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Human rights bodies and mechanisms

Impact of new technologies intended for climate protection on the enjoyment of human rights

Report of the Human Rights Council Advisory Committee*, **

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** The annex is being circulated as received, in the language of submission only.

I. Background

1. In its resolution 48/14, the Human Rights Council requested its Advisory Committee to conduct a study and to prepare a report on the impact of new technologies for climate protection on the enjoyment of human rights, to be submitted at its fifty-fourth session. At its twenty-seventh session, the Advisory Committee established a drafting group, currently composed of Buhm-Suk Baek, Rabah Boudache, Milena Costas Trascasas (Chair), Ajai Malhotra, Javier Palummo, Vasilka Sancin, Patrycja Sasnal (Rapporteur), Vassilis Tzevelekos and Frans Viljoen.

2. In the elaboration of the report, the Committee worked in cooperation with the Special Rapporteur on the promotion and protection of human rights in the context of climate change. The study is based on scientific knowledge publicly available, semi-structured interviews with stakeholders and rights holders, including representatives of Indigenous Peoples, and inputs from non-governmental organizations, States, public institutions, academics and business.

3. The term "new technologies intended for climate protection" (NTCPs) reflects more accurately the current debate on the issue. Attributing at this stage a "protective" function to speculative technologies may be misleading as it presupposes evidence-based knowledge that they are all beneficial or desirable. It may give a false impression that there is scientific certainty about the efficacy of these technologies, which is not currently the case.[1] NTCPs are examples of "geoengineering", a larger and widely used term that refers to a broad set of methods and technologies operating on a large scale that aim to deliberately alter the climate system in order to alleviate the impacts of climate change.[2]

4. Climate change is one of the biggest threats that humanity faces, requiring a global solution. States have human rights obligations to prevent, to the greatest extent possible, the current and future negative impacts of climate. In successive reports, the Intergovernmental Panel on Climate Change has made it clear that phasing out fossil fuels is imperative to mitigate climate change and minimize its future negative human rights impact on people. The Panel emphasizes that rights-based approaches, by employing readily available renewable energy technologies and conserving and restoring the earth's natural systems, which serve as carbon sinks, offer a sustainable pathway to keep climate change below 1.5°C. On the other hand, climate engineering solutions pose risks, including moral hazard and delayed action, and are not presently feasible in terms of their accessibility and scalability.

5. The General Assembly and the Human Rights Council have, in several resolutions on the interrelationship between environmental protection and human rights,[3] stressed that climate change action needs to happen in accordance with States' human rights obligations and commitments. Otherwise, climate policies and measures will lack coherency and legitimacy, and would not be sustainable.[4] Moreover, the principles of participation and information, transparency, accountability, (intergenerational) equity and non-discrimination need to guide global efforts to mitigate and adapt to climate change.

II. Introduction

6. So far, new and emerging technologies intended for climate protection have not been extensively examined from the human rights viewpoint. Human rights law contains,

[1] Speculative technologies should not be presented as measures taken in conformity with article 3 (4) of the United Nations Framework Convention on Climate Change, which requests States parties to adopt policies and measures to protect the climate system against human-induced change.

[2] Intergovernmental Panel on Climate Change, *Climate Change 2014: Synthesis Report – Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Geneva, Switzerland, 2014), p. 89.

[3] See www.ohchr.org/en/climate-change/human-rights-council-resolutions-human-rights-and-climate-change. The first time the Council expressed its concern, in a resolution, that climate change posed an immediate and far-reaching threat to people and communities around the world was in its resolution 7/23.

[4] Human Rights Council resolution 10/4.

however, norms and principles that apply to any new technological development or application, particularly when it has the potential to produce large and long-lasting impacts on the enjoyment of human rights and on the environment. The present report is intended to provide States and other interested stakeholders with useful information to assess such impacts and prevent human rights harms. The Advisory Committee seeks to clarify applicable human rights obligations to ensure that climate change responses and measures are coherent and in accordance with the human rights framework. A human rights-based approach helps to ensure that those policies are not regressive in human rights terms and can effectively improve the lives of all people, including through the realization of the right to a clean, healthy and sustainable environment.[5]

7. NTCPs are defined here as technologies developed in the last two decades that fulfil the following characteristics: (a) as regards purpose and intent, they are exclusively aimed at abating the adverse effects of climate change and do not serve for energy or goods production; and (b) in terms of scale, they have the hypothetical potential to alter the earth's planetary climate if implemented at scale. In the report, the Advisory Committee primarily assesses the human rights impacts of two general types of geoengineering: carbon dioxide removal and solar radiation modification. Carbon dioxide removal methods that meet the definition of NTCPs above are: direct air capture, enhanced weathering and ocean fertilization. The definition should not be considered binding as each single technology generates different risks to human rights and should be assessed on a case-by-case basis. Potential new technologies beyond carbon dioxide removal, solar radiation modification and other geoengineering approaches exist to tackle climate change if a broader definition of "technology" is used that does not exclude system change approaches that aim at a zero waste circular economy or agroecological transformation.

