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ORIGINAL ARTICLE

INTERNATIONAL LAW AND PRACTICE

Climate tipping points: Tracing the limits of political discretion

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Abstract

States' current emission policies are far from being aligned with what is needed to meet the Paris Agreement's temperature goal. Against this backdrop, an increasing number of lawsuits have been filed around the world. As of March 2024, most courts have exercised restraint in imposing substantive limits on the legislator's discretion in determining emission levels. Judicial restraint commonly rests on two premises: Climate models yield wide uncertainty ranges and choosing emission reduction levels is a normative decision belonging to the political domain. By engaging best available science on climate tipping points, this article examines the reasoning in favour of political discretion through a due diligence and equity lens. The analysis concludes that all factual requirements are met for states to be under an obligation to align their mitigation policies with a global carbon budget which is expected to limit global warming to 1.5°C at a likelihood as high as state capacities allow for.

Keywords: climate litigation; emission reduction obligations; equity principle; prevention principle; tipping points

1. Introduction

While the Paris Agreement is the one international treaty to include a temperature target, there are conflicting views among states and within the legal community as to which specific obligations the 2–1.5°C target entails for states. The gaping divide¹ between current emission policies and what is needed 'to prevent dangerous anthropogenic' climate change in accordance with the 'ultimate objective' of the United Nations Framework Convention on Climate Change (UNFCCC),² leaves no doubt as to the fact that many states exercise wide discretion in interpreting the Paris temperature target and specifying their climate obligations. In response to this alarming emissions gap, climate litigation cases have been on the rise across the globe. As of March 2024, most courts,

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¹IPCC, 'Summary for Policymakers', in H. Lee et al. (eds.), *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (2023), para. A.4.3; Climate Action Tracker (CAT), 'Warming Projections Global Update – November 2021', 9 November 2021, available at climateactiontracker.org/documents/997/CAT_2021-11-09_Briefing_Global-Update_Glasgow2030CredibilityGap.pdf.

²1992 United Nations Framework Convention on Climate Change, 1771 UNTS 107, Art. 2.

mindful of the constitutional division of roles between the legislative and the judiciary, have exercised restraint with respect to substantively specifying states' emission reduction obligations. While courts increasingly impose procedural obligations on the political branches of government,³ in substantive terms, the legislator generally continues to be afforded major discretion for reasons of democratic legitimization given the uncertainty underlying climate models and the inevitably normative quality of decisions specifying which levels of greenhouse gas emissions are permissible.⁴ This article explores this reasoning in favour of political discretion by examining the substance of extant knowledge and uncertainty concerning climate tipping points through a due diligence and equity lens. In doing so, the article aims to shed light on the question of which maximum global temperature pathway the remaining global carbon budget is to be aligned with.

The article unfolds in six stages. Following this Introduction (Section 1), Section 2 briefly discusses the extant emissions gap and subsequently deals with recurring lines of judicial reasoning granting substantive discretion to the political branches of government in devising emission policies. Section 3 engages with best available science⁵ to analyse the state of knowledge on the relationship between global warming and tipping points. Subsequently, the article examines the current state of knowledge or lack thereof as to its legal implications under treaty law (Section 4.1) and the principles of due diligence and equity (Section 4.2). Section 4.3 engages with the judicial concern of democratic legitimization in light of severity and irreversibility aspects relevant in the context of tipping points. Section 5 further explores these aspects as to their implications for the legal operationalization of tipping thresholds by drawing on philosophical logic. In light of best available science on tipping points, Section 6 offers a summary of the way in which factual requirements are met for treaty, equity, and due diligence obligations to require states to pursue a warming limit below tipping thresholds.

2. Judicial responses to the emissions gap

2.1 The emissions gap

In its latest Assessment Report (AR6), the IPCC identified:

a substantial “emissions gap” ... between global ... emissions in 2030 associated with the implementation of NDCs [nationally determined contributions] announced prior to COP 26 [in Glasgow in 2021] and those associated with modelled mitigation pathways that limit warming to 1.5°C ... or ... to 2°C⁶

³Note that this article uses the term ‘political branches of government’ to refer to the legislative and executive branches of government.

⁴On how stringent procedural obligations may amount to restricting political discretion in substantive terms, see the Postscript (text at notes 165–171, *infra*) on the European Court of Human Right’s ruling of April 2024 in the case of *Verein KlimaSeniorinnen Schweiz and others v. Switzerland*.

⁵The obligation to act in line with best available science is included in Arts. 4.1 and 14.1 of the Paris Agreement (2015 Paris Agreement, 55 ILM 740). In line with the principles governing IPCC work, IPCC reports are to ‘represent the latest scientific ... findings’, the views of ‘as many experts as possible’, be ‘as comprehensive as possible’ and undergo ‘an objective, open and transparent review process’ (IPCC, ‘Appendix A to the Principles Governing IPCC Work’, adopted at the Fifteenth Session in April 1999, last amended at the Thirty-Seventh Session in October 2013, available at www.ipcc.ch/site/assets/uploads/2018/09/ipcc-principles-appendix-a-final.pdf, at 6). The case has been made in international legal scholarship that these IPCC criteria serve as a valuable source for identifying best available science (K. Cook, ‘Judging “Best Available Science”: Emerging Issues and the Role of Experts’, (2018) 9 *Journal of International Dispute Settlement* 388). As argued in Section 3 below, consensus among epistemic communities is a powerful marker for reliability, and causal relationships described by the IPCC as unequivocal and virtually certain are to be considered scientific facts (see text at notes 74–79, *infra*). Lack of scientific consensus, however, does not translate to lack of best available science. Methodological robustness, such as non-bias, non-arbitrariness and the use of latest available data, are among the factors that are decisive in qualifying as best available science.

⁶See IPCC, *supra* note 1, para. A.4.3.

The IPCC specifies that the pathways consistent with 2030 NDCs announced ahead of COP 26 project an average global warming of 2.8°C by the end of the century.⁷ The Climate Action Tracker (the Tracker) observed ‘a massive credibility, action and commitment gap’ when analysing the climate pledges that states went on to make at COP 26, finding that then current emission policies put the world on track for a 2.7°C temperature rise by 2100.⁸ Two years on, the Tracker finds that global emission policies are still aligned with the same warming level.⁹ In the AR6, the IPCC found that ‘limited policies are ... in place to deliver on’ the ‘signalled ... intention[s] to achieve net zero’ by 2050.¹⁰ Indeed, none of the 40 countries covered by the Tracker’s current assessment have climate policies in place which are compatible with limiting global warming to 1.5°C. More than three quarters of all countries assessed are acting in line with a global temperature rise ranging between more than 2°C to more than 4°C by the end of the century according to the Tracker.¹¹ This indicative assessment speaks clearly as to the fact that states tend to exercise wide discretion in interpreting their obligations flowing from the Paris Agreement’s temperature goal. As a response to the alarming emissions gap, lawsuits are being filed across the globe claiming a violation of states’ legal obligations due to actions and omissions contributing to climate change. Courts amenable to this argument have increasingly started imposing procedural obligations on the political branches of government.¹² In substantive terms, however, courts tend to afford considerable discretion to the legislator when it comes to translating states’ climate obligations into specific emission reduction levels.¹³

2.2 Key variables in specifying states’ mitigation obligations

When specifying states’ obligations in this respect, the main substantive questions applicable concern which global temperature pathway is to be pursued and how the corresponding global carbon budget is to be distributed equitably among states. Both these questions are of critical importance when it comes to specifying states’ mitigation obligations in line with equity and best available science as mandated by the Paris Agreement.¹⁴ The distribution question has already been dealt with in interdisciplinary scholarship arguing that statistical methods are available which allow to distribute a given global carbon budget among states in a manner that comprehensively and transparently operationalizes the equity principle and is thus apt to ‘inform climate litigation’.¹⁵ This article thus focuses on contributing to tackling the first question, i.e., how to define the size of the global carbon budget in line with equity and best available science? Answering this question is a key prerequisite to then apply any distribution key identified in response to the second question. In this sense, transparency as to the size of an equitable global

⁷*Ibid.*

⁸See CAT, *supra* note 1.

⁹CAT, ‘Projected Warming Almost Unchanged for Two Years as Governments Push False Solutions over Climate Action’, 5 December 2023, available at climateactiontracker.org/press/release-projected-warming-almost-unchanged-for-two-years-as-governments-push-false-solutions-over-climate-action/.

¹⁰See IPCC, *supra* note 1, at para. A.4.3.

¹¹CAT, ‘Countries’, available at climateactiontracker.org/countries/ and climateactiontracker.org/countries/rating-system/.

¹²See, among many, Irish Supreme Court, *Friends of the Irish Environment CLG v. The Government of Ireland* [2020]; German Federal Constitutional Court, Order, 24 March 2021, 1 BvR 2656/18; *Commune de Grande-Synthe v. French Government* [2021]. At the time of writing, the latter case is pending before the Grand Chamber of the European Court of Human Rights (*Carême v. France*, App. no. 7189/21) as are the cases of *Verein KlimaSeniorinnen Schweiz and others v. Switzerland*, App. no. 53600/20 and *Duarte Agostinho and Others v. Portugal and 32 other States*, App. no. 39371/20.

¹³See text at notes 17–21, *infra* and cf. *supra* note 4 and the Postscript (text at notes 165–171, *infra*).

¹⁴See Paris Agreement, *supra* note 5, Arts. 2(2), 4(1), 4(3), 14(1).

¹⁵L. Rajamani et al., ‘National “Fair Shares” in Reducing Greenhouse Gas Emissions within the Principled Framework of International Environmental Law’, (2021) 21 *Climate Policy* 983, at 983, 1000; V. Ritz, ‘Towards a Methodology for Specifying States’ Mitigation Obligations in Line with the Equity Principle and Best Available Science’, (2023) 12 *Transnational Environmental Law* 95.

carbon budget is an essential guardrail in ensuring and reviewing the equitability of individual states' emission policies. To contribute to this quest, this article engages with the question as to what maximum temperature rise states are obliged to pursue in light of best available science on climate tipping points – a key step in defining the global carbon budget in line with equity and best available science. As of March 2024, most courts have generally displayed notable restraint in terms of providing specific answers to any of these questions.¹⁶ Two premises have commonly been engaged in support of this judicial stance.

