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# Can International Law Limit Our Technological Imagination? On the Implications of the Customary Law Obligation of Prevention for SRM Governance

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## Abstract

This article examines the role of customary international law in regulating SRM by analysing competing interpretations of the customary law principle of prevention and their implications for SRM governance. Existing customary law limitations are largely overlooked in current policy and expert discussions around the future of SRM, which seemingly proceed on the basis that there are no universally applicable limitations for states to develop SRM technologies should they decide so. The paper contrasts this view and argues, from a positivist point of view, that the customary principle of prevention does pose certain limits for states even before SRM-caused transboundary environmental harm occurs. It distinguishes between a retrospective and future-oriented dimension of the prevention principle, and it depicts three scenarios for how the prevention obligation may limit the development and deployment of SRM technology depending on how States (and international legal advisors) conceptualise the temporal scope and normative content of the prevention principle. The article also examines the implications of the different configurations of the customary law obligation for an eventual SRM treaty.

**Keywords:** customary international law; no-harm rule; prevention principle; solar radiation modification

## 1. Introduction

International law is racing against time in regulating (ultra)hazardous new technologies, including Solar Radiation Modification (SRM). Emerging technologies that break new grounds are typically not yet governed by their own international treaty, and they may not fall under any existing treaty regime in their entirety. However, this does not mean that they would operate in a legal vacuum. International law does pose some generally applicable binding obligations, mainly under customary international law, which are relevant for shaping the social environment in which new technologies are allowed to emerge. Curiously, however, such obligations are largely overlooked in policy analyses, expert dialogues, and the public discourse, which seem to proceed on the basis that there are no universally applicable limitations for States to develop SRM technologies should they decide so. This begs the question of whether and to what extent international law, viewed here as a “social technology,”<sup>1</sup> is capable of shaping the future of emerging geoengineering technologies.

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<sup>1</sup> JE Viñuales, “The Organisation of the Anthropocene – In Our Hands?” (2018) 1 International Legal Theory and Practice 1.

This paper focuses on the reach and implications of international law obligations for technological innovation, with a focus on SRM technology. SRM is a subset of climate engineering technologies that aims to reduce the warming of the Earth's atmosphere by reflecting sunlight back into space. It is an umbrella term encompassing several types of technologies, such as cirrus cloud thinning, marine cloud brightening, surface brightening, space mirrors, and stratospheric aerosol injection (SAI), where aeroplanes would constantly spray aerosols into the stratosphere to exert a cooling effect.

Proponents of SRM view this type of geoengineering technology as a possible strategy to temporarily reduce global warming to escape the catastrophic consequences for humanity caused by high levels of warming. As States are still falling markedly short of delivering on their emission reduction commitments even after a decade of signing the UN Paris Agreement on Climate Change,<sup>2</sup> the fate of the agreement's temperature goal to keep the rise in global temperatures well below 2 °C, and preferably below 1.5 °C,<sup>3</sup> has become precarious. The Paris Agreement envisages peaking global emissions soon and reaching net zero emissions in the second half of this century,<sup>4</sup> however States are still struggling to move forward with adopting and enforcing ambitious emissions reduction policies to decarbonise their economies.<sup>5</sup> While the latest report of the International Panel on Climate Change (IPCC) clearly stresses that global emissions should peak before 2025 in order to have a robust chance of keeping the 1.5°C<sup>6</sup> warming threshold, global emissions are still on the rise.<sup>7</sup>

Supporters of SRM view it as a particularly promising type of geoengineering and argue that deploying certain forms of SRM could buy humanity some time by reducing the level of warming even if States fail to achieve the politically and economically cumbersome net zero transition in time. Some forms of SRM already appear to be technically feasible,<sup>8</sup> and although none of them are currently deployed in practice, their future is intensively researched.

SRM technologies are, however, heavily contested owing to the pervasive risks they carry. Some forms of SRM may trigger a range of potentially devastating side-effects, including regional modification of precipitation, extreme weather events,<sup>9</sup> disruption of the monsoon, and degrading the stratospheric ozone layer.<sup>10</sup> These impacts would inevitably be transboundary in nature and could hit certain regions more severely than others. Moreover, certain SRM technologies could also be unilaterally deployed, which may yield weaponisation,<sup>11</sup> and trigger inter-state conflicts and litigation for adverse weather impacts simply due to the perception that such effects were the result of another country's SRM project.

<sup>2</sup> See First Global Stocktake, Section I.2. FCCC/PA/CMA/2023/L.17.

<sup>3</sup> Art 2(a) of the 2015 UN Paris Agreement of Climate Change.

<sup>4</sup> Art 4 of Paris Agreement.

<sup>5</sup> See, eg, UNEP Emissions Gap Report 2024.

<sup>6</sup> IPCC 6th Synthesis Report Climate Change 2023, Summary for Policymakers, Section B.6.1.

<sup>7</sup> Friedlingstein et al., "Global Carbon Budget 2024" *Earth System Science Data Discuss.* [preprint], <https://doi.org/10.5194/essd-2024-519>, in review, 2024.

<sup>8</sup> Royal Society: *Geoengineering the Climate*, Sept 2009, p 57, available at <<https://royalsociety.org/-/media/policy/publications/2009/8693.pdf>>.

<sup>9</sup> AC Jones et al., "Impacts of Hemispheric Solar Geoengineering on Tropical Eyclone Frequency" (2017) 8 *Nature Communications* 1382.

<sup>10</sup> SAPEA evidence review report, *Solar Radiation Modification* (December 2024), pp 54–68. available at <<https://scientificadvice.eu/scientific-outputs/solar-radiation-modification-evidence-review-report/>>.

<sup>11</sup> Benjamin K Sovacool, Chad Baum and Sean Low, "The Next Climate War? Statecraft, Security, and Weaponization in the Geopolitics of a Low-Carbon Future" (2023) 45 *Energy Strategy Reviews* 101031.