8. However, industrial or agricultural production that uses carbon capture and storage or direct air capture with enhanced oil recovery cannot be considered as protecting the climate by definition, since they are not exclusively deployed to produce negative emissions. Despite their potential for being transformative, in the present study, the Advisory Committee does not assess nature-based carbon dioxide removal, including agroecological techniques and circular economy approaches, which are not considered new. Widely used bioenergy with carbon capture and storage, a technology posing grave risks to human rights, also falls outside the definition of NTCPs because it is not novel or an energy production method.[6] However, the findings of the present report apply to bioenergy with carbon capture and storage, as well.

9. If greenhouse gas emissions are not cut and some of the worst future scenarios not avoided, interventionist solar radiation modification technologies could, by increasing the earth's reflectivity, lower the global average temperature. However, solar radiation modification technologies do not act on the core problem of greenhouse gas emissions and, as such, are fundamentally different from carbon dioxide removal. The modes of operation and impact on human rights of NTCPs are elucidated in the annex to the present report.

10. At the current stage of their development, NTCPs cannot be considered viable mitigation or adaptation measures.[7] Most geoengineering technologies remain unproven, unavailable and unfeasible at scale. Since the hypothetical benefits of such technologies are still to be practically and scientifically proven, they are considered speculative. NTCPs, as is the case of all other geoengineering technologies with the possible exception of some nature-based solutions, currently do not lower emissions, as they all increase carbon dioxide in the system if the overall emissions produced by constructing and operating the relevant facilities are taken into account. Uncertainty and potential harm in relation to solar radiation modification are still much greater than for carbon dioxide removal.

[5] General Assembly resolution 76/300.

[6] For more information, see Philipp Günther and Felix Ekardt, "Human rights and large-scale carbon dioxide removal: potential limits to BECCS and DACCS deployment", *Land*, vol. 11 (2022).

[7] There is, for example, too much uncertainty surrounding the potential of solar radiation modification techniques to allow adjustments to expected climate in order to moderate harm or exploit beneficial opportunities. See definition of "adaptation": www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Annex-II.pdf.

11. States parties to the Paris Agreement agreed to hold the increase in the global average temperature, caused by greenhouse gas emissions, to well below 2ºC above pre-industrial levels and pursue efforts to limit it to 1.5°C. There is an increasing consensus, formed on the basis of the best available science, that the higher ambition target of 1.5°C must be reached to prevent the worst impacts of climate change. Time is key in achieving it, because there is a rapidly closing window of opportunity to secure a liveable and sustainable future for all, as elucidated by the Intergovernmental Panel on Climate Change in its sixth assessment report. Reducing greenhouse gas emissions is the only scientifically certain way of coming close to achieving "real zero emissions". The use of that term is advocated by several civil society organizations because technologies to remove carbon dioxide from the planetary system are currently not only insufficiently developed, inefficient and financially unsustainable, but may also be used as an excuse not to cut emissions.[8]

12. One of the gravest risks that geoengineering technologies pose is that they act as a deterrent to cutting emissions (sometimes called "moral hazard risk"), which makes disastrous future scenarios more probable. A number of civil society organizations, Indigenous Peoples and researchers underscore that counting on the technological removal of carbon dioxide slows down reforms to cut emissions, including investing in renewables and the circular economy, and diverts public attention away from the primary goal, giving the false promise of a hypothetical future solution to a problem that requires immediate action. They recall that real, fundamental, long-term solutions to climate change are already available, but a major obstacle to their implementation is the lack of influence of frontline communities, small-scale food producers, Indigenous Peoples and others compared with that of polluting industries.