2.3 The normativity premise

The first premise concerns the fact that devising mitigation policies is an inherently normative undertaking. In emphasizing this fact, several judicial bodies conclude that devising mitigation policies falls within the competence of the legislator for reasons of democratic legitimization. It is in this vein that the Dutch Supreme Court held in its landmark *Urgenda* judgment that specifying states' mitigation obligations 'in concrete terms ... belongs, in principle, to the political domain, both internationally and nationally'.¹⁷ While the Dutch Court concluded that the judiciary is, however, authorized to define a minimum threshold, the US Ninth Circuit Court of Appeals in its 2020 *Juliana* ruling 'reluctantly' found that decisions on reducing greenhouse gas emissions and tackling climate change exclusively fall within the competence of the 'political branches of government' and exceed the 'constitutional power' of the judiciary.¹⁸ Similarly, in finding that the Australian government was not under a duty of care to protect young people from the consequences of global warming and thereby overturning a previous landmark decision, the Federal Court of Australia expressed its view that it is not for the judiciary to determine climate policies. Rather, Justice Allsop opined that:

decisions that involve certain types of policy and which may have important physical consequence upon the lives, health, well-being, property and economic interests of people may be made by government in its decision-making role in the interests of the polity which cannot be judged by a legal standard ... There are choices to be made by ... reference to political and democratic choices involving relationships of interests incommensurable by reference to any legal standard and which are appropriate for democratic (that is political) accountability ...¹⁹

The Supreme Court of Norway arrived at a similar conclusion when tracing the delineation between judicial and legislative powers in the climate context. The Norwegian Court did acknowledge the judiciary's mandate to review political majority decisions as to their conformity with constitutional values. At the same time, it noted that decisions on environmental matters frequently warrant 'a political balancing of interests and broader priorities'.²⁰ In conclusion, the

¹⁶A growing number of courts is, however, increasingly holding governments accountable with respect to meeting targets already set by national law. See, e.g., *Commune de Grande-Synthe*, *supra* note 12, paras. 2, 6 and Art. 1; *Friends of the Earth*, *supra* note 12.

¹⁷*The State of the Netherlands v. Urgenda Foundation* [2019], paras. 6.1, 6.2.

¹⁸*Juliana v. United States* [2020], at 11, 25. Note, however, that, in June 2023, the court of lower instance, the Oregon federal district court, allowed the plaintiffs to amend their complaint to assert that the federal government violated the plaintiff's constitutional rights to a stable climate system (*Juliana v. United States* [2023]). In December 2023, the Oregon federal district court denied the federal government's subsequent motion to dismiss the plaintiff's amended complaint (*Juliana v. United States* [2023]).

¹⁹*Minister for the Environment v. Sharma* [2022], FCAFC 35, para. 238.

²⁰*Nature and Youth Norway and others v. The State* [2020], para. 141.

Court held that '[d]emocracy considerations . . . suggest that such decisions should be made by popularly elected bodies, and not by the courts'.²¹

2.4. The uncertainty premise

Apart from the normativity involved in devising climate policies, the argument in favour of considerable political discretion is frequently buttressed by the scientific uncertainty inherent in climate models. The ultimate subject of this uncertainty concerns the exact consequences that specific levels of global warming entail. Arguably, the most pressing concern in this context revolves around the triggering of tipping points in the climate system. In its climate judgment of March 2021, the German Constitutional Court took note of this impending danger and the IPCC's finding that a maximum 1.5°C global temperature rise clearly decreases the likelihood of tipping points being surpassed.²² Ultimately, however, the German Court found that 'given the considerable uncertainty which the IPCC itself has documented by stating ranges and levels of confidence, the legislator presently retains significant decision-making leeway in fulfilling its duty of protection arising from fundamental rights . . .' and hence choosing which global temperature target to pursue.²³ A few months after the rendering of the German judgment, the IPCC published the first part of the AR6 which, arguably, does not contradict the judicial finding as to the existence of scientific uncertainties surrounding tipping points. Indeed, the Working Group I (WG I) contribution states that '[e]stablishing links between specific GWLs [global warming levels] with tipping points and irreversible behaviour is challenging due to model uncertainties and lack of observations . . .'.²⁴

Important similarities exist between legal and scientific approaches to (un)certainty. As Kaye writes:

[E]vidence is central to law and to science. The differences in the procedures for establishing facts in the two realms are starkly different, but the differences are explicable and, in a sense, superficial. The proof of facts, in law as in science, ultimately is a matter of inductive logic, and, I believe, the same logic governs both enterprises.²⁵

The starkest difference between law and science in this respect is rooted in the fact that the law, unlike science, 'has a need for decisive endings' and therefore must reach decisions where 'science . . . would be neither willing nor able to declare a winner'.²⁶ Basing decisions on perfection and complete certainty is thus an indulgence the legal community can seldom afford and hardly so when called upon to decide on the (un)lawfulness of states' actions and omissions that pose risks to life of an unprecedented scale in terms of both severity and irreversibility.

²¹*Ibid.* The Norwegian Supreme Court further notes that 'the courts must exercise restraint in reviewing the political balancing of interests' (*ibid.*, para. 182) and that the Norwegian Parliament 'has on a number of occasions discussed bills for complete or partial out-phasing of the Norwegian petroleum production due to the global greenhouse gas emissions' and that '[a]ll [such] propositions have been rejected with a broad political majority' (*ibid.*, para. 236).

²²German Federal Constitutional Court, Order, 24 March 2021, 1 BvR 2656/18, para. 161.

²³*Ibid.*, paras. 161–162.

²⁴P. A. Arias et al., 'Technical Summary', in V. Masson-Delmotte et al. (eds.), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (2021), 33, at 59. In the same vein, the WG I notes that '[d]ifficulties persist in determining the likelihood of occurrence and time frame of potential tipping points . . .' (S. I. Seneviratne, 'Weather and Climate Extreme Events in a Changing Climate', in *ibid.*, at 1534).

²⁵D. H. Kaye, 'Proof in Law and Science', (1992) 32 *Jurimetrics Journal* 313, at 318.

²⁶S. Jasanoff, *Science at the Bar: Law, Science, and Technology in America* (2009), 10.

2.5 On the need for a critical examination of the normativity and uncertainty premises

As outlined above, political discretion – claimed and granted on grounds of normativity and uncertainty – has so far translated into state climate policies that figure on the lower end of the ambition scale in terms of countering the risks of tipping points or cascading effects, putting the world on track for a global warming level of ‘about 2.7°C by the end of the century.’²⁷ Meanwhile, the WG I finds there is ‘high confidence’ that even at 1.5°C of global warming there will be a rise in ‘extreme events unprecedented in the observational record’.²⁸ Any ‘additional increment of global warming’ further increases ‘changes in extremes’, including the risk of tipping points being crossed.²⁹ Against this backdrop, a deep feeling of unease materializes with respect to the reasoning traced so far which, in building on the premises of normativity and uncertainty, derives legitimization for wide political discretion when it comes to specifying states’ climate obligations. To systematically confront this unease, it is imperative to examine the state of knowledge and uncertainty surrounding the relationship between global warming levels and tipping points and to conduct such analysis in light of the power and limits of human knowledge generally. It is against this backdrop that the final part of the article will turn to the question of normativity, focusing on the question of how states’ mitigation obligations *de lege lata* are to be interpreted in light of the analysed state of scientific knowledge on tipping points.

3. Tipping points – The state of knowledge and uncertainty

The IPCC defines tipping points as ‘critical thresholds beyond which a system reorganizes, often abruptly and/or irreversibly’, where ‘abruptly’ refers to ‘large-scale abrupt change in the climate system that takes place over few decades or less, persists . . . for at least a few decades and causes substantial impacts in human and/or natural systems’.³⁰ The IPCC considers such ‘a perturbed state of a dynamical system . . . as irreversible on a given time scale if the recovery from this state due to natural processes takes substantially longer than the time scale of interest’.³¹ In its latest Assessment Report the IPCC has identified a range of ‘tipping elements’, i.e., components in the Earth system that are ‘susceptible to a tipping point’,³² and assessed them as to their potential for triggering abrupt and/or irreversible change.³³ According to the IPCC, there is high confidence that the following tipping elements are susceptible to both abrupt and irreversible change: permafrost carbon, the West Antarctic ice sheet and shelves, global sea-level rise, ocean acidification and ocean deoxygenation.³⁴ A related but distinct question concerns the effect of global warming on such tipping elements. Importantly, in this regard, the IPCC’s WG I not only states that ‘[e]stablishing links between specific GWLs with tipping points and irreversible

²⁷See (text at) note 8, *supra*.

²⁸IPCC, ‘Summary for Policymakers’, in Masson-Delmotte et al. (WG I), *supra* note 24, at 19, para. B.2.2. See also IPCC, ‘Summary for Policymakers’, in H. O. Pörtner et al. (eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (2022), 3, at 15, para. B.3.

²⁹See IPCC, *supra* note 1, paras. B.1.3., B.3.2; IPCC (WG II), *supra* note 28, para. B.4. On the ‘additional severe risks’ of temporarily exceeding 1.5°C see *ibid.*, para. B.6.

³⁰See J.-Y. Lee et al., ‘Future Global Climate: Scenario-Based Projections and Near-Term Information’, in Masson-Delmotte et al. (WG I), *supra* note 24, at 633.

³¹See IPCC, ‘Annex VII: Glossary’, in Masson-Delmotte et al. (WG I), *ibid.*, at 2236.

³²See Lee et al., *supra* note 30, at 633.

³³*Ibid.*, at 634.

³⁴The IPCC’s analysis includes an assessment of the time scales at which change is (ir)reversible ‘if forcing reversed’. According to the IPCC, there is ‘high confidence’ that the decline in permafrost carbon is ‘irreversible for centuries’. For the West Antarctic Ice Sheet and Shelves, the IPCC concludes there is ‘high confidence’ that change is ‘irreversible for decades to millennia’. In terms of global sea-level rise, the IPCC expresses ‘very high confidence’ that change is ‘irreversible for centuries’. While ocean acidification and deoxygenation is ‘reversible at surface’, there is ‘very high confidence’ according to the IPCC that it is ‘irreversible for centuries to millennia at depth’ (*ibid.*).

behaviour is challenging due to model uncertainties and lack of observations . . .'.³⁵ Rather, this passage in the WG I contribution to the AR6 continues as follows: 'the occurrence [of tipping points, however,] cannot be excluded, and their likelihood of occurrence generally increases at greater warming levels'.³⁶ The AR6 Synthesis Report emphasizes this finding, concluding there is 'high confidence' that '[t]he likelihood and impacts of abrupt and/or irreversible changes in the climate system, including changes triggered when tipping points are reached, increase with further global warming'.³⁷

From these IPCC findings, it is to be deduced that the existence of tipping points *per se* and their susceptibility to global warming is not subject to noteworthy challenges. The question that remains is which specific global warming levels will trigger tipping points. Understanding the substance of the uncertainty surrounding this latter question engaging with the best available science on this matter.

