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Creating a Framework for Climate System Integrity in the Light of the ICJ Advisory Opinion

by Michael Obersteiner and Johannes Bednar

Lack of snowpack in 2025-2026 for Vail, Colorado, evident from bare ground and hillsides. Summer 2026 is projected to be the worst drought on record in Eagle County.

Key objectives of the United Nations Framework Convention on Climate Change (UNFCCC) aim to allow ecosystems to adapt naturally, ensure food security, and enable sustainable economic development.[1] Mitigation of risks associated with climate alteration is framed around a capped temperature target range by 2100.[2] Medium-term milestones figure as voluntary national net-zero emission pledges by 2050.[3] Issues of responsibility around the uncertain risks of climate-related impacts remain unresolved. The 2025 Advisory Opinion of the International Court of Justice (ICJ) argues that climate mitigation is a matter of state responsibility, requiring states to use all means at their disposal to prevent significant harm.[4] This article proposes a Climate System Integrity Framework (CSIF) as the basis for a precautionary approach that treats the growing atmospheric greenhouse gas stock as a form of strategic climate capital reserve, the deterioration of which would generate widespread macroeconomic and financial instability. Introducing carbon removal obligations (CROs), the

framework assigns liability for overshoot of the strategic capital reserve, and internalizes risks through interest premiums on the resulting carbon debt.[5] The article argues that central banks and prudential financial authorities are among the state institutions best positioned to support the implementation of CSIF in line with the ICJ's proposal for an international due diligence standard.[6]

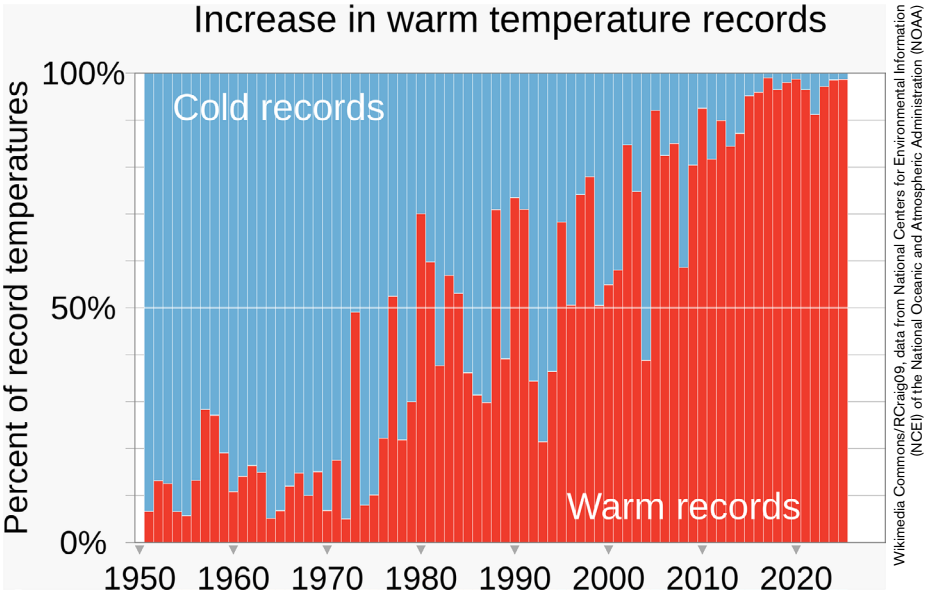

Chart showing percent of global record temperatures that are cold records or warm records.

Introduction

Greenhouse gas mitigation under the Paris Agreement is framed around temperature targets of 1.5 °C and 2 °C global warming by 2100. These targets have provided powerful focal points for international negotiations and have been conducive to ambitious emission reduction investments and net-zero pledges. By generating such voluntary national commitments to reduce greenhouse gas emissions, these targets have led to the implementation of a wide variety of climate policy actions.[7] These pledges are useful in achieving near-term policy milestones such as net-zero emission targets but have not yet led to the formulation of any long-run climate risk management frameworks. Current actions do not yet constitute a comprehensive and robust framework for managing systemic risk from climate change in the long run, allocating responsibility for the risks and resulting losses associated with climate overshoot, or coordinating institutional actions across states and within states.