SRM also comes with a moral hazard, that is, the possibility of undermining GHG reduction efforts by promising an easy way out of the period of “global boiling.”<sup>12</sup> Moreover, certain SRM techniques, such as SAI, would need to be maintained possibly even for centuries, in order to sustain the cooling effects. Ceasing SAI projects to operate would come with a termination shock, that is, an immediate spike in the rise of temperature, which would cause devastating effects.<sup>13</sup> Furthermore, the UNEP estimates the current state of knowledge on SRM as “extremely limited,”<sup>14</sup> and deems SRM to have a disruptive potential for humanity in the future.<sup>15</sup>

Despite widespread risks and knowledge gaps, there has been a flurry of attention paid to this technological possibility. The European Union, the United States and China are funding research to better understand the science of SRM, but currently, they do not openly support SRM deployment.<sup>16</sup> The outdoor experiment of SPICE was cancelled in the UK due to conflict of interest,<sup>17</sup> and a later SAI experiment run by Harvard University was cancelled in 2023 due to disagreements among stakeholders regarding the appropriate research governance scheme.<sup>18</sup> In February 2024, Switzerland tabled a proposal on furthering research on SRM in the UN Environment Assembly, but it was withdrawn due to a pushback from African countries.<sup>19</sup> In late 2024, some parties at CBD COP 16, have reportedly unsuccessfully attempted to include language condemning rogue SRM experiments in the draft decision on climate and biodiversity.<sup>20</sup> Around the same time, however, the Group of Chief Scientific Advisors of the EU recommended the EU Commission to adopt an EU-wide moratorium and work towards a non-deployment governance regime for the foreseeable future.<sup>21</sup>

Limits for the future of SRM are likely to be posed by social parameters rather than technological constraints.<sup>22</sup> Yet, the legal risks and the normative limitations as to what States are allowed to do in this arena under the current binding rules of international law are strikingly downplayed in the crescendo around SRM. Expert and public discussions have mainly focused on ethical risks, such as the moral hazard,<sup>23</sup> geopolitical as well as militarisation risks.<sup>24</sup> The philosophical and economic questions raised by the SRM are also at the forefront of discussion.<sup>25</sup> The lack of acknowledgement of legal limitations is

<sup>12</sup> See speech of UN Secretary General António Guterres, “Hottest July Ever Signals ‘Era of Global Boiling Has Arrived’ Says UN Chief”, 27 July 2023, available at <<https://news.un.org/en/story/2023/07/1139162>>.

<sup>13</sup> SAPEA evidence review report, Solar Radiation Modification (n 10) at 131.

<sup>14</sup> UNEP Foresight Report, 15 July 2024.

<sup>15</sup> UNEP Foresight Report, pp 33–34.

<sup>16</sup> UNEP Foresight Report, p 34.

<sup>17</sup> Erin Hale, “Geoengineering Experiment Cancelled Due to Perceived Conflict of Interest” (*Guardian*, 16 May 2012).

<sup>18</sup> Sikina Jinnah et al., “Do Small Outdoor Geoengineering Experiments Require Governance?” (2024) 385 *Science* 600–603. <https://doi.org/10.1126/science.adn2853>.

<sup>19</sup> F. Biermann and A Gupta, “A Paradigm Shift? African Countries Call for the Non-Use of Solar Geoengineering at UN Environment Assembly” (2024) 3 (5) *PLOS Climate* e0000413. <https://doi.org/10.1371/journal.pclm.0000413>.

<sup>20</sup> A briefing document prepared by HOME Alliance for COP 16 delegates mentioning instances of unilateral experiments see: <[https://etcgroup.org/sites/www.etcgroup.org/files/files/cop\\_16\\_briefing-en-final\\_rev.pdf](https://etcgroup.org/sites/www.etcgroup.org/files/files/cop_16_briefing-en-final_rev.pdf)>.

<sup>21</sup> Group of Chief Scientific Advisors, “Scientific Opinion No. 17, Solar Radiation Modification”, 9 December 2024, available at <<https://op.europa.eu/en/publication-detail/-/publication/9c2ac367-b5de-11ef-acb1-01aa75ed71a1/language-en>>.

<sup>22</sup> Royal Society: *Geoengineering the Climate* (n 8), page xi.

<sup>23</sup> Frank Biermann et al, on file with the author.

<sup>24</sup> Observatoire Defense et Climat report (Directorate General for International Relations and Strategy): *Solar Geoengineering: Geostrategic and Defence Issues*, 2023, available at <[https://defenseclimat.fr/wp-content/uploads/2023/11/Note\\_5\\_Obs\\_DC\\_EN.pdf](https://defenseclimat.fr/wp-content/uploads/2023/11/Note_5_Obs_DC_EN.pdf)>.

<sup>25</sup> See, eg, panel discussion held on 10 June 2024 during the Harvard Climate Action Week, where “leading Scholars from Atmospheric Chemistry, Climate Physics, Economics and Philosophy Discussed Our Current Understanding of Solar Geoengineering, Highlighting Areas of Uncertainty, and Identifying Ways to Move

particularly striking when compared to other emerging technologies such as AI, where the importance of legal obligations predating innovations is clearly acknowledged as imposing certain limits on the scope and types of technological advancements.

Lawyers themselves rarely discuss the existing international law obligations pertaining to SRM. With some notable exceptions,<sup>26</sup> the bulk of the analyses pertain to the range of multilateral treaties that are relevant to certain aspects of SRM.<sup>27</sup> In addition, there is an amplifying call for a global non-use agreement on SRM.<sup>28</sup> But even this initiative takes a *de lege ferenda* approach, instead of focusing on the existing legal building blocks that pose binding constraints for technological developments even *de lege lata*.

This article takes issue with the conspicuous absence of discussing the generally applicable, existing, and binding legal limits of SRM in scholarly and public discourse. It will argue that despite the lack of a specific treaty on SRM, which is currently not yet in sight, there is a wide range of applicable, yet often overlooked or unaddressed,<sup>29</sup> obligations under international law. International law does pose certain limitations to States' ability to develop and deploy environmentally harmful technologies through a range of international law obligations under customary international law, human rights law, and some fundamental legal principles.<sup>30</sup>

Due to limitations of space, this article confines itself to discussing the prevention obligation under customary law. Customary obligations have special importance in the dynamically evolving innovation policy space, as they are legally binding on every State, hence, they are generally applicable, with respect to an arena where technological advances outpace cumbersome treaty-making processes. Unsurprisingly, when treaty law is silent, legal disputes have often been resolved based on customary law in other areas as well.<sup>31</sup>

Legal dilemmas surrounding the permissibility of SRM technologies do not merely reopen the old techno-optimism versus techno-pessimism debate<sup>32</sup>; instead, they point to the more fundamental issue of whether international law could (and should) limit our

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Forward on Research While the Debate Intensifies on Its Possible Deployment", available at <[https://salatainstitute.harvard.edu/the-science-and-ethics-of-solar-geoengineering/?utm\\_source=SilverpopMailing&utm\\_medium=email&utm\\_campaign=Daily%20Gazette%2020240612%20\(1\)>](https://salatainstitute.harvard.edu/the-science-and-ethics-of-solar-geoengineering/?utm_source=SilverpopMailing&utm_medium=email&utm_campaign=Daily%20Gazette%2020240612%20(1)>)>.

<sup>26</sup> Kerry Brent, Jeffrey McGee and Amy Maguire, "Does the 'No-Harm' Rule Have a Role in Preventing Transboundary Harm and Harm to the Global Atmospheric Commons from Geoengineering?" (2015) 5 Climate Law 35; David Reichwein and Others, "State Responsibility for Environmental Harm from Climate Engineering" (2015) 5 Climate Law 142.