One year after the release of the WG I contribution to the AR6, *Science* published a study by Armstrong McKay et al. finding that it is likely for three tipping points involving 'global climate changes'³⁸ to be triggered and possible for another such 'global "core" . . . element' to cross a tipping point within the Paris temperature range.³⁹ More specifically, the authors find it is likely that at 1.5°C of warming the Greenland and the West Antarctic ice sheets will collapse. According to the authors, at 1.8°C the North Atlantic subpolar gyre convection,⁴⁰ which is a branch of the Atlantic Meridional Overturning Circulation, will likely collapse. They find it is possible that the entire Atlantic Meridional Overturning Circulation will collapse within the Paris temperature range.⁴¹

The authors base their findings on evidence extracted from a synthesis of a wide range of 'paleoclimate,⁴² observational, and model-based studies', producing what they argue is the first comprehensive reassessment of tipping elements, their tipping points and impacts in 15 years.⁴³ In 2008, Lenton et al. for the first time identified nine policy-relevant tipping elements – including the Atlantic Meridional Overturning Circulation and the Greenland and the West Antarctic ice sheets – and produced estimates as to their tipping points.⁴⁴ Between 2015 and 2019, four further prominent studies were published in this field.⁴⁵ These studies engaged with tipping elements identified by Lenton et al. in 2008, proposed further tipping elements and produced estimates as to their thresholds. In providing the first comprehensive meta-assessment of this literature and the general state of research, Armstrong McKay et al. extract information on evidence for the tipping points identified to date and produce best estimates of temperature thresholds, timescales and

³⁵See (text at) note 24, *supra*.

³⁶See Arias et al., *supra* note 24, at 59.

³⁷See IPCC, *supra* note 1, para. B.3.2.

³⁸The IPCC uses this term in the AR6, see Lee et al., *supra* note 30, at 633.

³⁹D. I. Armstrong McKay et al., 'Exceeding 1.5°C Global Warming Could Trigger Multiple Climate Tipping Points', (2022) 377 *Science* 1.

⁴⁰As Armstrong McKay et al. note, the North Atlantic subpolar gyre convection is '[e]ffectively a branch of . . . [the Atlantic Meridional Ocean Circulation] with marginally smaller consequences but a much lower warming threshold in models that do resolve it' (See Armstrong McKay et al., 'Supplementary Materials for Exceeding 1.5°C Global Warming Could Trigger Multiple Climate Tipping Points', *supra* note 39, at Table S3).

⁴¹*Ibid.*

⁴²Paleoclimatology is defined as 'the study of ancient climates, prior to the widespread availability of instrumental records'. See National Centers for Environmental Information, 'What Is Paleoclimatology?', available at www.ncel.noaa.gov/news/what-is-paleoclimatology.

⁴³See Armstrong McKay et al., *supra* note 39, at 1.

⁴⁴T. Lenton et al., 'Tipping Elements in the Earth's Climate System', (2008) 105 *Proceedings of the National Academy of Sciences* 1786.

⁴⁵H. Schellnhuber, S. Rahmstorf and R. Winkelmann, 'Why The Right Climate Target Was Agreed in Paris', (2016) 6 *Nature Climate Change* 649; W. Steffen et al., 'Trajectories of the Earth System in the Anthropocene', (2018) 115 *Proceedings of the National Academy of Sciences* 8252; T. Lenton et al., 'Climate Tipping Points – Too Risky to Bet Against', (2019) 575 *Nature* 592; S. Drijfhout et al., 'Catalogue of Abrupt Shifts in Intergovernmental Panel on Climate Change Climate Models', (2015) 112 *Proceedings of the National Academy of Sciences of the United States of America* 5777.

climate impacts by ‘us[ing] expert judgment’.⁴⁶ For each tipping element the authors draw up ‘estimates of central, minimum and maximum temperature thresholds’.⁴⁷ A confidence level ranging from ‘very low’ to ‘very high’ is assigned to each estimate in line with the IPCC’s confidence rating system. The latter provides that any confidence level is to ‘synthesize the author teams’ judgments about the validity of findings as determined through evaluation of evidence and agreement’.⁴⁸ Importantly, Armstrong McKay et al. define crossing a tipping point as ‘possible’ where global warming levels exceed the minimum temperature threshold and as ‘likely’ where warming levels exceed the central temperature threshold, i.e., the best estimate.⁴⁹ In line with scientific practice, the supplementary material accompanying the study explicates the reasons and evidence on which the various estimates and confidence levels rest.

Based on this methodology, Armstrong McKay et al. assign high confidence to their estimates of temperature thresholds for the collapse of the Greenland and West Antarctic ice sheet.⁵⁰ Among others, these estimates are based on paleoclimate evidence according to which both ice sheets collapsed within the Paris temperature range in past warm interglacial periods.⁵¹ Their estimate as to 1.8°C of warming being likely to trigger the collapse of the North Atlantic subpolar gyre convection is based on models from the Coupled Model Intercomparison Project (CMIP) which is led by the World Climate Research Programme and informs IPCC Assessment Reports.⁵² Armstrong McKay et al. find that several CMIP-models yield results consistent with 1.8°C being the best estimate and therefore assign a high level of confidence to it.⁵³

Armstrong McKay et al.’s use of likelihood and confidence as degrees of evidence in producing their estimates inevitably points to the existence of scientific uncertainty as to the global warming levels that will trigger tipping points. In fact, models on the collapse of the *entire* Atlantic Meridional Overturning Circulation, for instance, yield a large range and dispersion of values for temperature thresholds. While Drijfhout et al. estimated 1.6°C of warming to be a likely threshold in a study published in 2015,⁵⁴ Armstrong McKay et al. produce a central estimate of 4°C, a minimum estimate of 1.4°C and a maximum of as high as 8°C.⁵⁵ In light of the ‘wide range and lack of agreement amongst models’, Armstrong McKay et al. assign low confidence to these threshold estimates.⁵⁶ As far as the temperature threshold for the collapse of the Greenland and West Antarctic ice sheets is concerned, Armstrong McKay et al.’s finding differs substantially from that of the IPCC. While Armstrong McKay et al. conclude there is high confidence that 1.5°C of warming will likely trigger the collapse of both ice sheets,⁵⁷ the WG I finds there to be only ‘limited

⁴⁶See Armstrong McKay et al., ‘Supplementary Materials’, *supra* note 40, at 1.

⁴⁷*Ibid.*

⁴⁸*Ibid.*, and M. D. Mastrandrea et al., ‘Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties’, Intergovernmental Panel on Climate Change, 2010, available at www.ipcc.ch/site/assets/uploads/2018/05/uncertainty-guidance-note.pdf, at 3.

⁴⁹See Armstrong McKay et al., ‘Supplementary Materials’, *supra* note 40, at 1.

⁵⁰Armstrong McKay et al.’s high confidence rating is ‘based on multiple consistent estimates from different evidence bases (modelling and paleorecords).’ (*ibid.*, at S2.1).

⁵¹*Ibid.*, at Table S3.

⁵²See World Climate Research Programme, ‘WCRP Coupled Model Intercomparison Project (CMIP)’, 14 October 2022, available at www.wcrp-climate.org/wgcm-cmip.

⁵³See Armstrong McKay et al., ‘Supplementary Materials’, *supra* note 40, at S2.2. Note that the North Atlantic subpolar gyre convection is also referred to as Labrador-Irminger Sea Convection.

⁵⁴See Drijfhout et al., *supra* note 45, Supporting Information, at 12 (Table S1). See also Armstrong McKay et al., ‘Supplementary Materials’, *supra* note 40, at Table S1.

⁵⁵See Armstrong McKay et al., *ibid.*, at S2.2.

⁵⁶*Ibid.*

⁵⁷Note that this implies that Armstrong McKay et al. consider it possible for tipping points in the cryosphere (i.e., the frozen water in the Earth’s system) to already be crossed at a lower degree of warming (see text at note 49, *supra*). Indeed, in a study published in 2019, Lenton et al. reported that ‘several cryosphere tipping points are dangerously close’ and that ‘the Amundsen Sea embayment of West Antarctica might have passed a tipping point’ (see Lenton et al., *supra* note 45, at 592).

evidence' that these ice sheets will be 'lost almost completely and irreversibly' at warming levels of between 2°C and 3°C.⁵⁸

While this disparity in findings provides a telling story of extant epistemological uncertainty, it is important to bear in mind that disagreement in the course of epistemic investigation is a natural part of the scientific endeavour and that, arguably, it is a necessary condition for the progress of scientific insights. Notably, the 'essence' of the task incumbent on IPCC lead authors does not consist in 'writ[ing] original text themselves' but in 'synthesis[ing] . . . material drawn from available literature' and 'faithfully represent[ing] . . . contributions by a wide variety of experts'.⁵⁹ Published one year after the WG I contribution to the AR6, Armstrong McKay et al.'s study – arguably, the first comprehensive reassessment of tipping elements, their tipping points and impacts in 15 years⁶⁰ – was not part of the body of literature on which the WG I based its assessment. The same applies to a study on 'safe and just earth system boundaries' published in *Nature* in May 2023 that endorses Armstrong McKay et al.'s high confidence finding that major climate tipping points will likely be triggered within the Paris temperature range.⁶¹ Similarly, the Global Tipping Points Report of December 2023 had not yet been released – a report led by Timothy Lenton, which saw the participation of more than 200 researchers⁶² and which emphasizes that the likelihood of transgressing tipping points 'will likely grow substantially beyond 1.5°C'.⁶³ The report frequently draws on Armstrong McKay et al.'s study, including their best estimates for the Greenland ice sheet and the North Atlantic subpolar gyre convection.⁶⁴ As to the West Antarctic ice sheet, the report notes that threshold estimates range between 1°C and 3°C.⁶⁵ According to the report's website, the scientific content of the report's chapters on tipping points in the cryosphere and ocean circulation is based on manuscripts that, as of March 2024, are in preparation for submission or have been submitted to peer-reviewed scientific journals but have not been published there yet.⁶⁶

Generally, when gauging any disparity in threshold estimates, it is also necessary to bear in mind that absolute certainty is *a priori* unattainable in the scientific enterprise, given that there can never be an absolute body of evidence.⁶⁷ Inferring laws of nature from observed events necessarily involves a degree of generalization and probability if only because it is by definition impossible to provide absolute proof that the future will be like the past.⁶⁸ Absolute certainty in the

⁵⁸R. Ranasinghe et al., 'Climate Change Information for Regional Impact and for Risk Assessment', in Masson-Delmotte et al. (WG I), *supra* note 24, at 1861.

⁵⁹Annex 1, 'Tasks and Responsibilities for Lead Authors, Coordinating Lead Authors, Contributing Authors, Expert Reviewers and Review Editors of IPCC Reports and Government Focal Points', in IPCC, 'Appendix A', *supra* note 5, at 14.