The currently existing global temperature targets describe a mid-term milestone along a potential risky transient, rather than a desirable end state for a sustainable Earth and its climate.[8] As such, they offer limited guidance on how the atmospheric greenhouse gas stock should be managed over future centuries in the presence of deep uncertainty regarding climate sensitivity, climate feedbacks, and sociopolitical feasibilities. As a result, mitigation pathways are routinely presented as compatible with temperature goals even when they allow substantial overshoot, justified by assumptions about future carbon removal.[9] Overshoot is thereby normalized as a temporary deviation off trajectory, rather than being treated as a source of long-run accumulating risk requiring explicit management and governance.

The 2025 Advisory Opinion of the International Court of Justice (ICJ) fundamentally alters the judgmental context in which future governance arrangements for climate management will need to be assessed. The Court affirms that states are under binding obligations to prevent significant harm to the climate system, to act prudently on the basis of the best available scientific knowledge, and to protect the rights of present and future generations. Crucially, this formulation is cast in an explicit risk management framework that emphasizes that states must use "all means at their disposal" to fulfill these obligations. The advisory opinion also implies a duty to mobilize the full capacity of the state comprised of and coordinated by all its institutions.

Here we argue that a meaningful compliance with the ICJ's articulation of responsibility requires an augmentation of the deterministic temperature-based climate target formulation with a risk-based framework centered on long-run climate system integrity. We propose a Climate System Integrity Framework (CSIF), which treats the atmospheric greenhouse gas concentration as a prudential and sustainable climate capital stock whose deterioration is likely to generate systemic risk. The framework integrates carbon removal obligations (CROs) as a policy instrument that allocates liability of atmospheric carbon during overshoot and internalizes uncertainty. We further claim that central banks and prudential authorities are among the state institutions best positioned to support the implementation of the CSIF, consistent with their mandates for systemic stability and overall sustainability. Such provisions will expand deterministic measures of economic success from pure gross domestic product (GDP) to risk adjustment factors such as climate-related assets at risk.

A further motivation for this article concerns the regulatory and financial context within which climate mitigation decisions are made. Climate-related systemic risks remain only partially reflected in the financial assessment of individual investment projects, with the result that long-term climate risks are inadequately priced in capital allocation decisions. This is particularly consequential for publicly listed commercial entities for which the directors are subject to fiduciary duties to act in the interest of the company and its shareholders. In the absence of binding regulatory standards that internalize

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International Court of Justice in The Hague.

climate-related systemic liabilities, the voluntary pricing of long-term climate risks that materially reduce short-term financial performance may expose corporate management to governance and litigation risks. The resulting regulatory incompleteness creates a structural tension within market economies: Even firms seeking to operate responsibly face constraints when climate risks are not formally recognized within prevailing financial and prudential frameworks. By proposing carbon removal obligations within a Climate System Integrity Framework, this article addresses precisely this gap, translating climate responsibility into a liability structure that can be recognized within fiduciary governance and integrated into prudential and financial supervision.

Expanding Target-Based Climate Governance

Currently established climate target formulations, especially net-zero emission targets, have become focal points for negotiations formulating national pledges.[10] These targets structure much of the modeling and planning literature.[11] While these targets have played an important political role, their governance function remains limited. This is because the sum of climate pledges remains insufficient. Moreover, while the Paris Agreement provides a framework for progressively strengthening voluntary national climate mitigation pledges toward global net zero emissions, appropriate mechanisms for negotiating ambition levels and sharing the burdens associated with achieving net-negative emissions thereafter are still not developed. We conclude that a robust system for long-run systemic climate risk management is yet to be developed.