<sup>27</sup> For relevant overviews see Alexander Proelss and Robert C Steenkamp, "Geoengineering: Methods, Associated Risks and International Liability" in Peter Gailhofer and Others (eds), *Corporate Liability for Transboundary Environmental Harm* (Cham, Springer International Publishing 2023) pp 419–503; Gerd Winter, "Climate Engineering and International Law: Last Resort or the End of Humanity?" (2011) 20 Review of European Community & International Environmental Law 277, 280–4. Also see Joint Opinion of Philippe Sands and Kate Cook, *The Restriction of Geoengineering under International Law*, Commissioned by the Böll Foundation (26 March 2021).

<sup>28</sup> Frank Biermann and Others, "Solar Geoengineering: The Case for an International Non-use Agreement" (2022) 13 WIREs Climate Change e754.

<sup>29</sup> Edited by Robert N. Stavins and Robert C. Stowe, *Governance of the Deployment of Solar Geoengineering* (Cambridge, MA: Harvard Project on Climate Agreements, 2019).

<sup>30</sup> For an overview of relevant obligations including international human rights law, the customary duty to cooperate, the duty to conduct environmental impact assessment, the precautionary principle and the intergenerational equity principle see: SAPEA evidence review report, Solar radiation modification (n 10) pp 155–68.

<sup>31</sup> P-M Dupuy, G Le Moli and JE Viñuales, "Customary International Law and the Environment" In L Rajamani and J Peel (eds), *The Oxford Handbook of International Environmental Law* (Oxford, Oxford University Press 2021) pp 385–401, 389.

<sup>32</sup> More on the debate see: Samuel Alexander and Jonathan Rutherford, "A Critique of Techno-Optimism Efficiency without Sufficiency Is Lost" in A Kalfagianni, D Fuchs and A Hayden (eds), *Routledge Handbook of Global*

technological imagination. More specifically, should international law obligations compel relevant actors to forego technological solutions that would inevitably cause harm? Alternatively, is the role of international law confined to allocating responsibility for the adverse side effects of technology, as and when they arise? Overall, should existing legal rules limit our technological imagination?

To answer these questions, the analysis proceeds in five steps. Having set out the main context and research questions in Section I, Section II discusses the two main conceptualisations of the prevention obligation under customary international law, which differ in the temporal scope and the legal consequences of the obligation. Section III argues that the different views on the normative meaning and reach of the prevention obligation translate into three scenarios, where the customary international law obligation of prevention plays different roles in the regulation of SRM technology. Section IV argues from a positivist point of view that the obligation of prevention cannot be circumvented by States even if they wish to carve-out an exception for SRM related environmental harm in an eventual standalone SRM treaty. Section V draws conclusions on the power of international law vis-à-vis technological innovations.

## II. The customary law principle of harm prevention: two temporalities of obligations

Irrespective of existing relevant treaty law and a potential future standalone SRM convention, such activities do not take place “in a legal black hole.”<sup>33</sup> Most importantly, as will be argued in this article, any SRM deployment and research is not only subject to treaty-based (voluntary) international law obligations, but must also respect obligations under customary international law, which, as a general rule, are binding on every State. Customary international law is a distinct source of international law<sup>34</sup> one of the foundational pillars of international obligations. The obligation not to cause significant transboundary environmental harm (also called as the no-harm rule) is an established part of customary international law under the principle of prevention.

The no-harm rule, which forms part of the principle of prevention, poses a well-established, binding obligation on States under customary international law to discharge due diligence in order to prevent the use of their territories in a way that causes significant transboundary environmental harm to other States and territories beyond their national jurisdiction.<sup>35</sup> International fora have already applied this rule in the context of transboundary air pollution.<sup>36</sup>

Scholars have long suggested that the no-harm rule should logically apply in the context of anthropogenic climate change<sup>37</sup> and more specifically, also for SRM activities.<sup>38</sup>

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*Sustainability Governance* (Routledge 2019) pp 231–241; John Danaher, “Techno-Optimism: An Analysis, an Evaluation and a Modest Defence” (2022) 35 *Philosophy & Technology* 54.

<sup>33</sup> K Scott, “International Law in the Anthropocene: Responding to the Geoengineering Challenge” (2013) 34 (2) *Michigan Journal of International Law* 309–58, 330.

<sup>34</sup> Art 38 (1) b) of the Statute of the International Court of Justice.

<sup>35</sup> Leslie-Anne Duvic-Paoli, *The Prevention Principle in International Environmental Law* (Cambridge, Cambridge University Press 2018).

<sup>36</sup> Trail Smelter Arbitration, 1941, Nuclear Tests Case (New Zealand v France, 1973, ICJ).

<sup>37</sup> For an early scholarly analysis see: Sandrine Maljean-Dubois, “The No-Harm Principle as the Foundation of International Climate Law” in Benoit Mayer and Alexander Zahar (eds), *Debating Climate Law* (Cambridge, Cambridge University Press 2021) pp 15–28.

<sup>38</sup> Gerd Winter, “Climate Engineering and International Law: Last Resort or the End of Humanity?” (2011) 20 *Review of European Community & International Environmental Law* 277. CBD Secretariat: Update on Climate Geoengineering in Relation to the Convention on Biological Diversity: Potential Impacts and Regulatory Framework (October 2016), CBD Technical Series No. 84, Annex 3: Key Messages From CBD (2012) Geoengineering

The legal consequences of the prevention principle in the context of climate change will be determined authoritatively by the International Court of Justice (ICJ) in its climate change advisory opinion, expected to be delivered in 2025.<sup>39</sup> Importantly, 75% of the States participating in the proceedings have already argued that the duty to prevent environmental harm applies to climate change.<sup>40</sup>

The obligation of prevention is breached if States cause significant transboundary harm, or a foreseeable risk thereof. In the context of SRM, this article argues that if such a (risk of) harm occurs, the responsibility of the State deploying SRM techniques could be engaged.