⁶⁰See (text at) note 43, *supra*.

⁶¹J. Rockström et al., 'Safe and Just Earth System Boundaries', (2023) 619 *Nature* 102, at 104 and Table 1. The authors note that they 'rely on [Armstrong McKay et al.'s] . . . datasets for the climate boundary' (*ibid.*).

⁶²University of Exeter, 'Global Tipping Points – Report 2023', available at report-2023.global-tipping-points.org/.

⁶³S. Constantino et al., 'Tipping Point Impact Governance', in T. Lenton et al. (eds.), *The Global Tipping Points Report 2023* (2023), available at report-2023.global-tipping-points.org/download/4608/, 252.

⁶⁴R. Winkelmann et al., 'Tipping Points in the Cryosphere', in Lenton et al., *supra* note 63, at 63; S. Loriani et al., 'Tipping Points in Ocean and Atmosphere Circulations', in *ibid.*, at 134; D. Armstrong McKay and S. Loriani, 'Earth System Tipping Points', in *ibid.*, at 54.

⁶⁵See Winkelmann et al., *supra* note 64, at 65.

⁶⁶See 'Tipping Points in the Cryosphere', available at report-2023.global-tipping-points.org/section1/1-earth-system-tipping-points/1-2-tipping-points-in-the-cryosphere/ and 'Tipping Points in Ocean and Atmosphere Circulations', available at report-2023.global-tipping-points.org/section1/1-earth-system-tipping-points/1-4-tipping-points-in-ocean-and-atmosphere-circulations/.

⁶⁷A. Gallant and S. Lewis, 'Penguins Can't Fly and Humans are Causing Climate Change: How Scientists Build Theories', *The Conversation*, 20 August 2013, available at theconversation.com/penguins-cant-fly-and-humans-are-causing-climate-change-how-scientists-build-theories-15348.

⁶⁸The assumption of the future being like the past is commonly referred to as the 'uniformity principle'. See L. Henderson, 'The Problem of Induction', in E. N. Zalta and U. Nodelman (eds.), *The Stanford Encyclopedia of Philosophy* (2022), available at plato.stanford.edu/archives/win2022/entries/induction-problem/.

philosophical sense is thus an unavailable standard of evidence in the scientific enterprise generally and even more so where the aim is not just to explain natural processes but make projections as to how they will unfold in future.⁶⁹ It follows that absolute proof for the accuracy of Armstrong McKay et al.'s temperature threshold estimates or for those included in the IPCC Assessment Report, or for any other higher or lower estimates, is unattainable. As Newton put it, the only possible antidote to the limitations of the scientific method is further research, leading to further evidence for the general laws inferred from observed events or 'mak[ing] them more exact or liable to exceptions'.⁷⁰ The same applies to the climate context as underlined by Armstrong McKay et al.'s call for more research in order to gain more certainty about likely temperature thresholds.⁷¹ Meanwhile, climate scientists have also cautioned against equating uncertainty in the scientific enterprise with unreliability:

When taken out of a scientific context, "uncertainties" seem to indicate that scientists are just plain wrong. In scientific discourse, [however,] . . . uncertainty is about probabilities and likelihoods that describe our understanding of a particular outcome . . . "[U]ncertainty" does not imply that the science is unreliable.⁷²

Newton, evidently agreeing with this view, when questioned about the epistemic value of his laws of motion, responded that these 'are deduced from the phenomena and made general by induction which is the highest evidence that a proposition can have in this philosophy'.⁷³

While absolute proof is to remain an unattainable quantity in climate sciences as in all other disciplines, there is a sufficiently large body of evidence for the positive relationship between greenhouse gas emissions and global warming to be 'unequivocal'⁷⁴ and thus a scientific fact. A fact can be distinguished from opinions or estimates by reference to the very low degree of subjective appraisal and uncertainty involved.⁷⁵ Defining something as a fact can be described as the result of a 'social evolutionary process . . . [among] epistemic communities'.⁷⁶ With this in mind, any IPCC finding of 'virtual certain[ty]' or 'unequivocal[ness]' – endorsed by scientific experts and governments alike⁷⁷ – is a powerful indicator for the factual quality of such finding to be undisputable. This article thus considers causal relationships that the IPCC describes as 'unequivocal' and 'virtually certain' to amount to scientific facts.⁷⁸ Moreover, where the IPCC, for instance, finds there is (very) high confidence that a rise in global average temperature increases the probability of the occurrence of some event, this article considers it a scientific fact that increasing global warming augments the likelihood or risk of this event occurring. In line with this definition, there is sufficient evidence for the positive relationship between an increase in greenhouse gas emissions and an increase in damage due to climate change, including the risk of

⁶⁹See L. Münkler, *Expertokratie: zwischen Herrschaft kraft Wissens und politischen Dezisionismus* (2020), 240–1.

⁷⁰I. Newton, *The Principia: Mathematical Principles of Natural Philosophy: A New Translation* (translated by I. B. Cohen and A. Whitman, 1999), 796.

⁷¹See Armstrong McKay et al., *supra* note 39, at 7.

⁷²S. Lewis and A. Gallant, 'In Science, the Only Certainty is Uncertainty', *The Conversation*, 22 August 2013, available at theconversation.com/in-science-the-only-certainty-is-uncertainty-17180.

⁷³H. W. Turnbull et al. (eds.), *The Correspondence of Isaac Newton* (1959), 397.

⁷⁴See IPCC, *supra* note 1, paras. A.1, A.1.3, A.2.1.

⁷⁵See Münkler, *supra* note 69, at 197–8, 237–40, 247.

⁷⁶N. Grosche, 'Fehlbarkeit von Wissen – Wissen über (Nicht-)Wissen und staatliche Entscheidungen', in L. Münkler (ed.), *Dimensionen des Wissens im Recht* (2019), 27, at 30–1 (translated by the author). See also, I. Augsberg, 'Multi-, inter-, transdisziplinär? Zum Erfordernis binnenjuristischer Metaregeln für den Umgang mit extrajuridischem Wissen im Verwaltungsrecht', in I. Augsberg (ed.), *Extrajuridisches Wissen im Verwaltungsrecht: Analysen und Perspektiven* (2013), 3.

⁷⁷On expert and government involvement in the preparation, approval and acceptance of IPCC Reports see 'Appendix A', *supra* note 5, at 4–10.

⁷⁸Compare A. Buser, 'National Climate Litigation and the International Rule of Law', (2023) 36(3) LJIL 593, at note 20.

tipping points being triggered, to be considered a scientific fact.⁷⁹ By implication, it is a scientific fact that the fewer greenhouse gases we continue to emit, the more damage due to climate change we can avert and the lower the risk of tipping points being triggered.⁸⁰ We further know that there are ‘multiple causal interactions’ between tipping points in that the tipping of one Earth component may cause the crossing of other tipping points, thus leading to a tipping cascade – a factor Armstrong McKay et al. caution their study does not take into account.⁸¹

Against this backdrop, it becomes increasingly apparent that the ultimate questions that warrant immediate answering in this context are of normative quality: How should one act vis-à-vis both the knowledge that a rise in temperature augments the risk of tipping points being crossed, and the simultaneous uncertainty as to which exact degree of warming will trigger that outcome? Does this state of affairs call for action grounded in caution and humility, or is high ambition in preventing the risk of tipping points being crossed misplaced? What importance or desirability is attributed to preventing such an outcome and its ensuing consequences? What is the just aim to pursue in this respect? As Jasanoff puts it, ‘[c]limate change ... call[s] for ... [inquiries] where the departure point is asking what matters, and the questions turn from the epistemic to the normative’.⁸²

4. Turning from the epistemic to the normative

4.1 States’ mitigation obligations under treaty law

Affording political discretion concerning greenhouse gas emission levels has so far translated in state action that puts the world on track for a 2.7°C warming by the end of the century.⁸³ Deciding on a level of greenhouse gas emissions is undeniably a normative undertaking. Accordingly, the question arises as to how the current level of climate action corresponding to a 2.7°C of warming aligns with states’ legal obligations. The most apt starting point for such an analysis *de lege lata* is the Paris Agreement, the one international treaty to include a temperature target. Article 2(1)a of the Paris Agreement reads:

This Agreement ... aims to strengthen the global response to the threat of climate change ... including by: Holding the increase in the global average temperature to *well below* 2°C ... and *pursuing efforts* to limit the temperature increase to 1.5°C above pre-industrial levels ...⁸⁴

Being phrased as a range, the question arises as to what exact temperature limit the ‘well below 2°C’ and ‘pursuing efforts ... to 1.5°C’ target translates to, i.e., what exact temperature limit ought to be pursued and at what likelihood level. States’ interpretations as to the obligations flowing from the Paris temperature target vary to differing degrees. In its *Urgenda* judgment, the Dutch

⁷⁹See (text at) notes 74 and 37, *supra*. In its AR6 Synthesis Report, the IPCC further finds: ‘Continued greenhouse gas emissions will lead to increasing global warming ... Every increment of global warming will intensify multiple and concurrent hazards (high confidence).’ (*supra* note 1, para. B.1). A later passage in the Synthesis Report even reads: ‘Risks and projected adverse impacts and related losses and damages from climate change will escalate with every increment of global warming (very high confidence) (*ibid.*, para. B.2.2).

⁸⁰Lenton et al. point out that even if tipping points in the cryosphere should be transgressed, the timescale at which change unfolds varies substantially depending on the rate of warming and thus on the level of continued emissions (*supra* note 45, at 592).

⁸¹See Armstrong McKay et al., *supra* note 39, at 7. Research on tipping cascades finds that ‘the polar ice sheets on Greenland and West Antarctica are oftentimes the initiators of tipping cascades’ (N. Wunderling et al., ‘Interacting Tipping Elements Increase Risk of Climate Domino Effects under Global Warming’, (2021) 12 *Earth System Dynamics* 601, at 601, 614). See also N. Wunderling et al., ‘Global Warming Overshoots Increase Risks of Climate Tipping Cascades in a Network Model’, (2023) 13 *Nature Climate Change* 75.

⁸²S. Jasanoff, ‘Humility in the Anthropocene’, (2021) 18 *Globalizations* 839, at 851.

⁸³See (text at) note 8, *supra*.

⁸⁴See Paris Agreement, *supra* note 5, Art. 2(1)a (emphasis added).