13. Carbon dioxide removal has gained traction as a ploy to meet nationally determined contributions under the Paris Agreement, while solar radiation modification is often presented as a "plan B" to remedy the critical situation that the failure to reduce greenhouse gas emissions is creating and as the only means to address the "overshoot" (scenarios in which the temperature increases by more than 1.5°C or even 2ºC). However, in the absence of scientific certainty and an appropriate international governance framework to deter and sanction inappropriate action, relying on pre-emptive and emergency rhetoric will most probably lead to counterproductive results.[9]

14. In that context, proponents of solar radiation modification call for a regulatory framework to facilitate the potential use of NTCPs.[10] Opponents advocate for a moratorium or even a total ban until the environmental and human rights risks posed by such technologies are understood.[11] Regardless of the stance, as science stands today, the deployment of solar radiation modification technologies poses, in particular, cascading global risks to people and the environment, the distribution of which would potentially be global.

[8] Real Zero Europe statement, available from www.realsolutions-not-netzero.org/real-zero-europe.

[9] One of the first attempts at governance is the proposed set of guiding principles known as the Oxford Principles. However, that proposal and others since have remained theoretical so far. See www.geoengineering.ox.ac.uk/www.geoengineering.ox.ac.uk/oxford-principles/principles/index.html.

[10] A private initiative, the Climate Overshoot Commission, has adopted such a stance. The United Nations Environment Programme proposed a regulatory framework in a report, "One atmosphere: an independent expert review on solar radiation modification research and deployment" (Nairobi, 2023). See also Tyler Felgenhauer and others, *Solar Radiation Modification: A Risk-Risk Analysis* (New York, Carnegie Climate Governance Initiative, 2022). For examples in scientific literature, see Gernot Wagner, *Geoengineering: The Gamble* (Cambridge, United Kingdom of Great Britain and Northern Ireland, Polity Press, 2021).

[11] See an open letter of more than 60 climate scientists and governance scholars at www.solargeoeng.org/non-use-agreement/open-letter. See also Frank Biermann and others, "Solar geoengineering: the case for an international non-use agreement", *WIREs Climate Change*, vol. 13, No. 3 (May/June 2022), p. 3; Nils Markusson, "'In case of emergency press here': framing geoengineering as a response to dangerous climate change", *WIREs Climate Change*, vol. 5, No. 2 (March/April 2014), pp. 281–290; and https://www.ohchr.org/sites/default/files/2022-06/Annex-SubmissionCIEL-ETC-HBF-TWN-Geoengineering-Opinion.pdf.

III. Risks and side effects

15. The earth's climate is characterized by intense interconnectedness, the nature of which is the subject of ongoing studies. The Intergovernmental Panel on Climate Change finds that risks can arise from certain responses that are intended to reduce climate change – e.g. the adverse side effects of some emission reduction and carbon dioxide removal measures. Implementing solar radiation modification techniques, in particular, introduces a wide range of new risks to people and ecosystems that are not well understood.[12]

A. Physical risks

16. Implementing NTCPs is resource intensive. The physical risks posed by carbon dioxide removal are listed in table 1 in the annex to the present report, including extensive water and energy consumption, adverse impacts on marine biology and the food web, health risks, ecological impacts of mineral extraction and transport, waste pollution and the chemical footprint. The types of risks, however, are interlinked and mere compartmentalization does not tell the whole story of the potential interlinkages and cascades, which hold true for all the risks described herein. For example, technological and environmental risks for direct air capture and enhanced weathering, among other types of NTCPs, could also incite negative perceptions, such as technological domination or new forms of colonialism.[13]

17. As regards solar radiation modification, the possible negative physical effects include unpredictable changes in hydrological patterns, harm to the ozone layer, global dimming, reduced photosynthesis, changes in crop growth resulting in decreased food production and access, as well as further cascading risks in social and political systems and relations.[14]

B. Social, societal and socioeconomic risks

18. NTCPs cause social risks, including for future generations. They generally require land or/and have an impact on land and other natural resources and biodiversity. Exposure to the effects on land is greater for frontline communities, including Indigenous Peoples, local communities, peasants, fisherfolk, rural women and other persons working in rural areas. Solar radiation modification risks disrupting local and regional weather patterns and creating greater imbalance in the climate, with potentially catastrophic effects, including on water availability and food production. Several technologies could have transboundary side effects in neighbouring countries or across the world. The social consequences of such a modification would likely be uneven geographically, for example through hydrological cycle disruption, which would potentially be harsher for poorer States and the global South, depending on where certain technologies are used (see annex below). That may in turn strengthen entrenched inequalities and deepen climate injustice.

19. According to the Intergovernmental Panel on Climate Change, many NTCPs could have adverse socioeconomic impacts, especially if implemented on a large scale and where land tenure is insecure. The Panel warns against dependence on carbon dioxide removal as it constrains sustainable development.[15] It emphasizes that societal choices and actions

[12] Intergovernmental Panel on Climate Change, *Synthesis Report of the IPCC Sixth Assessment Report: Longer Report*, p. 37.