Relevant harm includes detrimental effects on human health, property, the environment, or the agriculture of other States,<sup>41</sup> and potentially also harming the climate system.<sup>42</sup> In order to be actionable, harm should be foreseeable,<sup>43</sup> and the State must know or should have known that the given activity has the risk of significant harm.<sup>44</sup> Given the IPCC's high-confidence statements on the foreseeable harm caused by the termination effects of SRM, scholars argue that the risk of SAI is foreseeable and triggers an obligation of the host state to prevent such risks by not deploying SAI.<sup>45</sup> SAI projects could entail direct and indirect transboundary harm, as well as harm to the global atmospheric commons.<sup>46</sup> It is also possible that a state benefitting from a warmer climate may claim harm from the cooling effects of SRM deployment.<sup>47</sup>

The prevention obligation entails a due diligence obligation, where the required degree of care is proportional to the degree of the hazard involved.<sup>48</sup> This duty is breached if the State fails to take appropriate measures to prevent harm to occur or to minimise the risk thereof.<sup>49</sup> If SAI projects were deemed as ultra-hazardous activities owing to the pervasive risks they carry,<sup>50</sup> the standard of care would be even stricter in cases of SRM activities. The Special Rapporteur of the International Law Commission (ILC), a prestigious expert body set up by the UN General Assembly to help develop and codify rules of customary international law, also prepared reports and adopted guidelines on the rules of protecting the atmosphere. The third report of the ILC Special Rapporteur, in addressing the responsibilities surrounding causing harm to the atmosphere, although noting the risks

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In Relation To The Convention On Biological Diversity: Technical And Regulatory Matters, Section 2.2., Third report of ILC Special Rapporteur Murase (A/CN.4/692), deems the no harm rule to be applicable to transboundary air pollution, see International Law Commission, Third Report of the Special Rapporteur, Mr Shinya Murase, Third report on the protection of the atmosphere (2016) I Doc.A/CN.4/92. Available at <[https://legal.un.org/ilc/documentation/english/a\\_cn4\\_692.pdf](https://legal.un.org/ilc/documentation/english/a_cn4_692.pdf)>, Annex Draft guidelines, Guideline 3(a).

<sup>39</sup> Advisory Opinion is to be issued by the International Court of Justice on the obligations of states in respect of climate change. See: <<https://www.icj-cij.org/case/187>>.

<sup>40</sup> Thomas Burri, "The ICJ's Advisory Opinion on Climate Change: A Data Analysis of Participants' Submissions" (2024) 28 ASIL Insights 1, 5.

<sup>41</sup> Commentaries to ILC Draft Articles on Prevention of Transboundary Harm from Hazardous Activities, with commentaries, 2001, Art 2, Section (4).

<sup>42</sup> On the interpretation, which includes harm caused to the climate system see Question included in the request of the UN GA for an advisory opinion of the ICJ on States' obligations concerning climate change.

<sup>43</sup> Reichwein and Others (n 26).

<sup>44</sup> ILC Draft Articles on Prevention of Transboundary Harm from Hazardous Activities (n 41) p 115, para 18. See also: Reichwein and others (n 26) 153.

<sup>45</sup> Reichwein and Others (n 26) 169.

<sup>46</sup> Brent, McGee and Maguire (n 26) 48.

<sup>47</sup> Proelss and Steenkamp (n 27) 489.

<sup>48</sup> ILC Draft Articles on Prevention of Transboundary Harm from Hazardous Activities (n 41) p 115, para 18. See also: Reichwein and Others (n 26) 153.

<sup>49</sup> Brent, McGee and Maguire (n 26) 44.

<sup>50</sup> Kerry Brent, "Solar Radiation Management Geoengineering and Strict Liability for Ultrahazardous Activities" in Neil Craik and Others (eds), *Global Environmental Change and Innovation in International Law* (1st edn, Cambridge, Cambridge University Press 2018) pp 161–179.



posed by SAI, took no position on this question.<sup>51</sup> Another open question concerns whether the level of required care is different for SRM research and SRM deployment.<sup>52</sup>

In any case, the prevention obligation under customary international law has two dimensions, or rationales,<sup>53</sup> namely, a retrospective reparative aspect and a future-oriented preventive aspect. As the ILC Special Rapporteur on the protection of the atmosphere also clearly pointed out, the customary law obligation of the *sic utere tuo* principle consists of two different obligations, one being “the obligation to ‘prevent’ before actual pollution or degradation occurs, and the other being the duty to ‘eliminate’, ‘mitigate’, and ‘compensate’” of the harm already occurred.<sup>54</sup>

The retrospective dimension of obligation, also referred to as the no-harm rule, has been consistently enforced in the practice of international judicial fora.<sup>55</sup> By contrast, to date, there have been no judgments to find a violation of the forward-looking dimension of prevention obligation, that is, in the absence of material harm. However, this does not mean that the forward-looking aspect of the obligation is any less real or binding. The literature acknowledges that a breach is possible even when no environmental harm has occurred.<sup>56</sup> What is more, the forward-looking aspect of prevention is arguably even more important than the reparative dimension. As Judges Simma and Al-Khasawneh pointed out in their dissenting opinion in the Pulp Mills case, “embrac[ing] a preventive, rather than compensatory logic . . . has particular cogency”<sup>57</sup> whenever irreversible harm is at stake.

The above cited jurisprudence and doctrinal work relate to transboundary environmental harm, which is a broad category including harm to biodiversity, habitats, water resources, and all types of natural resources. However, the harmful effects of SRM can also be evaluated from a narrower point of view, in the context of the protection of the atmosphere. Building on the prior works of the Special Rapporteurs, the ILC has adopted Draft guidelines on the protection of the atmosphere in 2021, which are a comprehensive, yet non-binding set of obligations,<sup>58</sup> two of which are especially relevant for SRM. The first concerns the obligation to protect the atmosphere (Guideline 3), which comprises the duty of preventing atmospheric pollution. The second specifically relates to international large-scale modification of the atmosphere (Guideline 7), including SRM. This section also reiterates that geoengineering activities are “subject to any applicable rules of international law.” Importantly, therefore, it is argued here that the obligations under the protection of the atmosphere do not extinguish the obligations under customary international law with respect to the duty to prevent transboundary environmental harm.

In sum, it is argued here that the principle of prevention under customary international law poses a well-established, justiciable, and universally applicable obligation for States also with respect to SRM activities on two temporalities, including a retrospective (reparative) dimension and a future-oriented (“pure”) preventive dimension. Whether this obligation is deemed to render SRM activities as such illegal is, however, dependent upon

<sup>51</sup> ILC Special Rapporteur: Third report on the protection of the atmosphere (n 38).

<sup>52</sup> Secretariat of the Convention on Biological Diversity (2012). *Geoengineering in Relation to the Convention on Biological Diversity: Technical and Regulatory Matters*, Montreal, Technical Series No. 66, 152 pages. Part II: The Regulatory Framework for Climate-related Geoengineering Relevant to the Convention on Biological Diversity.

<sup>53</sup> Duvic-Paoli (n 35) 54–9.

<sup>54</sup> ILC, Third report on the protection of the atmosphere (n 38) para. 15.

<sup>55</sup> *Pulp Mills in the River Uruguay (Argentina v Uruguay)*, Judgment, I.C.J. Reports 2010, p 14; *Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica v. Nicaragua)* and *Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica)*, Judgment, I.C.J. Reports 2015, p 665; *Trail smelter case (United States, Canada)* 16 April 1938 and 11 March 1941 Vol. III. pp 1905–82.