Supreme Court held that emission policies in line with 2°C of warming are to be considered an ‘absolute minimum’ ambition level.⁸⁵ The German Constitutional Court elaborated on a 1.75°C warming target with a 67 per cent likelihood as potentially offering an apt point of reference for calculating Germany’s carbon budget.⁸⁶ The German Federal Climate Law – as amended subsequently to the Court’s decision to increase mitigation ambitions – however, exceeds the carbon budget that the Court considered to correspond to a 1.75°C warming by almost one fourth.⁸⁷ The climate policies and targets currently in place in the EU and the USA are rated as corresponding to a global warming of almost 2°C and up to 3°C according to the Climate Action Tracker which bases its assessment on various equity criteria such as capability and responsibility.⁸⁸ In the UK, the Climate Change Committee recommended calculating the UK’s carbon budget based on global least-cost pathways corresponding to a 1.5°C temperature target.⁸⁹ The UK implemented this recommendation in its 2030 nationally determined contribution.⁹⁰ As the Climate Action Tracker points out, however, such pathways are based on ‘global least-cost solutions rather than an equitable distribution of burdens’.⁹¹ Apart from the UK’s lack of implementation policies necessary to meet its climate targets, the Tracker finds that from an equity perspective, the UK’s nationally determined contribution corresponds to a warming level of up to 3°C by 2100.⁹² Meanwhile, China’s climate policies are rated as corresponding to a warming of up to 4°C and Russia’s policies to a global temperature rise of even higher than 4°C.⁹³

In analysing states’ views on necessary mitigation action, the ‘resol[ution]to pursue . . . efforts to limit the temperature increase to 1.5°C’ expressed by the UNFCCC Conference of the Parties both in the Sharm el-Sheikh Implementation Plan and the Glasgow Climate Pact is of immediate relevance.⁹⁴ However, the legal bindingness of the Paris temperature target in Article 2(1)a, i.e., keeping warming to well below 2°C and pursuing efforts to limit it to 1.5°C, is not universally accepted. In pointing to the fact that Article 2(1)a of the Paris Agreement is phrased as a mere objective, some readings contest that Article 2(1)a is capable of imposing legally binding obligations on states.⁹⁵ In this respect, however, it is important to bear in mind that a treaty’s

⁸⁵See *Urgenda*, *supra* note 17, paras. 6.6, 7.5.1.

⁸⁶See German Federal Constitutional Court, *supra* note 22, paras. 216, 219–22, 225 referring to German Advisory Council on the Environment, ‘Umweltgutachten 2020 – Für eine entschlossene Umweltpolitik in Deutschland und Europa’, 14 May 2020, available at www.umweltrat.de/SharedDocs/Downloads/DE/01_Umweltgutachten/2016_2020/2020_Umweltgutachte_n_Entschlossene_Umweltpolitik.html, 1, at 52.

⁸⁷The carbon budget that the German Court refers to equals 6.7 gigatons, while the cumulative amount of emissions based on the targets specified in the amended law exceeds 8.2 gigatons. See German Federal Constitutional Court, *supra* note 22, at paras. 219, 231, 234, 235; German Federal Climate Change Act (12 December 2019, last amended 31 August 2021), available at www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Gesetze/ksg_aendg_en_bf.pdf, 1, at 12–13 (see Ritz, *supra* note 15, at note 42). On the extent to which the European Court of Human Rights considers the 1.5°C-target to be binding on states in its ruling of April 2024 in the case of *Verein KlimaSeniorinnen Schweiz and others v. Switzerland*, see the Postscript (text at notes 165–171, *infra*).

⁸⁸CAT, ‘Countries – Overview’, available at climateactiontracker.org/countries/.

⁸⁹UK Committee on Climate Change, ‘Box 2 CCC recommendations on the UK’s Nationally Determined Contribution for 2030’, December 2020, available at www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf, 1, at 16.

⁹⁰CAT, ‘United Kingdom’, available at climateactiontracker.org/countries/uk/targets/.

⁹¹CAT, ‘United Kingdom – Country Summary’, available at climateactiontracker.org/countries/uk/2022-10-17/; CAT, ‘CAT Rating Methodology – Modelled Domestic Pathways’, available at climateactiontracker.org/methodology/cat-rating-methodology/modelled-domestic-pathways/.

⁹²See CAT, *supra* note 90.

⁹³See CAT, *supra* note 88.

⁹⁴UNFCCC ‘Decision 1/CP.27 Sharm el-Sheikh Implementation Plan’, 20 November 2022, para. 4; ‘Decision –/CP.26 Glasgow Climate Pact’, 13 November 2021, para. 16.

⁹⁵See B. Mayer, ‘The Judicial Assessment of States’ Action on Climate Change Mitigation’, (2022) 35 LJIL 801, at 810ff; B. Mayer, ‘Temperature Targets and State Obligations on the Mitigation of Climate Change’, (2021) 33 *Journal of Environmental Law* 585, at 596–7.

‘object and purpose’ plays a fundamental role in treaty interpretation pursuant to Article 31(1) in the Vienna Convention on the Law of Treaties (VCLT).⁹⁶ In fact, a strong argument is to be made that the overriding objective of the international legal climate regime laid down in Article 2 UNFCCC is of key importance when interpreting the 1.5°C to well below 2°C temperature range as to its specific meaning. Article 2 UNFCCC reads:

The ultimate objective of this Convention and *any related legal instruments* that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would *prevent dangerous anthropogenic interference* with the climate system.⁹⁷

The fact that this ‘ultimate objective’ of the UNFCCC is to play a major role when interpreting the Paris temperature range is not only mandated by Article 31(1) VCLT and Article 2 UNFCCC itself but also emphasized in Article 2(1) of the Paris Agreement which affirms its purpose to ‘enhanc[e] the implementation of the Convention, including its objective . . .’.⁹⁸ On that basis, the question that remains to be settled concerns the definition of ‘dangerous anthropogenic interference’.⁹⁹ While finding agreement on an exhaustive, clear-cut definition would defy possibility, there can be no doubt that crossing tipping points such as the collapse of the North Atlantic subpolar gyre convection, let alone the entire Atlantic Meridional Overturning Circulation, would constitute a ‘dangerous anthropogenic interference’.¹⁰⁰ These considerations, arguably, already suggest that a strong argument is to be made that states are under a legally binding obligation to pursue a temperature limit below thresholds that will likely trigger major tipping points in the climate system.¹⁰¹ For the sake of analysis, however, it is opportune to consider a scenario under which there were no substantial challenges to the view according to which there is no legally binding temperature limit *de lege lata*.¹⁰² Arguably, this would entail that the current state of climate action corresponding to a 2.7°C of global warming were in compliance with the law *de lege lata*. The immediate question this would trigger is whether such a situation *de lege lata* were just, i.e., in compliance with equity. This is of utmost importance because as shown by international case law and scholarship equity *infra legem* or *praeter legem*, and arguably also *contra legem*, can be considered a ‘catalyst for change and modernization of the law’.¹⁰³

4.2 Tipping points and the role of equity

In her account on equity, and intergenerational equity in particular, Brown Weiss recounts how the concept of equity, from being considered as synonymous with justice in general, was invoked by the International Court of Justice in the second half of the twentieth century with respect to territorial disputes in the sense of an equitable sharing of resources.¹⁰⁴ Brown Weiss submits that the same idea underlies the principle of intergenerational equity, i.e., an equitable sharing of resources among generations.¹⁰⁵ For the purposes of this article, equity is understood as equivalent with justice within and among generations, going beyond an anthropocentric/economic focus on

⁹⁶1969 Vienna Convention on the Law of Treaties, 1155 UNTS 331, Art. 31(1).

⁹⁷See UNFCCC, *supra* note 2, Art. 2 (emphasis added).

⁹⁸See Paris Agreement, *supra* note 5, Art. 2(1).

⁹⁹See UNFCCC, *supra* note 2, Art. 2.

¹⁰⁰See Armstrong McKay et al., *supra* note 39.

¹⁰¹See (text at) notes 38–41, 50–53, 61–63, *supra*.

¹⁰²See note 95, *supra*.

¹⁰³F. Francioni, ‘Equity in International Law’, in *Max Planck Encyclopedia of Public International Law* (2020); see also Mayer, ‘The Judicial Assessment of States’ Action on Climate Change Mitigation’, *supra* note 95.

¹⁰⁴E. Brown Weiss, ‘Intergenerational Equity’, in *Max Planck Encyclopedia of Public International Law* (2021).

¹⁰⁵*Ibid.*

the sharing of resources. Any understanding of equity inevitably touches upon the terrain of the question as to what is wrong and what is right. Given that the answer to this question is contingent on ideas, perception, feelings and convictions, the theory of relativism deduces that properties such as right and wrong are not given *'simpliciter'*, but are relative to a certain 'framework of assessment', i.e., a normative framework.¹⁰⁶ Arguably, however, the wrongness or rightness of certain acts can present itself with such force that it attains factual qualities. Put differently, the wrongness or rightness of certain acts can be as undeniable as the fact that the earth is (roughly) spherical as opposed to flat.¹⁰⁷ A paramount example for such materialization of the normative is enshrined in the first sentence of the Charter of Fundamental Rights of the European Union (CFR) which reads: 'Human dignity is inviolable.'¹⁰⁸ Unlike the earth's spherical shape, however, the non-violation of dignity is directly contingent on human behaviour. Indeed, as Kermani points out with respect to the nearly identically phrased Article 1 of the German Constitution,¹⁰⁹ if '[d]ignity . . . exist[ed] independently of, and be unaffected by, any authority', there would be no need for the subsequent sentence in Article 1 CFR: 'It [i.e., human dignity] must be respected and protected.'¹¹⁰ In dwelling on this paradox, Kermani writes:

By definition, the inherent characteristic of a paradox is that it contains a puzzle, a conundrum . . . [The meaning of the first sentence] is immediately clear, but the more we consider the sentence which follows it, namely that there is, nonetheless a duty to respect and protect human dignity, the more elusive its meaning becomes. The two sentences cannot be true simultaneously, and yet they can only be true together.¹¹¹

Arguably, this inviolability-fragility paradox finds its correspondence in nature. Looking at the Earth from space, a thin shiny layer of cold air is detectable that encircles the Earth. In preventing water vapor from escaping to space and boiling, this thin layer prevents the Earth from suffering a runaway greenhouse effect as occurred on Venus.¹¹² From an Earth-centric viewpoint, this faint layer is the most important thing there is – simultaneously inviolable and fragile. In formulating the impossible in the first article of the CFR, the European legislator excluded the possibility of imposing any lawful limitation on the guarantee of human dignity.¹¹³ The sense emerges that the same should apply to knowingly exposing the biosphere to dangers of a calamitous magnitude. It is difficult to imagine that the latter is to be considered in line with equity within a framework of assessment that is to protect and respect not just human dignity but the right to life generally. Anthropogenic emissions largesse leading to the triggering of tipping points in the climate system most severely interferes with the right to life of millions across the planet and arguably, among

¹⁰⁶M. Baghrarian and J. A. Carter, 'Relativism', in E. N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy* (2022), available at plato.stanford.edu/archives/spr2022/entries/relativism/.