[13] Benjamin K. Sovacool, Chad M. Baum and Sean Low, "Risk-risk governance in a low-carbon future: exploring institutional, technological, and behavioral tradeoffs in climate geoengineering pathways", *Risk Analysis*, vol. 43, No. 4 (April 2023), pp. 838–859.

[14] Alan Robock, "20 reasons why geoengineering may be a bad idea", *Bulletin of the Atomic Scientists*, vol. 64, No. 2 (May 2008), pp. 14–18.

[15] The Panel states that modelled pathways that assume using resources more efficiently or shift global development towards sustainability include fewer challenges, such as dependence on carbon dioxide removal and pressure on land and biodiversity, and have the most pronounced synergies with respect to sustainable development (Intergovernmental Panel on Climate Change, *Synthesis Report of the IPCC Sixth Assessment Report: Longer Report*, p. 54).

implemented in the present decade will determine the extent to which medium- and long-term pathways will deliver higher or lower climate resilient development. In that light, NTCPs weaken the time pressure to take appropriate actions[16] and pose overarching risks to equity, inclusion and just transitions, which enable deeper societal ambitions for accelerated mitigation and climate action more broadly.[17]

20. Surveys show that people worldwide are not familiar with carbon dioxide removal nor solar radiation modification. That may result in increased distrust should a technology be used on a larger scale, fuelling conspiracy theories in relation to NTCPs. Given the popularity of disinformation campaigns and their usage as tools of internal and international political conflict, climate technologies may become their subject, in which case it may be increasingly difficult to conduct an informed public debate about these methods. That would add to the growing distrust of technology and science.

C. Vested interests

21. There could be vested interests (personal or group stakes) in promoting NTCPs. When vested interests are combined with a relatively small pool of scientists researching the climatic (physico-chemical) impact of these technologies, there is a risk of group think. According to several interviewees, there is a tendency among these groups to exaggerate the certainties of the technologies in question, while underplaying the uncertainties. Moreover, discussions about the impacts of technologies are mostly confined to physicists, climatologists and other natural scientists with very limited involvement of social scientists, political scientists, economists and specialists in non-natural sciences. Most academic papers are focused on nature-based carbon dioxide removal methods and very few are published in social sciences or humanities journals. The scientific community working on carbon dioxide removal excludes social scientists at the research, development and implementation stages. Techno-fixes, such as climate engineering, assume solutions without addressing the root causes of climate change and are often supported by proponents of polluting industries.

D. Deterrence to cutting emissions and greenwashing

22. The deterrence risk of NTCPs, as described in paragraph 12 above, is multifaceted. The risk can be exacerbated by States, which, although they are top emitters, can afford investment in such technologies and hence can claim that their climate and energy goals are in accordance with the Paris Agreement, and by business entities, which are interested in continued emissions but can buy carbon credits by investing in NTCPs. Deterrence to cut emissions may be amplified in the near future by a public debate increasingly focused on the topic of carbon removal rather than carbon cuts, and research path dependencies.[18]

23. Fossil fuel extraction and production companies can use the prospect of carbon capture and storage to justify continued fossil fuel production. The business model of NTCPs raises questions about the lack of transparency concerning investors, who are often big emitters, and their intentions. Investment in such technologies may be used to improve an otherwise negative public image. However, ill-intentions should not be automatically assumed, as some companies claim that they began carbon dioxide removal research and/or investment because of climate concerns and deficiencies in the current system of carbon credits.

24. Another range of risks pertains to carbon markets and carbon credits, which are used to offset emissions. The portion of carbon offsets from artificial carbon dioxide removal technologies is growing. Overall, demand for credits is now greater than the supply. The offset market is unregulated, many of the credits sold do not meet efficiency goals or, simply,

[16] Ibid., p. 56.
[17] Ibid., p. 66.
[18] "Research on NETs, like research on SRM, may create path-dependencies, locking in a requirement for NETs to meet climate goals" (Jan C. Minx and others, "Negative emissions: part 1 – research landscape and synthesis", *Environmental Research Letters*, vol. 13, No. 6 (June 2018), p. 20).

do not contribute to emissions reductions at all (see annex below). The problems, revealed in studies on the most common rainforest protection credits, may reoccur in carbon dioxide removal credits if methodologies, certification and oversight are not objectively and rigidly administered and regulated and conflicts of interest avoided. If the situation persists, it will not only work against emission cuts but expand opportunities for greenwashing, misinformation and social distrust of these technologies. Currently, major emitters already put offsetting at the heart of their climate strategies rather than emissions reductions.