A central limitation of current climate governance systems lies in its treatment of temperature stabilization as an endpoint, rather than as a condition requiring continuous and robust long-run climate risk management. In the current framing, policy success is typically evaluated in terms of alignment with essentially medium-term temperature outcomes, rather than the adequacy of institutions and instruments for managing the risks and the anticipated losses associated with progressive deterioration of the climate/economic system over time. This framing relies on climate risk being path dependent and avoids the likelihood that climate-related socioeconomic risks accumulate over time during overshoot, and that temporary deviations from nominal targets can generate irreversible harm in the longer run. Overshoot is therefore normalized as a transitional feature, rather than treated as a governance failure for avoiding responsibility for associated harm and for failing to incorporate backstops.[12]

At present, most imaginable mitigation pathways consistent with the Paris Agreement will lead to a substantial overshoot of atmospheric greenhouse gas (GHG) concentrations over the coming decades before the concentrations decline later in the century. These overshoots are justified by expectations of large-scale carbon dioxide removal in the future. However, target-based climate governance provides no mechanism to allocate responsibility for delivering these removals, nor does it manage the resulting risk should they not be delivered at scale. Overshoot functions as an implicit transfer of risk from present GHG creators to future generations, without creating suitable governance frameworks regulating liability, compensation, or consent, avoiding any financial

liability for today's emitters. These are conditionalities asked for by the ICJ in its powerful advisory opinion.

Here are two relevant interpretations in line with the ICJ report:[13]

- While the emission of GHGs is not unlawful, per se, failure to take appropriate measures to prevent foreseeable harm—including through fossil fuel production and consumption, new exploration licenses, subsidies, or inadequate regulation—can constitute a wrongful act attributable to the state.
- States must regulate private actors' emissions as part of their due diligence obligations. Where states fail to do so, responsibility arises from their failure to regulate the conduct of private actors within their jurisdiction or control.

Another structural weakness of the present climate governance system lies in its treatment of uncertainty. Climate sensitivity, feedback dynamics, sociopolitical feasibility, and technological development introduce widespread uncertainties into mitigation planning. Rather than confronting these uncertainties directly, current frameworks embed it implicitly within scenario ranges. Integrated assessment models generate multiple deterministic pathways that appear orderly and internally consistent, but these pathways do not characterize uncertainties in a systematic way and often rely on optimistic and optimizing assumptions regarding future policy coordination, technological deployment of carbon removal technologies, and social acceptance.

Although science-based, this approach creates an illusion of control. By presenting uncertainty as a matter of ranges of alternative scenarios rather than as a source of risk requiring governance, current frameworks implicitly justify delay. Policymakers may hide behind slower near-term mitigation by pointing to pathways that rely on accelerated action later, even when the feasibility of such acceleration is unprecedented and uncertain. In the absence of mechanisms that adjust obligations in response to uncertainty, there is little to discourage this form of cross-generational optimism among countries pledging morally and legally justifiable climate action.

The allocation of responsibility across sovereign states is an important matter of concern raised by the ICJ advisory opinion that has received only limited attention in a global mechanism that is based on voluntary "Nationally Determined Contributions" (NDCs).[14] Furthermore, under current climate governance arrangements, only few states specify which state institutions are responsible for ensuring compliance—how responsibilities are distributed across ministries, regulators, and independent authorities of relevant climate-related risk management issues. In practice, mitigation responsibility is largely confined to environmental and energy ministries, while institutions that shape investment, credit allocation, and long-term economic trajectories remain legally and politically peripheral.

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The carbon budget frameworks have improved understanding of cumulative emissions. They describe common constraints, but do not yet create obligations or enforcement mechanisms ideally based on the principle of common but differentiated responsibility as laid down in Art. 3.1 of the UNFCCC convention. Carbon budgets are typically portrayed within deterministic settings, at least on the national level. As a result, the governance of the multitude of climate-related risks remains vulnerable to delay and to moral hazard. Emerging overshoot calculations are starting to unearth some of these misgoverning issues.