¹⁰⁷On the scholarly debate concerning whether normative knowledge can be objective see, e.g., Münkler, *supra* note 69, at 243–4.

¹⁰⁸2000 Charter of Fundamental Rights of the European Union, OJ C 326/391, Art. 1, first sentence.

¹⁰⁹Basic Law for the Federal Republic of Germany (23 May 1949, last amended 19 December 2022), available in English at www.gesetze-im-internet.de/englisch_gg/, Art. 1(1), first sentence. The original German version reads: 'Die Würde des Menschen ist unantastbar.' Note that the English official translation does not translate 'ist' literally with 'is' but instead reads: 'Human dignity shall be inviolable.'

¹¹⁰N. Kermani, 'A Perfect Text', in *Ceremony at the German Bundestag Celebrating the 65th Anniversary of the Entry into Force of the Basic Law for the Federal Republic of Germany* (23 May 2014), available at www.btg-bestellservice.de/pdf/20099850.pdf, 64, at 64; CFR, *supra* note 108, at Art. 1, second sentence. The second sentence of the Basic Law reads: 'To respect and protect it [i.e., human dignity] shall be the duty of all state authority.' See Basic Law, *supra* note 109, at Art. 1(1), second sentence.

¹¹¹See Kermani, *supra* note 110, at 65.

¹¹²D. Archer, 'Water Vapor Feedback', in *Global Warming I: The Science and Modeling of Climate Change* (2021), available at www.coursera.org/learn/global-warming.

¹¹³Cf. H. Jarass and B. Pieroth, *Grundgesetz für die Bundesrepublik Deutschland – Kommentar* (2024), 48, para. 15.

other things, poses significant threats to the guarantee of human dignity.¹¹⁴ In assessing the severity of interference with fundamental rights, it is essential to bear in mind that where a tipping point is crossed which involves a shift from one steady state to another, changes may take millennia to revert if forcing is removed or not revert at all.¹¹⁵

The severity of the interference with the fundamental rights of present and future generations may give rise to the argument that due diligence obliges states to pursue a warming limit below likely tipping thresholds. Due diligence obligations of immediate relevance in the environmental context are the obligation of precaution and the obligation of prevention,¹¹⁶ the former requiring a lower level of diligence¹¹⁷ as it applies when it is uncertain whether an action or omission will result in ‘severe or irreversible damage’.¹¹⁸ The question of whether states are under a mere obligation of precaution or whether the prevention principle – a customary rule of international law¹¹⁹ – applies, requiring states to take all reasonable measures at their disposal so as to prevent the damage from occurring, depends on whether the harm is not only significant but also foreseeable.¹²⁰ As elaborated on above, substantial epistemological uncertainty exists in terms of the specific temperature thresholds triggering tipping points. Arguably, however, this does not exclude the legal standard of foreseeability from being met. Indeed, the triggering of tipping points is not unforeseeable in the sense that it is ‘unanticipated’ in the way that ‘a series of major volcanic eruptions or a nuclear war . . . and unexpected biological epidemics’ may be, a class of risk that the IPCC classifies as ‘surprises’.¹²¹ Rather, it is to be considered a scientific fact that rising warming levels augment the risk of triggering major tipping points in the climate system.¹²²

¹¹⁴In the General Comment on Art. 6 of the International Covenant on Civil and Political Rights, the Human Rights Committee, for instance, makes clear that ‘[t]he obligation of States parties to respect and ensure the right to life extends to reasonably foreseeable threats and life-threatening situations that can result in loss of life’ and classifies climate change as one ‘of the most pressing and serious threats to the ability of present and future generations to enjoy the right to life’ (Human Rights Committee, General Comment No. 36 on Article 6 of the International Covenant on Civil and Political Rights, on the Right to Life, CCPR/C/GC/36 (2018), paras. 7, 65). See also Special Rapporteur on Human Rights and the Environment, Report on Safe Climate, A/74/161 (15 July 2019), para. 28; Rockström et al., *supra* note 61, at 104–5. Other rights severely interfered with by emissions largesse include the rights to a healthy environment, water, food, health, housing, culture, development, property and home and private life’ (Special Rapporteur on Human Rights and the Environment, Report on the Right to a Healthy Environment, A/73/188 (19 July 2018), para. 28). For an elaborate argument on the interference of emissions largesse with the prohibition of torture and inhuman and degrading treatment, see C. Heri, ‘Climate Change before the European Court of Human Rights: Capturing Risk, Ill-Treatment and Vulnerability’, (2022) 33 *European Journal of International Law* 925.

¹¹⁵See note 34, *supra*. In its Technical Summary, the WG I states that ‘even a return to pre-threshold surface temperatures or to atmospheric carbon dioxide concentrations does not guarantee that the tipping elements return to their pre-threshold state’ (see Arias et al., *supra* note 24, at 106).

¹¹⁶*Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area*, Advisory Opinion of 1 February 2011, [2011] ITLOS Rep. 10, at 75 and paras. 131–132.

¹¹⁷*Ibid.*, para. 117.

¹¹⁸*The Environment and Human Rights*, Advisory Opinion OC-23/17 of 15 November 2017, Series A No. 23, para. 180. See also J. E. Viñuales, ‘Due Diligence in International Environmental Law: A Fine-Grained Cartography’, in H. Krieger, A. Peters and L. Kreuzer (eds.), *Due Diligence in the International Legal Order* (2020), 111, at 116–17.

¹¹⁹*Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgment of 20 April 2010, [2010] ICJ Rep. 14, para. 101.

¹²⁰In the *Pulp Mills* case, the ICJ found that states are under the obligation not to ‘knowingly’ allow ‘activities . . . causing significant damage to the environment of another State’ and to ‘use all the means at . . . [their] disposal to avoid [such] activities’ (*ibid.*) (emphasis added). See also ILC, Draft Articles on Prevention of Transboundary Harm from Hazardous Activities – With Commentaries, UN Doc A/56/10 (2001), 148, at 152 (Art. 2, Commentary para. 2), available at legal.un.org/ilc/documentation/english/reports/a_56_10.pdf. On the obligation incumbent upon the state to ‘prevent . . . significant . . . harm and only in case this is not fully possible [to] . . . exert its best efforts to minimize the risk thereof’, see *ibid.*, at 153–4 (Art. 3, Commentary paras. 3, 7). As Duvic-Paoli put it, ‘it is the lack of applicability of prevention that makes precaution applicable’ (L. Duvic-Paoli, *The Prevention Principle in International Environmental Law* (2018), 274). For a scholarly account on the role of the severity/‘significant harm’ and foreseeability of a risk in triggering the duty to prevent see among others, Viñuales, *supra* note 118.

¹²¹D. Chen, ‘Framing, Context and Methods’, in Masson-Delmotte et al., *supra* note 24, at 203.

¹²²See (text at) note 79, *supra*.

Depending on one's definition of knowledge, not engaging in deep mitigation action to prevent such risks cannot even be considered an 'epistemic fallacy' where, put simply, we do not act because we do not know.¹²³ Current emissions largesse putting the world on track for 2.7°C of warming by 2100 is not a case of 'mistakenly and anthropocentrically reduc[ing] the question of what is to the question of what can we know'.¹²⁴ Rather, the current situation is one of insufficient action *despite* knowledge. In sum, a strong argument is to be made that in the context at hand, both the severity and foreseeability criteria are met – an important requirement for prevention obligations to apply.

Assessing states' due diligence obligations, naturally, also requires balancing the right(s) at risk with countervailing rights and competing interests as well as assessing state capacities to actually protect the right(s) at risk.¹²⁵ In this respect, the WG III's contribution to the IPCC is of immediate relevance. The IPCC finds a range of synergies between low emission policies and the promotion of several Sustainable Development Goals (SDGs).¹²⁶ While the IPCC also identifies some potential trade-offs between deep mitigation action and the promotion of other SDGs,¹²⁷ it finds that such trade-offs can be minimized, even avoided,¹²⁸ by intelligent policy design and implementation placing equity at its core.¹²⁹ Critically, according to the IPCC's analysis there is sufficient global financial capital and liquidity to close the investment gap for global warming to be limited to 1.5°C.¹³⁰ The IPCC further finds that 'there are mitigation options which are feasible to deploy at scale in the near term'¹³¹ and that 'technologies capable of deep emission cuts are already available' for many energy- and carbon-intensive products.¹³² The technologies necessary for a major shift towards a green economy hence already exist.¹³³ These considerations strongly suggest that the prevention principle, as 'a primary obligation of due diligence',¹³⁴ imposes a legally binding obligation on states to adopt mitigation policies which cumulatively are aligned with warming levels not exceeding 1.5°C. While equating the prevention principle, or due diligence generally, with the equity principle would amount to a reductive interpretation of equity, the argument can be advanced that a breach of the prevention principle, and due diligence generally, also constitutes a breach of equity.¹³⁵ In this respect, not undertaking deep emission cuts – despite

¹²³Cf. R. Bhaskar, 'General Introduction', in M. Archer et al. (eds.), *Critical Realism: Essential Readings* (1998), ix, at xii.

¹²⁴Cf. *ibid.*

¹²⁵See *Application of the Convention on the Prevention and Punishment of the Crime of Genocide (Bosnia and Herzegovina v. Serbia and Montenegro)*, Judgment, [2007] ICJ Rep. 43, para. 430. On the way in which technological advances increase the degree of diligence required by states see *Activities in the Area*, *supra* note 116, para. 117; ILC, *supra* note 120, at 154 (Art. 3, Commentary para. 11); ILA Study Group on Due Diligence in International Law, Second Report (2016), 1, at 21. For a scholarly discussion of the capacity-requirement see, among others, Viñuales, *supra* note 118, at 125; B. Baade, 'Due Diligence and the Duty to Protect Human Rights', in Krieger, Peters and Kreuzer, *supra* note 118, at 99.

¹²⁶See IPCC, *supra* note 1, paras. C.4, C.4.2. See also IPCC, 'Summary for Policymakers', in J. Skea et al. (eds.), *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (2022), para. D.1.3.

¹²⁷*Ibid.*

¹²⁸See IPCC (WG III), *supra* note 126, para. D.1.5.

¹²⁹See IPCC, *supra* note 1, paras. C.5, C.5.2.

¹³⁰See IPCC (WG III), *supra* note 126, para. E.5.2.

¹³¹*Ibid.*, para. E.1.

¹³²See I. A. Bashmakov et al., 'Industry', in Skea et al., *supra* note 126, at 1203, 1196. See also IPCC (WG III), *supra* note 126, para. C.4.3.

¹³³See, among others, J. Airbib, A. O'Leary and J. Rosenow. 'Rethink Climate: Green Technology and Innovation', 5 January 2023, available at www.bbc.co.uk/programmes/m001gl5k.