E. Other ethical risks

25. NTCPs, which are unproven on a large scale, may create climate-related harms in the future if these technologies prove not as efficient as assumed by some. If the gamble fails, present and future generations and the poorest within them will bear the cost of that failure. Another ethical risk emanates from hubris. Large-scale NTCPs deployment may greatly overestimate the ability of humans to understand complex natural systems and manage carbon cycle flows, thereby risking doing more harm than good. If climate change is a socially created problem, it may not be solvable technologically.

26. NTCPs may promote systemic close-mindedness and avert structural change. Inequalities keep increasing as long as the profit-driven business model dominates the global economy. Structural inequalities are also baked into the economic modelling that underpins climate mitigation scenarios, thus limiting the number of imagined futures; all such scenarios assume continued injustices. Failure to design and implement effective and equitable mitigation plans that will rapidly achieve emission reduction targets is inconsistent with the obligation of States to protect human rights from grave and foreseeable risks.[19]

F. Political and security risks

27. Climate change per se, apart from the principle of common but differentiated responsibilities and respective capacities, has for the most part not been the subject of international political conflict. Currently, although emissions are known to be harmful, there is no intended harm.[20] If countries begin to make large-scale investments in NTCPs or even to transgress boundaries by carrying out unilateral action, the situation could change. Solar radiation modification projects would be intentional and therefore could be seen as deliberate and politically hostile acts.

28. Hostile use of weather-modification technologies is prohibited under international law. Still, even “peaceful” use of such technologies could pose immense risks and result in negative human rights impacts. If climate becomes a tool a State can use against another State, such an action could radically change climate politics, making it a security issue. The use of solar radiation modification could bring about an unknown political and social order. Proponents of solar radiation modification recommend that it be subjected to well-structured global governance, although an international agreement on the use of such a controversial and uncertain technique borders on the impossible if it is not to ban it completely.

IV. Applicable normative framework

29. The General Assembly recently affirmed that the full implementation of multilateral environmental agreements under the principles of international environmental law was

[19] Amicus curiae brief submitted to the European Court of Human Rights by the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes, the Special Rapporteur on the issue of human rights obligations relating to the enjoyment of a safe, clean, healthy and sustainable environment and the Independent Expert on the enjoyment of all human rights by older persons, available at www.ohchr.org/sites/default/files/Documents/Issues/ToxicWaste/AmicusKlimmaECtHR.pdf.

[20] Olaf Corry, “The international politics of geoengineering: the feasibility of Plan B for tackling climate change”, *Security Dialogue*, vol. 48, No. 4 (August 2017), pp. 297–315.

required for the realization of the human right to a clean, healthy and sustainable environment.[21] Respect for this right is instrumental in the realization of other human rights, such as the rights to life, health, food, water and housing. In the context of climate change, human rights experts and bodies are urging States to step up their mitigation actions through emissions reductions.[22] There is a pressing need to determine whether the recourse to speculative technologies can even be considered as an alternative to mainstream mitigation measures. The current focus of climate action should be on deploying existing, tested and safe measures and technologies using a rights-based approach in line with the findings of the Intergovernmental Panel on Climate Change.

30. Global action to combat climate change is shaped by several instruments, including the Rio Declaration on Environment and Development (1992), the United Nations Framework Convention on Climate Change (1992), the Kyoto Protocol to the United Nations Framework Convention on Climate Change (1997), the Paris Agreement (2015) and the 2030 Agenda for Sustainable Development. States have to guarantee that actions carried out in pursuing the set objectives do not endanger the environment and the enjoyment of human rights as provided by human rights law. The International Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights, as well as the other core human rights treaties and other principles and rules of general scope, provide a comprehensive and authoritative normative framework for a coherent, coordinated and collective response to climate change. That framework already provides standards and principles that require States to ensure access to information, participation in decision-making and access to justice in environmental matters. The principles of do no harm, transparency, prevention, precaution and the polluter pays are equally relevant and applicable to any policy or decision related to NTCPs.

A. Restrictions on the development and deployment of new technologies intended for climate protection

31. To date, States have not responded to the need to regulate NTCPs. Lack of regulation does not mean that such speculative technologies are permitted or can be developed in a legal vacuum. On the contrary, general principles of international law derived from environmental and human rights law may apply to any assessment or policy decision related to such technologies. In fact, in the context of multilateral environmental agreements, consideration of such principles has led to prohibiting the deployment of some NTCPs as a consequence of persistent uncertainties regarding their effectiveness and of their potential negative impact on human rights.