<sup>56</sup> Dupuy et al., “Customary International Law and the Environment” (n 31) pp 385–401.

<sup>57</sup> Joint Dissenting Opinion of Judges Al-Khasawneh and Simma, *Pulp Mills case*, para 22.

<sup>58</sup> ILC, Draft Guidelines on the protection of the atmosphere (2021), Adopted by the International Law Commission at its seventy-second session, in 2021, and submitted to the General Assembly as a part of the Commission’s report covering the work of that session (A/76/10, para 39).

how States and international lawyers conceive the temporality and normative content of the harm prevention obligation. The following section will distinguish three possible approaches in this respect and will critically examine their weaknesses from a legal positivist point of view.

The debates and normative uncertainties surrounding the legal content of state obligations concerning SRM bring out the complex relationship between international law and time.<sup>59</sup> This relationship appears to be lopsided when it comes to the future, as international law seems to be primarily linking “the present to the past.”<sup>60</sup> Indeed, several features suggest a strong retrospective orientation of international law, such as the general rule of prohibiting the retroactive application of its rules,<sup>61</sup> and the law on state responsibility, which focuses on harm that has already occurred. Developing harmful technologies in the present puts international law to a test as to whether and to what extent customary law can impose any hard limits on technological imagination and innovation.

### III. What are the consequences of the prevention obligation for developing technological innovations? Three scenarios in the context of SRM

The different interpretations of the extent and meaning of the harm prevention obligation assign radically different roles to international law norms in regulating new technologies, including SRM, and would impose different limits for such activities. This article distinguishes three scenarios that logically arise in light of the different temporal configurations of the prevention principle. The following subsections discuss the differences in the operation of the possible interpretations of the principle.

#### 1. An *a priori* ban on technologies that are incompatible with the duty of prevention

The first possible scenario would afford the most ambitious and intrusive role for the obligation to prevent transboundary harmful environmental impacts, where such constraints would be viewed as a reason to forego technological innovations that are incompatible with these obligations. Prohibitory and restrictive regimes already exist in international law, for instance, with regard to chemical and biological weapons, ozone-depleting substances, hazardous waste, and the proliferation of nuclear weapons.<sup>62</sup> A moratorium was also called for deep seabed mining.<sup>63</sup> The ongoing legal struggle

<sup>59</sup> Christian Djeflal, “International Law and Time: A Reflection of the Temporal Attitudes of International Lawyers Through Three Paradigms” in Mónika Ambrus and Ramses A Wessel (eds), *Netherlands Yearbook of International Law* 2014, vol 45 (TMC Asser Press 2015) <[https://link.springer.com/10.1007/978-94-6265-060-2\\_5](https://link.springer.com/10.1007/978-94-6265-060-2_5)> accessed 17 July 2024.

<sup>60</sup> Edith Brown Weiss, *In Fairness to Future Generations: International Law, Common Patrimony, and Intergenerational Equity* (Tokyo, Japan, The United Nations University 1989) p 30.

<sup>61</sup> Christian Tomuschat: “The Relevance of Time in International Law” (2021) 41 *Polish Yearbook of International Law* 9–30.

<sup>62</sup> Aarti Gupta and Others, “Towards a Non-Use Regime on Solar Geoengineering: Lessons from International Law and Governance” (2024) 13 *Transnational Environmental Law* 368–399.

<sup>63</sup> British Institute of International and Comparative Law, “Deep Seabed Mining & International Law: Is a Precautionary Pause Required?” (31 May 2023); Toby Fisher, Professor Zachary Douglas, Jessica Jones, “Opinion in the Matter of a Proposed Moratorium or Precautionary Pause on Deep-Sea Mining Beyond National Jurisdiction, Commissioned by Pew Trusts,” available at <<https://www.pewtrusts.org/-/media/assets/2023/03/deep-sea-mini-ng-moratorium.pdf>>.



aiming to outlaw fossil fuel technologies<sup>64</sup> rests on a similar conceptual basis. Importantly, the ITLOS Advisory Opinion has clearly found that States have an obligation to “take all measures necessary to ensure that anthropogenic GHG emissions under their jurisdiction or control do not cause damage to other States and their environment.”<sup>65</sup> Considering the inevitability of causing harm to the marine environment through States’ GHG emissions, it requires taking only one logical step to read this finding as ultimately requiring the phasing out of fossil fuels.<sup>66</sup>

In the specific context of SRM, an open letter signed by hundreds of scholars demands a global non-use regime for SRM,<sup>67</sup> whereas others argue for a moratorium on SRM due to the possible adverse human rights impacts of SRM deployment.<sup>68</sup> The Group of Chief Scientific Advisors to the EU has also recommended that the Commission work towards a moratorium on deployment and large-scale outdoor experiments.<sup>69</sup>

Against this background, it is possible to read the harm prevention obligation as one that entails prohibitive legal consequences, namely foregoing certain technological possibilities or halting and phasing out destructive technologies. This idea seems to imbue the questions submitted by the UN General Assembly to the ICJ in its pending advisory proceedings on climate change,<sup>70</sup> which ask for clarification about the legal consequences of breaching the customary prevention obligation by States emitting GHGs. Some States in the proceedings have argued for a wide range of cessation measures, including immediate and drastic reductions in GHG emissions.<sup>71</sup> A crucial difference is, however, that GHG-emitting technologies have already dominated the world economy for centuries, and hence, a phase-out obligation could be discerned from the retrospective aspect of the prevention duty, since climate harm is already widespread. In contrast, in the context of SRM, a ban on such technology should appeal to the forward-looking, “purely preventive” dimension of the obligation.

In summary, under the first scenario, States cannot escape their customary law obligations by drawing up a treaty that waters down the strong conception of the prevention obligation. Customary law obligations exist independently of treaty law, with standalone content. Under this approach, transboundary environmental damage caused by SRM would be deemed unacceptable harm under customary international law, and therefore, technologies leading to such effects could not be developed.

This conception of the customary prevention obligation would mark the coming of age of international environmental law, as this would allow the prevention principle to affect “the core of the transaction,”<sup>72</sup> something which has normally not been the case with rules of preventive environmental law obligations. In the context of technological innovation, affecting such a core would mean not allowing the deployment of SRM technologies at a minimum, as long as the emergence of transboundary harm could not be excluded with certainty.

<sup>64</sup> Harro Van Asselt and Fergus Green, “COP26 and the Dynamics of Anti-fossil Fuel Norms” (2023) 14 WIREs Climate Change e816.

<sup>65</sup> ITLOS Advisory Opinion No. 31, Request for an Advisory Opinion Submitted by the Commission of Small Island States on Climate Change and International Law, 2024, para. 258.