¹³⁴See Duvic-Paoli, *supra* note 120, at 111.

¹³⁵Reuter finds that 'proportionality' is one of three principal ways in which equity has commonly been specified in the legal realm (P. Reuter, 'Quelques réflexions sur l'équité en droit international', (1980) 15 *Revue Belge de Droit International* 165, at 165; see also R. Lapidoth, 'Equity in International Law', (1987) 22 *Israel Law Review* 161, at 177). See the definition of equity given above (text following note 105, *supra*).

the capacity to do so and the severity and foreseeability of harm – not only amounts to a breach of the due diligence obligation to prevent but can also be considered to constitute a breach of equity.

The equity principle is not only enshrined in the Paris Agreement¹³⁶ but according to case law by the International Court of Justice, it classifies as a general principle of international law:

[Equity] was often contrasted with the rigid rules of positive law, the severity of which had to be mitigated in order to do justice. In general, this contrast has no parallel in the development of international law; the legal concept of equity is a general principle directly applicable as law.¹³⁷

Arguably, this makes equity ‘highly relevant in treaty interpretation’¹³⁸ pursuant to Article 31(3)(c) of the VCLT and Article 38(1)(c) of the Statute of the International Court of Justice (ICJ).¹³⁹ The same applies to the prevention principle as it constitutes a customary rule of international law.¹⁴⁰ From this it follows that both principles have a key role to play in determining the specific mitigation obligations that flow from the Paris Agreement and the UNFCCC’s Article 2.

Defining equity and prevention as general rules of international law further has important implications for states’ secondary obligations under the law on state responsibility. In line with Article 38(1) of the ICJ Statute, the Commentary to the Draft Articles on Responsibility of States for Internationally Wrongful Acts (ARSIWA) defines internationally wrongful acts as states’ actions and omissions that are not in conformity with international obligations that ‘may be established by a customary rule of international law, by a treaty or by a *general principle applicable within the international legal order*’.¹⁴¹ Article 30 ARSIWA states that ‘[t]he State responsible for the internationally wrongful act is under an obligation . . . to cease that act, if it is continuing’.¹⁴² Importantly, making reparations is a mandatory complement but not an alternative to ceasing the breach of international obligations as the Commentary to Article 29 clarifies: ‘Even if the responsible State complies with its obligations under Part Two to cease the wrongful conduct and to make full reparation for the injury caused, it is not relieved thereby of the duty to perform the obligation breached.’¹⁴³ In the case at hand, ceasing the breach of wrongful conduct would thus, among others, require states to undertake mitigation action that is in line with their capacity¹⁴⁴ and that cumulatively is aligned with keeping global warming to a level not exceeding 1.5°C.¹⁴⁵

Classifying equity and prevention as general rules of international law may also have direct implications for national jurisdictions. In Germany, for instance, treaties generally require parliamentary consent prior to ratification and thus prior to creating binding obligations on

¹³⁶See Paris Agreement, *supra* note 5, Arts. 2(2), 4(1), 4(3), 14(1).

¹³⁷*Continental Shelf (Tunisia v. Libyan Arab Jamahiriya)*, Judgment of 24 February 1982, [1982] ICJ Rep. 18, para. 71.

¹³⁸See Francioni, *supra* note 103.

¹³⁹See VCLT, *supra* note 96, Art. 31(3)(c); 1945 Statute of the International Court of Justice (ICJ), 33 UNTS 993, Art. 38(1)(c).

¹⁴⁰See note 119, *supra*.

¹⁴¹See ICJ Statute, *supra* note 139, Art. 38(1); ILC, Draft Articles on Responsibility of States for Internationally Wrongful Acts – With Commentaries, UN Doc. A/CN.4/SER.A/2001/Add.1 (Part 2) (2001), 26, at 55 (Art. 12, Commentary para. 3), available at [legal.un.org/ilc/publications/yearbooks/english/ilc_2001_v2_p2.pdf](https://www.legal.un.org/ilc/publications/yearbooks/english/ilc_2001_v2_p2.pdf) (emphasis added).

¹⁴²*Ibid.*, Art. 30.

¹⁴³*Ibid.*, Art. 29, Commentary para. 2.

¹⁴⁴The Commentary to Art. 3 clarifies: ‘The economic level of States is one of the factors to be taken into account in determining whether a State has complied with its obligation of due diligence. But a State’s economic level cannot be used to dispense the State from its obligation under the present articles.’ (*ibid.*, Art. 3, Commentary para. 13).

¹⁴⁵M. Wewerinke-Singh argues that ‘the duty of cessation could involve withdrawing fossil fuels subsidies . . . phas[ing] out fossil fuels, and bringing all relevant existing regulations and policies in line with the goals of the Paris Agreement and the objective and principles of the Convention’ (M. Wewerinke-Singh, *State Responsibility, Climate Change and Human Rights under International Law* (2019), 136).

Germany. Once entered into force, treaty law has been interpreted as having the same rank as ordinary federal law.¹⁴⁶ By contrast, with respect to the general principles of law, Article 25 of the German Constitution clearly provides:

The general rules of international law shall be an integral part of federal law. They shall take precedence over the laws and directly create rights and duties for the inhabitants of the federal territory.¹⁴⁷

General rules of international law are thus directly applicable within the German legal system and take precedence over federal laws.¹⁴⁸

4.3 The question of democratic legitimization

Section 2 brought to the fore that the claim for political discretion is based on the premise that normative decisions belong to the political branches of government for reasons of democratic legitimization. As Alexy put it, ‘the formal principle of the democratically legitimated decision-taking competence of the legislature . . . requires that the democratically legitimated legislature should take as many important decisions for society as possible’.¹⁴⁹ Naturally, however, in line with the principle of the separation of powers, the legislature cannot enjoy absolute discretion in a democratic legal order. Within the system of checks and balances, the primary role incumbent on the judiciary, arguably, is to review the acts of the political branches of government as to their compatibility with an ‘effective fundamental rights protection’.¹⁵⁰ As Alexy puts it, the competition in competences between the judiciary and the legislature is an expression of ‘the old tension between constitutional rights and democracy’.¹⁵¹ There cannot be an absolute resolution to this tension as this would either lead to ‘legislative paralysis’ or unchecked power of the legislature to interfere in constitutional rights in an ‘extremely intensive’ manner.¹⁵² Arguably, the reason why the tension between fundamental rights protection and democracy cannot be resolved by choosing one over the other is that for their realization, both these elements depend on one another. Fundamental rights protection is indispensable for a functioning democracy if one agrees that democracy does not derive its legitimacy solely from the rule of the majority.¹⁵³ In light of the above analysis, the strong sense emerges that emission policies aligned with a temperature rise above likely tipping thresholds constitute an interference of such severity with fundamental rights¹⁵⁴ that they ought not to be exempt from judicial review.

¹⁴⁶German Federal Constitutional Court, Order of 15 December 2015, 2 BvL 1/12 (*Treaty Override*), paras. 33, 37. In its decision, the Court held: ‘In the order established by the Basic Law, international treaties generally share the rank of ordinary federal statutes. Therefore, they can be superseded by subsequent federal statutes that contradict the treaty stipulations.’ (*ibid.*). Note, however, that Justice König disagreed with this view in her dissenting opinion (*ibid.*, Dissenting Opinion, paras. 4–12).

¹⁴⁷See Basic Law, *supra* note 109, Art. 25.

¹⁴⁸Note, however, that the majority opinion in the German *Treaty Override* decision held: ‘[W]ithin the national legal order the general rules of international law rank higher than (ordinary) statutes but lower than the Constitution’ (see *Treaty Override*, *supra* note 146, para. 38).

¹⁴⁹R. Alexy, *A Theory of Constitutional Rights* (2010), 416–17. See also M. Klatt and M. Meister, *The Constitutional Structure of Proportionality* (2012), 82.

¹⁵⁰See Klatt and Meister, *ibid.*, at 77.

¹⁵¹See Alexy, *supra* note 149, at 417.

¹⁵²*Ibid.*, at 417–18. See also Klatt and Meister, *supra* note 149, at 83.

¹⁵³See, among many, M. Young, *Inclusion and Democracy* (2002), 21, 27, 50; D. Grimm, *Verfassungsgerichtsbarkeit* (2021), 187. For a different view see C. Invernizzi-Accetti, ‘Does Democratic Theory Need Epistemic Standards? Grounds for a Purely Procedural Defense of Majority Rule’, (2017) 4 *Democratic Theory* 3.

¹⁵⁴On the severity of the interference see (text at) notes 28–29, 37, 38–41, 79, 81, 99–100 114–115, *supra*.

5. From tipping thresholds to legally binding carbon budgets?

The fact that the Paris temperature target is phrased as a range has commonly led to a rejection of states being obliged under treaty law to align their emission policies with a specific temperature limit at a specific likelihood. As shown above, however, it can be argued that the principles of prevention and equity impose an obligation on states to, as far as possible, pursue a temperature limit below likely tipping thresholds and that, in view of the severity and foreseeability of harm as well as states' capacity to afford protection, such obligation requires states to adopt emission policies in line with keeping warming to a maximum of 1.5°C. Where this view is agreed upon, the ensuing question concerns the likelihood level at which states are required to adhere to this maximum temperature threshold. Of relevance in this context are the IPCC's estimates for remaining carbon budgets as of 2020 and corresponding warming levels.¹⁵⁵ Any legal specification in this regard, however, could be challenged given inevitable epistemological uncertainties. For instance, why exactly should a carbon budget be pursued which is considered to align with a warming of 1.5°C at an 83 per cent likelihood? Why not at a 60, 70, 82 or 84 per cent likelihood? Naturally, this argument could be pursued *ad infinitum*. This, however, is not to be taken as a testimony to its rationality. Rather, such an argument is prone to falling prey to what is known in philosophical thought since Eubulides as the 'Sorites paradox'. The *Stanford Encyclopedia of Philosophy* illustrates the 'Sorites paradox' as follows:

- '1 grain of wheat does not make a heap.
- If 1 grain doesn't make a heap, then 2 grains don't.
- If 2 grains don't make a heap, then 3 grains don't.
- ...
- If 999,999 grains don't make a heap, then 1 million grains don't.