32. In the context of the Convention on Biological Diversity, a general moratorium on climate-related geoengineering was introduced in 2010 given the lack of transdisciplinary research.[23] The potential effects on the environment and biodiversity deriving from such activities and the associated social, economic and cultural impacts were decisive in prohibiting climate-related geoengineering without an adequate scientific basis and prior assessment of the associated risks.[24] Small-scale controlled scientific research could only take place exceptionally when justified by the need to gather specific scientific data and

[21] General Assembly resolution 76/300, para. 3.

[22] Office of the United Nations High Commissioner for Human Rights, “COP27: urgent need to respect human rights in all climate change action, say UN experts”, 4 November 2022.

[23] A decision in 2008 by the Conference of the Parties on ocean fertilization activities (decision IX/16) was broadened, in 2010, to other climate-related geoengineering activities in its decision X/33 and renewed in 2016. Such decisions are not legally binding, but authoritative; they represent a broad consensus on this issue and are adopted by the governing body of this multilateral treaty with universal application.

[24] See decision X/33 of the Conference of the Parties, para. 8 (w), in which it provides a definition of these technologies: “any technologies that deliberately reduce solar insolation or increase carbon sequestration from atmosphere on a large scale that may affect biodiversity (excluding carbon capture and storage from fossil fuels when it captures carbon dioxide before it is released into the atmosphere)”.

subject to a thorough prior assessment of the potential impacts on the environment.[25] It was recognized that there was a need to establish a transparent and effective global control and regulatory mechanism and that institutions should share knowledge to better understand impacts and options.[26]

33. The governing bodies of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention, 1972) and its Protocol (1996) have also called for extreme precaution and are currently evaluating several marine geoengineering technologies, having already agreed to prohibit ocean fertilization. In a resolution adopted in 2008, the parties to the London Convention and its Protocol introduced a ban, subject to review, on other marine geoengineering activities, while allowing legitimate scientific research (without commercial motivation) to proceed.[27] While carbon dioxide sequestration, research and deployment were generally permitted following an assessment of their environmental impact, ocean fertilization deployment was totally prohibited and associated research controlled as projects could only be carried out to increase knowledge without creating significant risks to the marine environment.[28] In 2023, the scientific groups reporting to the consultative meetings/meetings of the contracting parties agreed that four marine geoengineering techniques had the potential to cause deleterious effects that were widespread, long-lasting or severe.[29] The levels of uncertainty and of potential detrimental effects are the decisive criteria for such differentiated treatment.

34. The Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (1976) expressly prohibits all techniques that are intended to alter − through deliberate manipulation − the natural processes, dynamics, composition or structure of the earth, including its biota, lithosphere, hydrosphere and atmosphere or of outer space. In its recently adopted draft set of principles on protection of the environment in relation to armed conflicts, the International Law Commission included specific principles on environmental modification techniques, which provide that, in accordance with their international obligations, States should not engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State.[30] Even if the scope of the principles is to protect the environment from damage during armed conflict, it seems self-evident that the use of techniques leading to such serious environmental consequences are even less acceptable in peacetime. According to the Commission, in all circumstances, the environment remains under the protection and authority of the principles of international law derived from established custom, from the principles of humanity and from the dictates of public conscience.[31]

[25] Ibid.

[26] Decision XIII/14 of the Conference of the Parties, para. 5. That approach has been endorsed by the Kunming-Montreal Global Biodiversity Framework, which includes target 10 to maintain nature's contribution to people, as well as, in general, the objectives of the Convention on Biological Diversity.

[27] Resolution LC-LP.1 on the regulation of ocean fertilization.

[28] Harald Ginzky, "Marine geo-engineering", in *Handbook on Marine Environment Protection*, Markus Salomon and Till Markus, eds. (Springer International Publishing, 2018), pp. 997–1011, available from https://doi.org/10.1007/978-3-319-60156-4_53.

[29] These involve carbon dioxide removal and solar radiation modification: ocean alkalinity enhancement and electrochemical carbon dioxide removal; biomass cultivation for carbon removal; marine cloud brightening; and surface albedo enhancement involving reflective particles and/or other materials (International Maritime Organization, "Marine geoengineering: assessing the impacts on the marine environment", 24 March 2023).

[30] A/77/10, para. 58, principle 17.