From a policy and planning perspective, this gap is significant. We argue that governance frameworks that tolerate overshoot without assigning liability are poorly equipped to manage the systemic physical and transition risks associated with climate overshoot. They allow present actors to benefit from delayed mitigation while shipping the costs and subsequent risks to unsuspecting future societies. This failure undermines precautionary policy design and weakens intergenerational justice. The limitations of today's governance system become particularly salient when viewed through the lens of legal responsibility. The advisory opinion of the International Court of Justice clarifies that states have an obligation to prevent "significant harm" to the climate system and to act with due diligence in light of scientific uncertainty. It can therefore be argued that allowing overshoot without mechanisms to manage its inherent but calculable risks might, under certain conditions, contradict the emitter responsibilities identified by the ICJ.

The challenge is therefore not simply to refine temperature targets or improve scenarios, but to develop governance frameworks capable of managing cumulative risk under uncertainty. This requires moving beyond endpoint-oriented thinking, toward approaches that establish a system of robust climate risk management as a framing that must be actively managed and maintained over time. The Climate System Integrity Framework proposed in the following could respond directly to these limitations.

Atmospheric Carbon as a Governance Object and Prudential Capital Stock

The atmospheric greenhouse gas stock is a cumulative and persistent variable for which the condition determines the evolution of systemic future climate risk. If not proactively removed, carbon dioxide remains in the atmosphere for centuries, meaning that unabated emissions today commit societies to increasing future climate risks. A prudential perspective would treat reduced levels of atmospheric carbon as a form of systemic capital buffer. Just as insufficient financial capital buffers increase the probability of financial default, excessive levels of atmospheric carbon increase the probability of destabilizing climate dynamics.[15] This can include tipping cascades and abrupt transitions.[16] Risk arises not from marginal flows alone, but from the condition of the stock relative to the system's capacity to absorb shocks without transgressing critical thresholds or dynamic system boundaries.

This perspective motivates a balance-sheet approach of assets and liabilities to climate governance. Mitigation and guaranteed removals constitute climate assets, while excess atmospheric carbon constitutes a liability. Inspired by the tolerable windows approach, the CSIF formalizes this logic by specifying a risk-informed integrity domain for the atmospheric stock of greenhouse gases, requiring states to ensure adequate risk buffers to jointly remain within the

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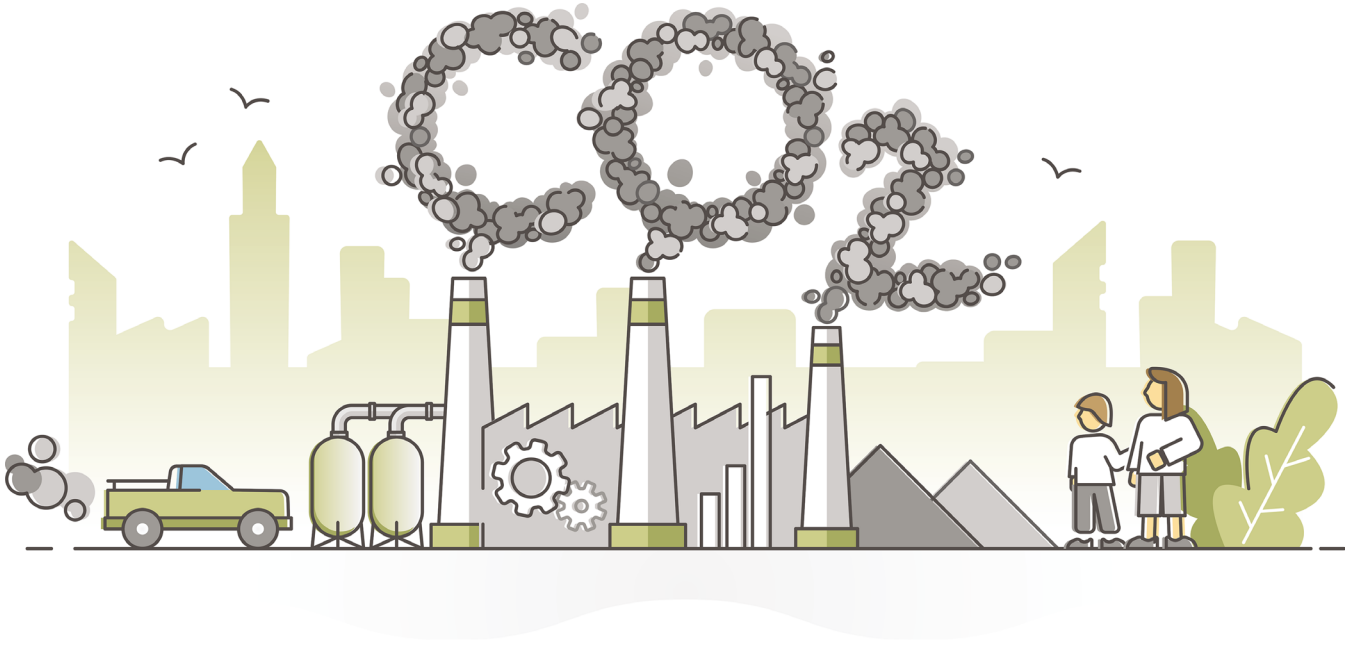