<sup>66</sup> Vinuales and Margaretha Wewerinke-Singh, “More than a Sink, Verfassungsblog”, 07 June 2024, available at <<https://verfassungsblog.de/more-than-a-sink/>>.

<sup>67</sup> Biermann and Others (n 28).

<sup>68</sup> Joint Opinion of Philippe Sands and Kate Cook (n 27) at 4.

<sup>69</sup> Group of Chief Scientific Advisors, Scientific Opinion No. 17 (n 21).

<sup>70</sup> See General Assembly resolution 77/276 of 29 March 2023.

<sup>71</sup> For such positions see Written Comments of the Republic of Vanuatu (2024), para 178.

<sup>72</sup> JE Vinuales and JF Mercure, “Pathway to Reframing Environmental Law” (2020) 50 Environmental Policy and Law 509.

This may strike some as a radically stringent reading of the prevention obligation; yet it is not a mere aspirational interpretation of the duty of prevention. In the context of other types of technologies, one may even find important precedents. This approach is for instance reflected in AI Act of the European Union,<sup>73</sup> which lists certain prohibited AI practices due to the unacceptable risks and harm they pose to individuals that are, therefore, banned.<sup>74</sup>

## **2. Close incorporation of legal limits in the scope of permissible technological innovations**

It is also possible to argue, however, that breaching the prevention obligation by causing transboundary environmental harm should not prompt an a priori prohibition on SRM technologies. Instead of phase out obligations and moratoria, this scenario favours allowing technological developments if certain legal safeguards, typically procedural obligations, are met. After all, so the argument goes, nuclear weapons were also not found illegal by the ICJ on account of their capacity to harm the environment and human health. At the same time, the Nuclear Weapons Advisory Opinion also clearly stated that international law, even back in 1996, included several “important environmental factors that are properly to be taken into account in the context of” implementing other international law obligations.<sup>75</sup> This can be read as requiring state obligations under international environmental law be closely observed and incorporated in the process of developing technologies in the future.

It must be noted at the outset that this scenario rests on the assumption that it is possible to deploy SRM without generating transboundary harmful effects – a view that is heavily contested by some scientific projections.<sup>76</sup>

Other technologies legal regimes sometimes follow such an ex post regulatory approach. The Council of Europe’s conception on Artificial Intelligence is a case in point. The Framework Convention on Artificial Intelligence and Human Rights, Democracy, and the Rule of Law was adopted in May 2024 with the express aim “to ensure that activities within the lifecycle of artificial intelligence systems are fully consistent with human rights, democracy and the rule of law.”<sup>77</sup> Article 4 imposes a general obligation on States to “adopt or maintain measures to ensure that the activities within the lifecycle of artificial intelligence systems are consistent with obligations to protect human rights.”

Another support for this techno-limiting approach to prevention emerges from a handful of climate litigation judgments, where domestic courts have found that excessive reliance on negative emissions technologies was impermissible under human rights law. This approach transpires from the judgments of Dutch, German, and Irish courts.<sup>78</sup> Although these findings do not refer to the specific context of SRM, but apply to negative

<sup>73</sup> Regulation (EU) 2024/1689 of the European Parliament and of the Council.

<sup>74</sup> Art 5, on the background of the list see also the EU Commission’s proposal: Proposal for a Regulation of the European Parliament and of the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act) and Amending Certain Union Legislative Acts [SEC(2021) 167 final] – [SWD(2021) 84 final] – [SWD(2021) 85 final].

<sup>75</sup> Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion (8 July 1996), para. 33.

<sup>76</sup> See, eg, n 10 and 11 above.

<sup>77</sup> Framework Convention on artificial intelligence and human rights, democracy, and the rule of law, Art 1.

<sup>78</sup> Hoge Raad, “Stifting Urgenda v The Netherlands, Judgment” (20 Dec 2019), *ECLI:NL:HR:2019:2007*, para 7.2.5, where the Court argues that relying by the State on negative emissions technologies that does not yet exist at the time would be taking “irresponsible risks” that “run counter to the precautionary principle” under human rights obligations; German Federal Constitutional Court, *Neubauer* decision (24 March 2021), para. 33; The High Court, *Friends of the Irish Environment v. Ireland*, [2017 No. 793 JR], Judgment (19 Sept 2019) para 9.

emissions technologies, they do signal that deploying certain technological innovations are viewed as incompatible with human rights obligations.

The crucial question of this scenario lies in the implications of such incompatibility. In other words, what types of legal safeguards, if not a moratorium, does customary international law impose on SRM projects? The legal requirements that lawful SRM projects must meet are necessarily weaker than an *a priori* ban, as their overall effectiveness in preventing the emergence of actual harmful effects is precarious and depends on many factors.

First of all, defining the exact, nuanced legal requirements of permissible technologies that flow from the obligation of prevention often necessitates further standard-setting to determine red lines and causes for concern, together with applicable remedies or response mechanisms. For instance, the more nuanced requirements and safeguards mandated by the Council of Europe Framework Convention on AI will be defined by a Handbook on Human Rights and Artificial Intelligence, which is currently being negotiated.<sup>79</sup> Such standard setting processes are typically slow, may require consensus, and carry the risk of watering down applicable legal limits.

Moreover, the stringency of such safeguards is also closely linked to their binding character and the procedures and institutions that administer them. In the specific context of the protection of the atmosphere, the ILC Guideline 7 mentions three specific obligations that must be observed by geoengineering activities, namely, that they “should be conducted with prudence and caution”, should be conducted “in a fully disclosed, transparent manner”, and meeting “environmental impact assessment” obligations.<sup>80</sup> The exact requirements flowing from caution vary greatly,<sup>81</sup> and it is also notoriously difficult to pin down what “prudence” and “transparency” actually mean with regard to a specific project, increasing doubts about the effectiveness of this version of prevention. In any case, the wording of the Guidelines resembles a conception of the SRM, where this type of technology can be compatible with international law in case certain safeguards are being met, at least as long as the protection of the atmosphere is concerned. Notably, the guidelines also acknowledges that these obligations are additional to applicable international law obligations, which necessarily includes the transboundary environmental harm prevention duty.

In sum, the legal “bite” of such a construction of the harm prevention obligation is less marked than in the first scenario; however, it is still more consequential than in the third scenario to be addressed in the following section, as this version of prevention still functions as a prescriptive, future-oriented norm.

### 3. International law as a tool for the mere regulation of SRM's side-effects

A third possible approach would carve out an even more limited role for customary international law rule in the regulation of emerging technologies. This scenario follows a “weak” conception of prevention, one that tolerates engaging in SRM activities as long as the respective State meets its due diligence obligation to address ancillary harm arising from such activities. Such a view allows for the creation of SRM technologies that may later cause widespread violation of the harm prevention obligation under customary law. This much weaker version of prevention would merely require States to discharge due

<sup>79</sup> CDDH Drafting Group on Human Rights and Artificial Intelligence, Draft Handbook on Human Rights and Artificial Intelligence, CDDH-IA(2025-1), available at <<https://rm.coe.int/drafting-group-on-human-rights-and-artificial-intelligence-draft-handb/1680b366e2>>.