[31] Ibid., principle 12. The International Law Commission introduces an environmental "Martens clause", which would apply in cases not covered by international agreements. See also World Conservation Congress, Amman, 4–11 October 2000, recommendation 2.97, entitled "A Martens Clause for environmental protection". The recommendation was adopted by consensus and was meant to apply during peacetime, as well as during armed conflicts.

B. Principled approach

35. In the absence of a legal treaty or regulations on speculative technologies, decision makers and policymakers should follow a principled approach to preserve human rights and environmental protection from the risk of uncertain or uncontrolled impacts. That is in line with the environmental "Martens clause" referring to cases that are not covered by a specific rule or treaty or whenever the legal regulation provided by a treaty or customary rule is doubtful, uncertain or lacking in clarity.[32]

36. The precautionary principle has been and should be applied to geoengineering.[33] States have a general obligation to adopt legislative, administrative, judicial and other measures to prevent harm to the environment at an early stage and to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction. Because the restoration of the situation that existed before environmental damage occurred is often impossible, prevention is the main approach to be followed by policymakers.[34] In situations in which scientific evidence of the environmental impacts of certain activities is not yet conclusive, States are required to act cautiously and diligently to avoid any steps that may cause harm to human health or the environment.[35]

37. Any technology to mitigate climate change, despite the scientific uncertainty regarding its impacts, must be evaluated against alternative options, including those about which there is more scientific certainty. In the event that there is a total or partial gap in governance, the precautionary principle dictates that alternatives should be assessed, so that less uncertain and risky alternatives should be recognized as preferable. From that perspective, a moratorium on fossil fuel extraction could be the least potentially harmful option. Other existing proposals and low-cost technologies, such as peatland and forest management, address climate change and its drivers, many of which have been tested and involve little or no risk, but provide benefits for people and the planet. A human rights-based approach to climate action, interpreted in accordance with the Paris Agreement, primarily requires prevention of further emissions by stopping excessive levels of greenhouse gas emissions. Failure to take measures to prevent foreseeable harm to human rights caused by climate change, or to regulate activities contributing to such harm, could thus constitute a violation.[36]

38. There is scientific uncertainty surrounding the risks and impacts of NTCPs on complex global planetary systems, but it is generally accepted that, at the current stage of development, these may be irreversible. Moreover, the existence of proven low-risk approaches and alternatives make the use of NTCPs, at their current stage of development, untenable under both human rights and environmental law. In such circumstances, human rights obligations, interpreted in the light of fundamental principles of environmental law, impose a rigorous application of the precautionary principle. That requires States to take action to diminish any potential environmental harm threatening human life or health in a

[32] The interpretation of human rights obligations in this area must be informed by fundamental principles under environmental law.

[33] At the international level, this principle was first codified in principle 15 of the Rio Declaration on Environment and Development (1992): "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." The preambles to the Convention on Biological Diversity and the Cartagena Protocol on Biosafety thereto also contain this principle.

[34] Inter-American Court of Human Rights, Advisory Opinion OC-23/17, 15 November 2017, para. 130.

[35] This principle "provides justification for public policy and other actions in situations of scientific complexity, uncertainty and ignorance, where there may be a need to act in order to avoid, or reduce, potentially serious or irreversible threats to health and/or the environment, using an appropriate strength of scientific evidence, and taking into account the pros and cons of action and inaction and their distribution" (European Parliamentary Research Service, "The precautionary principle: definitions, applications and governance" (2015), p. 10).

[36] A/74/161, paras. 62 and 70.

serious and irreversible manner. Because the effects of such harm would be inequitable to present and future generations, the possibility of accepting it is untenable.[37]

39. National case law follows that approach. It increasingly relies on the *pro persona* and *in dubio pro natura* principles to prioritize the most favourable protection of individuals and the environment. They are used as interpretative criteria to solve gaps in rights protection or to enhance environmental protection against harmful activities, giving preference to the least harmful option.[38] Those principles are endorsed in national case law and apply to all matters before courts, administrative agencies and other decision makers.[39] States are increasingly being brought before regional and international human rights bodies in climate change-related claims.[40]

C. Operationalizing a human rights-based approach

40. The obligation of States to take all measures necessary to respect, protect and fulfil human rights remains fully applicable in the context of NTCPs. That obligation applies to the development and application of any emerging technology. Existing guiding documents, such as the framework principles on human rights and the environment (2018), the United Nations Declaration on the Rights of Indigenous Peoples (2007) and the Guiding Principles on Business and Human Rights (2011), as well as other relevant practice from human rights bodies and mechanisms, should inform States when addressing challenges related to NTCPs. According to that framework, States should avoid taking or authorizing actions entailing environmental impacts that interfere with the enjoyment of human rights.[41]

41. Human rights, including the right to a clean, healthy and sustainable environment, have an extraterritorial dimension, which implies that States have a duty to refrain from causing environmental harm outside their own territory. That includes the duty to prevent areas subject to its jurisdiction or control being used for acts that may cause serious adverse environmental consequences to others. Preventive measures have to be taken to avoid not only environmental damage to other States, but also to areas beyond the limits of national jurisdiction, including the atmosphere and the high seas.