"A prudential perspective would treat reduced levels of atmospheric carbon as a form of systemic capital buffer. Just as insufficient financial capital buffers increase the probability of financial default, excessive levels of atmospheric carbon increase the probability of destabilizing climate dynamics."

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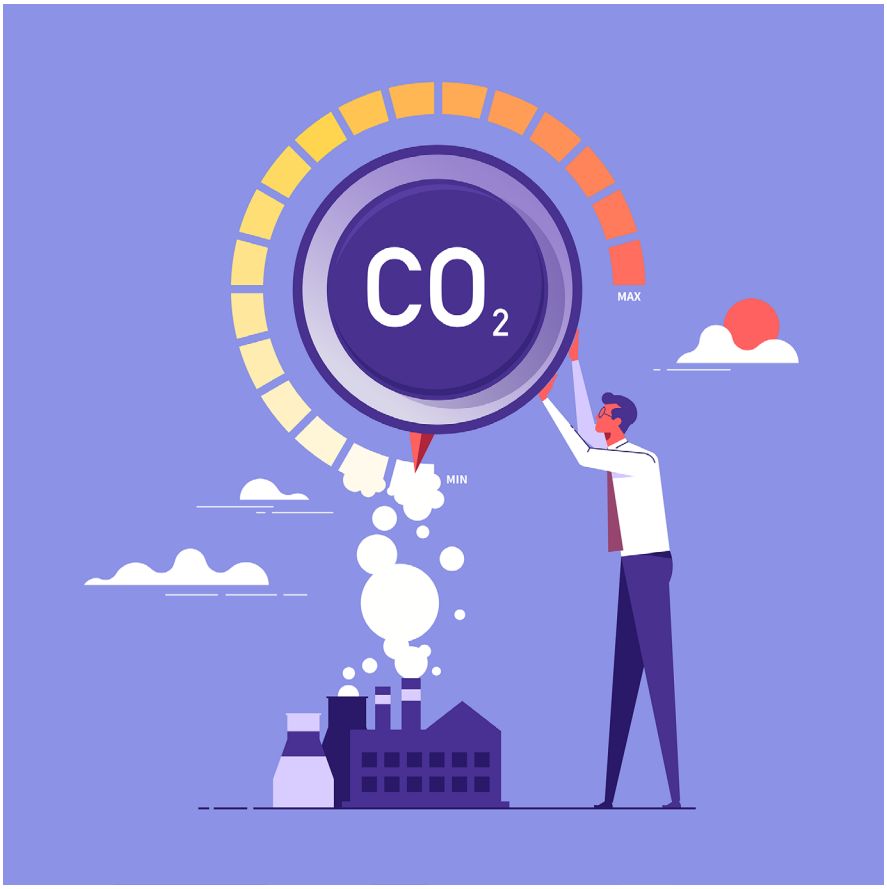

"Carbon Removal Obligations (CROs) require an emitter of a ton of carbon dioxide to remove the same amount (or a specified share larger or smaller than 100%) from the atmosphere at a specified maturity date. CROs are therefore designed to provide a mechanism for translating abstract climate goals into enforceable responsibilities."

framework.[17] Climate governance should focus on climate risk adequacy and solvency rather than on a limited and misguided ambition to simply to achieve the "right" temperature target.

