvR 288/20)

reflects the on-going dialogue about environmental stewardship towards corporate organisations.

In Milieudefensie et al. v. Royal Dutch Shell,[16] The Hague district court had ordered Shell to reduce and lessen its global carbon emissions, bringing to spotlight the corporate accountability in addressing the issue of climate change. This decision marked an expanding mind-set and approach towards understanding that the ecosystem at large cannot be managed exclusively by the state parties, but should also demand cooperation from multiple stakeholders, whose work regimes greatly affect ecological management and preservation. It should be noted that on 12 November 2024, the Court of Appeal of The Hague overturned the specific 45 per cent emissions reduction target imposed by the District Court, holding that a civil court cannot mandate a fixed reduction percentage, although it upheld Shell's general duty of care to counter dangerous climate change. [17]

The Amazon rainforest case[18] is another important empirical case study within ecological conservation literature. An on-going dialogue has forever existed between the academicians, who describe the Amazon as a turning point due to its pivotal role in carbon drawdown, ecological management and hydrological equilibrium. The Amazon crisis sets an example about the discord between utilisation of resource and the global common good. It also highlights and intensifies the loopholes of the existing international regime in preventing ecological degradation happening within national and international jurisdictions, but affecting the overall global ecological balance. Likewise, the small island states' eco justice movement has gained momentum in relation to on-going negotiations on ecological governance. States like Tuvalu and the Maldives have consistently maintained their standing before international platforms and forums that spike in the oceanic levels constantly threaten their geographical placement and identity and cultural presence. Their contentions added to the request that led the International Court of Justice, on 23 July 2025, to deliver its advisory opinion recognising binding state obligations to address climate change.[19]

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[16] *Milieudefensie and others v. Royal Dutch Shell plc*, District Court of The Hague, Judgment of May 26, 2021, case number C/09/571932 / HA ZA 19-379.

[17] Burges Salmon, 'Court of Appeal of The Hague Overturns Emissions Reduction Ruling, Finding in Shell's Favour in Landmark Climate Case' (Burges Salmon, 2024) <https://www.burges-salmon.com/articles/102jos8/court-of-appeal-of-the-hague-overturns-emissions-reduction-ruling-finding-in-she/> accessed 24 September 2026.

[18] Colombian Supreme Court of Justice, Judgment STC4360-2018 (April 5, 2018).

[19] International Court of Justice, 'Obligations of States in Respect of Climate Change' (Advisory Opinion, 23 July 2025) <https://www.icj-cij.org/case/187> accessed 24 September 2026.

CONCLUSION

In conclusion, the informative material surrounding ecological boundaries and international environment law shares and reflects a subtle shift in the contemporary legal philosophy. The massive disasters in ecological systems and biodiversity have laid open the regulatory and systematic flaws of the aggressive and poor decision making by the state and hence have amplified the need for integrated ecological governance. The available empirical data largely helps shape a legal narrative and judicial interpretation, while judicial precedents and judgements reflects a spike in the elevated urgency to decode environmental mandates and obligations which are multifaceted and international in nature and are shared across generations. Likewise, summative analysis of studies from TWAIL and global south scholarship flags a cautionary approach against balanced ecological governance mechanisms that miserably fail to narrate historical injustice and regional differences. The future of international environmental law, hence lies not just in stricter regulations and but in reshaping the fragmented global management mechanism itself. A subtle and smooth shift from aggressive usage and ownership to responsible and thoughtful management, from fragmented ecological management towards sustainable usage and from voluntary initiations towards biodiversity conservation may actually decide if international law remains worthy of preserving the earth stability for future generations.

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