<sup>80</sup> ILC, Draft Guidelines on the protection of the atmosphere (n 58).

<sup>81</sup> See the widely different operation and normative role of the precautionary principle or approach in European and in the US legal system.

diligence by taking certain steps to minimise the likelihood or extent of harm arising from SRM activity. At a minimum, the obligation to conduct a prior environmental impact assessment would arise, which traditionally forms part of the duty of prevention.<sup>82</sup>

This scenario, however, would overall tolerate – and in fact, factor in – such side effects to occur. So much so that this view would assign the duty of prevention the same marginal role in the context of technology as in the case of environmental pollution. As pointed out by Vinuales, the international law of the environment is also only allowed to function as a law of side effects without limiting the underlying polluting activity itself.<sup>83</sup>

Such an approach to international law obligations would essentially deprive the prevention obligation of its forward-looking aspect by confining States' prevention duties to remedying harm that has already arisen from SRM. Indeed, the issue of how to ensure a just compensation scheme for the loss and damage caused by SRM has been widely discussed in the ethics literature.<sup>84</sup> Such a reading of prevention, however, would go against the forward-facing, *stricto sensu* preventive character of the norm.

Such an interpretation of the prevention principle can, however, be readily contested from a positivist point of view in at least two important ways. The first challenge emanates from the *Bosnian Genocide* case, where the ICJ famously found that “logic dictates that a State cannot have satisfied an obligation to prevent [and act] in which it actively participated.”<sup>85</sup> This implies that the no-harm rule prevention obligation can only be met if States do not engage in activities that knowingly trigger transboundary environmental harm.

The second counterargument concerns the content of due diligence, which is avowedly onerous<sup>86</sup> in the context of climate change, and may, arguably, include prohibitory implications for engaging in harmful technologies. As ITLOS emphasised in its recent Advisory Opinion, the prevention obligation poses requirements far exceeding simple best-efforts obligations, which are, in fact, “highly demanding,”<sup>87</sup> and cannot be construed as requiring “a lesser degree of effort to achieve the intended result”<sup>88</sup> that an obligation of result. Furthermore, in cases of a high risk of serious and irreversible harm to the environment from State conduct, the standard of expected care is stringent, requiring all necessary measures to prevent harm,<sup>89</sup> which must be informed by the best available scientific knowledge on the risks and their possible impacts.<sup>90</sup> Importantly, as part of the overall obligation of conduct, States even have an obligation of result “to adopt and implement all measures necessary to prevent”<sup>91</sup> relevant harm. There is a shared understanding among scholars that these findings practically require decarbonisation from States, that is, putting in place a regulatory framework in which anthropogenic GHG emissions cease to be lawful.<sup>92</sup>

<sup>82</sup> The ICJ found that “to fulfil its obligation to exercise due diligence in preventing significant transboundary environmental harm, a State must, before embarking on an activity having the potential adversely to affect the environment of another State, ascertain if there is a risk of significant transboundary harm, which would trigger the requirement to carry out an environmental impact assessment.” See the joint cases concerning *Certain Activities Carried out by Nicaragua in the Area* (*Costa Rica v Nicaragua*) and *Construction of a Road along the San Juan River* (*Nicaragua v Costa Rica*) Judgment I.C.J. Reports 2015, p. 665, para 104.

<sup>83</sup> Vinuales and Mercure (n 72).

<sup>84</sup> Robert K Garcia, “Towards a Just Solar Radiation Management Compensation System: A Defense of the Polluter Pays Principle” (2014) 17 *Ethics, Policy & Environment* 178.

<sup>85</sup> *Case Concerning the Application of the Convention on the Prevention and Punishment of the Crime of Genocide* (*Bosnia and Herzegovina v Serbia and Montenegro*), Judgment (26 Feb 2007) para 382.

<sup>86</sup> ITLOS Advisory Opinion No. 31 (n 65), para 240.

<sup>87</sup> *Ibid.*, para 257.

<sup>88</sup> *Ibid.*

<sup>89</sup> *Ibid.*, para 243.

<sup>90</sup> *Ibid.*, para 241.

<sup>91</sup> *Ibid.*, para 237.

<sup>92</sup> Vinuales and Wewerinke-Singh, n (66).

In sum, fostering this scenario would go radically against the established view on prevention, also accepted by the ILC<sup>93</sup> and the ICJ,<sup>94</sup> which clearly states that the obligation of prevention relates to the risk of harm, and not only the harm already materialised. This radically narrow view on prevention, therefore, can hardly be validly endorsed by States in the context of SRM activities.

#### IV. Customary law obligations in an SRM treaty: Can States overwrite their obligation in a treaty?

Having reviewed the different legal configurations of the prevention obligation, the question arises of what the implications are of such a customary law obligation for an eventual SRM treaty regime. Simply put, can States adopt a treaty that creates special rules on SRM related environmental harm derogating from the above addressed customary law limits?

For the sake of the argument, let us assume that certain States intend to draw up an SRM treaty, which circumvents the limits flowing from customary international law. There are three possible normative justifications for this conception of customary law limitations. The first stems from the derogation from customary obligations by a treaty; the second views rules on technology as *lex specialis* to international environmental law where the prevention obligation is rooted; and the last argues for the possibility of changing the content of customary international law. However, none of these strategies is immune to doctrinal challenges from a positivist perspective, as shown below with respect to each in turn.

First, as to the derogation by a treaty from customary law obligations, such a possibility indeed exists under international law, given that there is no hierarchy between the two types of sources of international law obligations. As a general rule, a later treaty can overwrite previous customary international law obligations, however, under the *pacta tertiis* rule enshrined under Article 35 of the Vienna Convention on the Law of Treaties (VCLT),<sup>95</sup> a treaty can only impose obligations on third States if they expressly consented to such an obligation. Given that a treaty allowing SRM activities would impose an obligation on other States to bear significant environmental impacts, derogating from the harm prevention obligation would only be permissible if all potentially affected States consented to it.

However, this scenario is highly unlikely in the current political climate. The recent pushback from African States at the UNEA meeting in February 2024 is an apt illustration of the distrust and suspicion of Global South states over SRM-related initiatives of the Global North. African States refused to even discuss the proposal tabled by Switzerland on further SRM research with reference to their marked opposition to considering SRM as a potential solution to climate change.<sup>96</sup>

A second possibility to circumvent the no harm obligation lies in differentiating “the law of technology,” or the “law on the atmosphere” from the “international law of environmental protection” and to argue that the no-harm rule is only applicable in the context of the latter, but not in other spheres of international law governing SRM technology. However, this position does not hold water for at least three reasons. First, there is a limit to claim fragmentation in international law, and generally applicable

<sup>93</sup> ILC, Draft Article on the Prevention of Transboundary Harm from Hazardous Activities (n 41).