Carbon Removal Obligations as a Policy Instrument for Overshoot Liability

Carbon removal obligations (CROs) require an emitter of a ton of carbon dioxide to remove the same amount (or a specified share larger or smaller than 100%) from the atmosphere at a specified maturity date. CROs are therefore designed to provide a mechanism for translating abstract climate goals into enforceable responsibilities. Within an intertemporal CSIF as proposed here, CROs serve as the central policy instrument for managing overshoot by converting excess emissions that appear unavoidable during the time to net zero emissions into explicit and financially assured liabilities. CROs generate an intertemporal requirement that must be recognized, managed, and ultimately discharged. The core logic of CROs starts with the proposition that emissions from fossil fuels do not need any longer to be viewed as "permanent" and irreversible. CO_2 emissions once emitted can be removed by the appropriately effective and regulated deployment of negative emission technologies. Emissions that push the atmospheric greenhouse gas stock beyond a risk-informed integrity envelope or peak overshoot threshold create a form of carbon debt. In current climate policy, peak overshoot is defined through the sum of all net-zero emission targets by mid-century. This debt represents a commitment to restore the climate system by removing carbon dioxide from the atmosphere past peak overshoot. Such an obligation should not be voluntary, nor should it be contingent on future political will. It should be a binding liability that accrues over the period of overshoot according to a negotiated burden-sharing formula ideally compliant to the principles of the UNFCCC as articulated in the ICJ advisory opinion.

A defining feature of CROs is that carbon debt accrues interest. Interest can be interpreted as a rental or user fee to store carbon temporarily in the atmosphere. It also reflects the financial (idiosyncratic) risk of obligated entities. This interest reflects uncertainty regarding the future feasibility, durability, and governance of carbon removal, as well as climate system uncertainties such as feedback emissions from melting permafrost.[18] The longer an obligation remains open, the greater is the risk that removal options will be constrained by ecological limits, social opposition, or political instability. By applying interest to carbon debt, CROs price uncertainty and control demand for carbon debt. There is a certain correspondence between CROs and climate risk with term structures of bond markets and their relations to expected macro-economic behavior.[19] CROs can be applied at the state, sectoral, or firm level and integrated into planning and existing financial frameworks such as carbon markets. Within the CSIF, CROs constitute the core mechanism for enforcing climate system integrity. CROs, priced at higher interest rates, strengthen incentives for early mitigation by making delayed action progressively more costly. They ensure that removal is treated as a scarce and risky resource rather than a convenient substitute for emissions reductions. In doing so, they address fundamental weaknesses of current governance by enhancing intergenerational accountability in line with the spirit of the ICJ's advisory opinion.

State Responsibility, Due Diligence, and the Distribution of Institutional Duties

The advisory opinion of the International Court of Justice clarifies that

climate obligations apply to the state as a whole. Under international law, the conduct of any state organ is attributable to the state, regardless of its degree of independence. Due diligence requires proactive and precautionary governance of foreseeable risks. Applied to climate mitigation, this implies that allowing overshoot without liability is difficult to reconcile with the duty of prevention of "significant harm." Responsibility must therefore be distributed across institutions according to capacity, rather than confined to environmental policy domains. The CSIF could therefore provide a mechanism for translating national legal responsibility into governance architecture by specifying what it means to act with due diligence in managing cumulative emissions by an explicit and ideally standardized risk calculus.