Therefore,

- 1 million grains don't make a heap.¹⁵⁶

It is impossible to know which added grain makes a heap. In fact, it is not just a matter of a lack of knowledge or understanding. Rather, an ontological answer to this question does not exist. The vagueness of the term 'heap' makes the determination of any specific threshold that marks the transition between heap and non-heap arbitrary. With respect to climate tipping points, there too is inevitable epistemological uncertainty as to the exact point at which tipping points or even tipping cascades¹⁵⁷ will be triggered (see Section 3). There is an irresolvable degree of uncertainty as to how long exactly negative feedbacks will counterbalance and cushion the ramifications of emissions largesse and when they will instead turn into positive feedbacks and amplify these effects.¹⁵⁸ Unlike with the heap, however, there is a particular point in ontological terms at which climate tipping points will be triggered, a point at which things will 'tip'. In the transition from non-heap to heap there is no one such point that triggers a system change in the ontological world. Critically, while there is always the possibility to remove one or several grains from a (non-)heap, such possibility to undo things and try again is not readily available with respect to tipping points

¹⁵⁵See IPCC (WG I), *supra* note 28, at 29. These include, among others, 500 GtCO₂ for a 50% likelihood of keeping global warming below 1.5°C, 400 GtCO₂ for a 67% likelihood to do so, and 300 GtCO₂ for an 83% likelihood of not exceeding a 1.5°C global temperature rise.

¹⁵⁶D. Hyde and D. Raffman, 'Sorites Paradox', in E. N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy* (2018), available at plato.stanford.edu/archives/sum2018/entries/sorites-paradox/.

¹⁵⁷See note 81, *supra*.

¹⁵⁸As Archer points out, 'the land biosphere, like the ocean has the potential to switch from being a negative feedback, stabilizing and saving us from ourselves today, to being an amplifying positive feedback in the fullness of time in future' (D. Archer, 'The Biosphere in the Carbon Cycle', in Archer, *supra* note 112).

triggering self-perpetuating, and potentially abrupt, change in the climate system which in some cases may be irreversible for millennia or more.¹⁵⁹ Against this backdrop, the objection that no emission budget would *guarantee* the achievement of any temperature target¹⁶⁰ does not absolve states from aligning their emission policies with a global carbon budget that pursuant to best available science is expected to keep warming to a maximum of 1.5°C at a likelihood level as ambitious as state capacities allow for.¹⁶¹

Determining a global temperature limit to be pursued is not the only relevant factor in an endeavour aimed at specifying states' mitigation obligations in line with equity and best available science. Rather, another key question concerns how the global mitigation burden is to be distributed among states. Defining a perfect distribution key in form of an impeccable operationalization of equity in this respect is, arguably, impossible given the vast array of ways in which equity could be interpreted in this context. For instance, criteria such as responsibility or capability are generally considered relevant equity interpretations with respect to the distribution question.¹⁶² Similarly as with the heap example, there is no one particular point at which things tip and a state's emission level indisputably ceases being in line with equity. Here again, however, it would be fallacious to fall prey to the Sorites paradox and draw the conclusion that any level of greenhouse gas emissions is to be considered in line with equity. While any choice of distribution key will be 'approximate',¹⁶³ recent interdisciplinary studies increasingly show that there are statistical ways of operationalizing the equity principle as enshrined in the Paris Agreement with respect to the distribution question that can be considered sufficiently accurate, transparent and comprehensive as to be apt for legal use.¹⁶⁴

6. Conclusion

This article has dealt with the recurring argument that the political branches of government are to be afforded major discretion in specifying states' mitigation obligations for reasons of democratic legitimization given the uncertainty underlying climate models and the inevitably normative quality of the decisions at play. In focusing on the question of what maximum global temperature rise states are to align their mitigation policies with, the article analysed the substance of epistemological (un)certainty by drawing on best available science on climate tipping points and their susceptibility to global warming. Such analysis revealed that while there is uncertainty as to which warming levels trigger tipping points, the positive relationship between global warming and the risk of crossing tipping points qualifies as a scientific fact. Against this backdrop, major questions of normative quality materialize concerning the legal implications that flow from this current state of knowledge. In delving into such examination, the article as a first step turned to relevant treaty law and argued that current global emission levels are not only incompatible with the Paris temperature target but in light of best available science, they are also not in conformity with the UNFCCC's 'ultimate objective' of keeping emissions to a level that 'prevent[s] dangerous

¹⁵⁹Importantly, however, once tipping points in the cryosphere are crossed, the level of continued emissions matters in terms of the timescale at which melting unfolds (see note 80, *supra*). While stressing that temperature overshoots increase the risk of tipping cascades, Wunderling et al also find it is possible that a small, temporary overshoot of temperature thresholds in the cryosphere might not cause 'tipping events and thus . . . cascades' if the 'temperature overshoot trajectories are limited in both magnitude and duration' (see Wunderling et al., 'Global Warming Overshoots Increase Risks of Climate Tipping Cascades in a Network Model', *supra* note 81, at 80–1).

¹⁶⁰See Mayer, 'The Judicial Assessment of States' Action on Climate Change Mitigation', *supra* note 95, at 811.

¹⁶¹See note 125, *supra* and the Postscript (text at notes 165–171, *infra*).

¹⁶²For an overview of different equity criteria see, e.g., CAT, 'Comparability of Effort', available at climateactiontracker.org/methodology/comparability-of-effort/; N. Höhne, M. den Elzen and D. Escalante, 'Regional GHG Reduction Targets Based on Effort Sharing: A Comparison of Studies', (2014) 14 *Climate Policy* 122, at 128–32.

¹⁶³See Mayer, 'The Judicial Assessment of States' Action on Climate Change Mitigation', *supra* note 95, at 822.

¹⁶⁴See Rajamani et al., *supra* note 15; Ritz, *supra* note 15.

anthropogenic interference with the climate system'. Given the importance of a treaty's objective and purpose for interpreting the obligations it creates, a strong argument can be made that under treaty law states are legally obliged to pursue a warming limit below major tipping thresholds. In a subsequent step, the article found that such obligation also arises from the principles of due diligence and equity. In analysing whether the factual requirements are met for the duty of prevention to apply in the context at hand, the article found that there can be no question about the severity of harm were ice sheets and ocean convections to collapse – tipping events which are likely within the Paris temperature range according to leading scientific studies. The article further argued that the requirement of foreseeability is likewise to be considered fulfilled given that the triggering of tipping points with rising global temperature is not unanticipated. As to states' capacity to protect against most severe interferences with fundamental rights of present and future generations, there is sufficient global financial capital and liquidity to close investment gaps for global warming to be limited to 1.5°C pursuant to the IPCC's latest Assessment Report. The IPCC also finds that the technologies necessary for deep and large-scale emission reductions are already available. Based on these considerations, there is a strong argument to be made for states to be under a legally binding obligation to pursue a warming limit not exceeding 1.5°C. Not doing so – despite the severity and foreseeability of harm and the international community's financial capacity to close the emissions gap – would also amount to a breach of equity. A general principle of law according to the International Court of Justice, the equity principle – like the prevention principle – creates binding obligations under the law of state responsibility and is directly applicable in certain domestic legal systems. The article subsequently turned to the judicial concern of democratic legitimization. Given that fundamental rights protection is a key pillar of any functioning democracy, the article put forward the view that emission policies aligned with a temperature rise above tipping thresholds ought not be exempt from judicial review given their degree of interference with fundamental rights in terms of foreseeability, severity and irreversibility. In a final step, the article engaged with questions concerning the legal operationalization of tipping thresholds into a binding global carbon budget. In this translation exercise from the scientific to the legal discipline, any specification of the likelihood level at which a 1.5°C warming limit is to be pursued could be challenged. In engaging the Sorites paradox, the article argued that a blanket rejection of any likelihood specification, may be prone to fallacious reasoning in the form of a slippery slope. Against this backdrop, the analysis led to the conclusion that treaty law, fundamental rights law and the general international law principles of prevention and equity impose an obligation on states to align their emission policies with a global carbon budget that pursuant to best available science is expected to limit warming to a maximum of 1.5°C at a likelihood level as ambitious as state capacities allow for.

Postscript

The above article was written before April 2024. On 9 April 2024, the European Court of Human Rights ruled that Switzerland had violated the right to respect for private and family life under Article 8 of the European Convention on Human Rights (ECHR)¹⁶⁵ by failing to enact sufficient legislative measures to reduce greenhouse gas emissions and by failing 'to quantify, through a carbon budget or otherwise, national GHG emissions limitations'.¹⁶⁶

In assessing Switzerland's national reduction targets for 2030 and 2040, the European Court of Human Rights juxtaposed these targets with calculations of the remaining global carbon budget and, based thereon, Switzerland's remaining carbon budget for a 67 per cent or 83 per cent chance of keeping global warming to 1.5°C. The European Court of Human Rights found that, even if the Swiss carbon budget were calculated based on equal emissions per capita for the present day – a quantification approach that is particularly favourable to industrialized countries – Switzerland

¹⁶⁵1950 European Convention on Human Rights, ETS 5, Art. 8.

¹⁶⁶*Verein KlimaSeniorinnen Schweiz and others v. Switzerland*, Judgment of 9 April 2024, [2024] ECHR, para. 573.

would have already depleted its budget by 2034 for a 67 per cent chance of keeping global warming to 1.5°C, or by 2030 for an 83 per cent chance of doing so. The Court concluded that ‘under its current climate strategy, Switzerland allowed for more GHG emissions than even an “equal per capita emissions” quantification would entitle it to use’.¹⁶⁷

This may suggest that the European Court of Human Rights considers the Contracting States to the ECHR to be under an obligation to align their emission policies with a carbon budget that is expected to limit global warming to 1.5°C. There is another factor that may strengthen this impression. After, among others, taking note of an AR6 ‘high confidence’-finding according to which ‘all global modelled pathways’ limiting global warming to 1.5°C involve reaching net zero CO₂ emissions ‘in the early 2050s’,¹⁶⁸ the European Court of Human Rights establishes that:

effective respect for the rights protected by Article 8 of the Convention requires that each Contracting State undertake measures for the substantial and progressive reduction of their respective GHG emission levels, with a view to *reaching net neutrality within, in principle, the next three decades*.¹⁶⁹

In stressing the declaratory nature of its judgments and the complexity of the issues at hand, the Court notes that it itself is ‘unable to be detailed or prescriptive as regards any measures to be implemented in order to effectively comply with the present judgment’.¹⁷⁰ Thanks to its thorough analysis of the scientific evidence before it, the European Court of Human Rights did, however, demonstrate how imposing procedural obligations, such as an obligation to quantify a carbon budget and to define interim targets, may amount to narrowing political discretion in substantive terms. Doing so is an unequivocal signal that interferences with fundamental rights due to climate change are not exempt from judicial review.¹⁷¹

¹⁶⁷*Ibid.*, para. 569.

¹⁶⁸*Ibid.*, para. 116, referring to IPCC, *supra* note 1, at 20–3.

¹⁶⁹*Ibid.*, para. 548 (emphasis added).

¹⁷⁰*Ibid.*, para. 657.

¹⁷¹*Cf.* text at note 154, *supra*.