<sup>94</sup> *Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgment, I.C.J. Reports 2010, p 14, para 101.

<sup>95</sup> Vienna Convention on the Law of Treaties, 1155 U.N.T.S. 331, 8 I.L.M. 679, entered into force 27 January 1980.

<sup>96</sup> F Biermann, A Gupta, “A Paradigm Shift? African Countries Call for the Non-Use of Solar Geoengineering at UN Environment Assembly” (n 19).

obligations between the parties cannot be excluded.<sup>97</sup> As also stressed by the ILC, when States adopt new rules of international law relating to the atmosphere, they should do so in a manner harmonious with other relevant rules of international law.<sup>98</sup>

Second, and in any case, the harm prevention principle is rooted in the *sic utere tuo* principle, which is not confined to an environmental law context, as confirmed by the ICJ in the *Corfu Channel* judgment.<sup>99</sup> Third, States have been unable to rely on the *lex specialis* argument also in recent climate change advisory proceedings. ITLOS firmly found that the Paris Agreement was not a *lex specialis* to UNCLOS; therefore, the obligations under the law of the sea were not reduced to the mainly procedural obligations stipulated by the Paris Agreement.<sup>100</sup> In the same vein, arguably, SRM obligations would also not constitute a *lex specialis* to other existing international law obligations.

Finally, as to the strategy of altering the content of customary law obligations, a theoretical possibility indeed exists to change the obligation itself by carving out SRM related impacts from the scope of the no harm obligation. This would require a change in state practice and opinion juris, aiming to modify the original content of the prevention obligation. However, under established rules of international law, the practice of States suggesting a new norm should be consistent and general, and must include the conduct of those States “whose interests are specially affected”.<sup>101</sup> The ILC notes that the exact number and distribution of States necessary to achieve generality cannot be stated in the abstract.<sup>102</sup> Determining the scope of specially affected States has special importance in the context of state conduct with likely harmful impacts. Albeit disappointingly, the ICJ did not address this issue in the *Nuclear Weapons Advisory Opinion*, where the question was inherently relevant.<sup>103</sup> Yet, as pointed out by Judge Weeramantry, it would be “unrealistic” to confine the scope of specially affected States to those endowed with the technological capacity to deploy SRM by excluding States on the receiving end of the harmful impacts.<sup>104</sup> Scientists suggest that the Global South is likely to be disproportionately affected by unequal weather conditions.

In sum, such a reading of the prevention obligation designates an extremely narrow path for States to escape from the customary harm prevention obligation in the context of SRM, which may exist in theory, but is highly unlikely to be successfully invoked in practice.

## V. Conclusion: Testing the power of social technology in the face of SRM technology

The above assessment reveals that the development and deployment of SRM would put almost the entire structure of international legal obligations pertaining to environmental protection under strain, especially the harm prevention obligation under international

<sup>97</sup> Art 31 (3) c) VCLT, see also *Fragmentation of International Law: Difficulties Arising From The Diversification And Expansion Of International Law Report of the Study Group of the International Law Commission, Finalized by Martti Koskeniemi*, para 462.

<sup>98</sup> ILC Draft Guidelines on the protection of the atmosphere (n 58), Guideline 9.

<sup>99</sup> *Corfu Channel (United Kingdom of Great Britain and Northern Ireland v. Albania)*, Judgment, 9 April 1949, ICJ Reports (1949), p 4.

<sup>100</sup> ITLOS Advisory Opinion No. 31 (n 65), para. 224.

<sup>101</sup> *North Sea Continental Shelf Cases* (Federal Republic of Germany/ Denmark; Federal Republic of Germany/ The Netherlands), Judgment, ICJ Reports 1969, p 3, para 74.

<sup>102</sup> ILC draft conclusions on the formation of customary international law with commentaries (2018), A/73/10, Commentary to conclusion 8, section (3).

<sup>103</sup> A Roberts and S Sitvakumaran, “The Theory and Reality of the Sources of International Law” in MD Evans (ed), *International Law* (Oxford, Oxford University Press 2018) pp 89–118, at 95.

<sup>104</sup> Dissenting Opinion of Judge Weeramantry, *Nuclear Weapons Advisory Opinion*, p 535.



customary law. Against this backdrop, strong arguments can be made for reading this obligation as rendering SRM deployment unlawful, even in the absence of a specific treaty to that effect. The extent of legal constraints depends on how States conceptualise the temporal scope and content of prevention. This paper argues that strong doctrinal arguments can be made against the weak conceptualisations of the principle that would relegate its role to regulating only the harmful side effects of SRM or would deem it an optional limit that States can modify or circumvent by a treaty arrangement.

Importantly, stronger configurations of prevention not only arise as a logical necessity from the positivist reading of relevant rules of international law, but they also find budding support in the practice of influential stakeholders. More concretely, the Scientific Advice Mechanism advised the EU Commission in December 2024 to give effect to an EU-wide moratorium on SRM deployment and large-scale experiments and to work towards a global governance framework with a position favouring non-deployment in the foreseeable future.<sup>105</sup>

The future of SRM technology largely depends on how its social perception will unfold; and how the risks, uncertainties, and opportunities of this form of geoengineering are framed against the background of the escalating effects of the climate crisis. This article zeroed in on the specific role of international law in shaping this public discourse. It is argued that international law, a special type of social technology, may even be capable of halting the advent of harmful physical technologies. It depends on whether international lawyers conceive the harm prevention obligation as one that tolerates further technological research and development despite their foreseeable harmful effects, or rather, they amplify a reading of this obligation that has a binding, justiciable and future-oriented character, which can be breached even before respective harm occurs.

This paper showed how the unique temporality of emerging geoengineering technologies, such as SRM, puts the normative “teeth” and strength of the prevention principle to the test. SRM technologies do not yet exist in the real world only in the shared imagination of experts, policy advisors, and political stakeholders. So are the inevitable risks and potential impacts triggered by SRM, which currently manifest themselves in model calculations and projections. The international community is currently at a critical juncture with respect to our technological future. The extent to which SRM technologies – and the accompanying harmful risks and impacts – will materialise largely depends on whether international law is capable of establishing some bottom lines for technological innovation by giving effect to the duty of prevention. This, in turn, depends on what international lawyers think and project towards the wider public about the temporality and normative implications of the harm prevention obligation under customary international law.

<sup>105</sup> Scientific Opinion No. 17 on Solar Radiation Modification (n 21).