Central banks and prudential regulatory authorities are an integral part of the state system and could act as stewards of climate system integrity. Climate change increasingly manifests as a source of macroeconomic and financial instability, affecting inflation dynamics, asset valuations, fiscal space, and financial system resilience.[20] As a result, institutions charged with safeguarding systemic stability, such as central banks and prudential regulators, are becoming increasingly relevant to climate governance.[21] Through the Network for Greening the Financial System (NGFS), central banks and prudential regulators are already tasked with quantifying risk associated with mostly climate transition risks. Climate overshoot generates risks analogous to financial leverage, accumulating gradually through emissions and delayed mitigation, while materializing abruptly through disorderly transitions, physical shocks, or potential cascading systemic failures.

The Climate System Integrity Framework would provide a conceptual bridge between climate mitigation and prudential governance. By treating the atmospheric greenhouse gas stock (or concentration) as a form of systemic capital, the CSIF aligns climate risk with the logic of balance-sheet supervision. It would demand a multi-risk climate capital adequacy ratio similar to capital adequacy ratios in financial market regulation. Mitigation and guaranteed removals would function as stabilizing assets, while overshoot functions as a liability that increases systemic exposure. Central banks possess a range of instruments, such as setting interest rates, that can support climate system integrity without prescribing specific mitigation

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Wikimedia Commons/Matt Hrkac, Otway Climate Emergency Action Network Protest Against Carbon Capture and Storage

"We believe that the time has come for a serious assessment of our proposals, even though there is considerable political and ethical debate about the probity of removing overshoot carbon. This debate needs to be overcome through a robust and independently monitored CSIF and equally robust and independent application of early and increasingly punitive CROs."

pathways. Collateral frameworks, capital requirements, stress testing, and supervisory guidance all shape financial incentives and risk management practices. Integrating climate system integrity considerations into these instruments aligns with existing mandates for financial stability but remain highly contested. This is particularly the case with powerful and politically connected GHG-emitting vested interests. Engaging prudential institutions as complementary regulators reflects the requirement that states use all means at their disposal to prevent "significant" harm. In such an institutional scenario, prudential authorities act as actors independent from, but complementary to, the more volatile political process of climate policy by fulfilling a function of stewardship of systemic resilience with focus on long-run macroeconomic stability during the period of climate overshoot.

Implications for Climate Policy and Practice

A Climate System Integrity Framework consistent with the ICJ advisory opinion would complement the current framework of climate risk planning for a static warming target by a risk-augmented system of ensuring integrity through progressive emissions removal. Planning becomes iterative and adaptive, focused on risk adequacy rather than economic cost optimization, attaining an agreed warming target through global carbon budget constraints. National climate plans would include carbon debt accounts, removal obligation schedules, and integrity assessments, in addition to risk adequacy requirements for climate adaptation and residual impacts as loss and damage. Such an approach would prioritize robustness to avoid significant harm under uncertainty. Furthermore, it should facilitate coordination across policy domains through a system of multi-institutional risk management. Climate mitigation would be reframed as an ongoing stewardship task managing multiple climate-related risks and resulting losses and damages, rather than constantly struggling through transitional phases. Finally, a Climate System Integrity Framework could offer a climate governance architecture capable of operationalizing state responsibility for climate mitigation under uncertainty. By integrating legal obligations such as CROs, prudential logic, and institutional capacity, the CSIF complements existing climate agreements and strengthens the ability of states to prevent systemic climate harm.

It is easy to dismiss these propositions as idealistic and unenforceable.

The global scientific consensus remains convinced that climate futures are dangerous and damaging in all manner of ways. The present climate governance arrangements are not sufficiently reliable to change this trajectory. The ICJ advisory opinion makes it clear that the time has come to address both the knowable causes of harm and the responsibilities of state and private entities to protect the viability of the planet. We believe that the time has come for a serious assessment of our proposals, even though there is considerable political and ethical debate about the probity of removing overshoot carbon. This debate needs to be overcome through a robust and independently monitored CSIF and equally robust and independent application of early and increasingly punitive CROs.

Disclosure Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Use of Artificial Intelligence

During the preparation of this article the authors used artificial intelligence–based language assistance tools to improve clarity, readability, and conciseness of the text, including limited text shortening, and the authors take full responsibility for the content of the article.

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