42. States also have a duty to protect all persons against potential human rights violations involving companies developing NTPCs.[42] Adequate measures need to be taken to protect persons from human rights and environmental harms that can be caused by such companies. In particular, there is a duty to prevent exposure of individuals and communities to toxic substances by adopting positive adequate measures.[43] States have to ensure that their own activities, including those conducted in partnership with the private sector, respect and protect human rights; and, in situations in which harm does occur, to ensure effective remedies.

D. Business regulation

43. As part of the obligation of States to exercise human rights due diligence with regard to the potential development and deployment of NTCPs, they are called upon to ensure that

[37] Committee on Economic, Social and Cultural Rights, general comment No. 25 (2020), paras. 56 and 57.

[38] Serena Baldin and Sara De Vido, "The *in dubio pro natura* principle: an attempt of a comprehensive legal reconstruction", *Revista General de Derecho Público Comparado*, No. 32 (December 2022), pp. 168–199.

[39] In Guatemala, the law on a climate change framework (Decree No. 7-2013) refers to these principles in article 6, noting that they must be observed by all entities when making decisions and acting in their respective areas of competence.

[40] For example: Committee on the Rights of the Child, *Sacchi et al. v. Argentina* (CRC/C/88/D/104/2019); and European Court of Human Rights, *Verein KlimaSeniorinnen Schweiz and others v. Switzerland*, Application No. 53600/20.

[41] A/HRC/37/59, annex, framework principle 8.

[42] Guiding Principles on Business and Human Rights.

[43] A/74/480, paras. 83 and 84.

environmental and human rights standards are effectively enforced against private actors.[44] Private actors must participate responsibly in climate change mitigation and adaptation efforts, which implies acting with full respect for human rights and being accountable for negative environmental impacts and human rights violations.[45] The compliance of businesses with those responsibilities is especially critical in situations in which States incorporate private financing or market-based approaches to climate change within the international framework, including the Paris Agreement.[46]

44. States should adopt appropriate regulatory measures to prevent and address human rights abuses by companies. Even if some examples of relevant legislation can be found at the national and regional levels, such a fragmented approach is insufficient to effectively address global risks and challenges posed by speculative technologies. It has been observed that global regulations are needed to effectively manage such technologies as fragmented national responses create governance gaps, perpetuating the technological divide and economic disparities, to the detriment of the enjoyment of economic, social and cultural rights.[47]

45. There are already more than a thousand climate engineering projects being developed and implemented, mostly in Europe, North America and Asia.[48] A moratorium on such projects should be put in place until a proper governance framework is developed.[49] That should include prior assessment of the possible environmental impacts of proposed projects and policies, including on the enjoyment of human rights. Where feasible, the framework principles on human rights and the environment provide guidelines for such an assessment.

V. Assessing the human rights impact

46. Because NTPCs are meant to be applied on a global scale, they have the potential to affect everyone indiscriminately. They could seriously interfere with the enjoyment of human rights for millions and perhaps billions of people.[50] The magnitude of the potential negative socioeconomic and human rights impacts is currently incommensurable with any hypothetical benefits.[51]

A. Impact on specific rights

47. There is a broad range of human rights that are at serious risk of the adverse impacts of the testing and deployment of NTCPs.

48. *Right to life.* NTCPs could perpetuate and exacerbate the threats that climate change already pose to life and the enjoyment of the right thereto by present and future generations. As mentioned, the mere possibility of their use could delay the implementation of urgent climate action. In the hypothetical case of deploying certain NTCPs, such as solar radiation modification, the potential adverse environmental impacts could increase food insecurity and diminish the quality of life of many people, particularly of those whose livelihoods rely on natural resources. Furthermore, it could lead to drought, delayed ozone recovery, changes in precipitation patterns and rapid warming pulses. If solar radiation modification is abruptly terminated (so-called termination shock; see table 1 in the annex), it would have a devastating

[44] A/HRC/37/59, annex, framework principle 12.

[45] Article 6 of the Paris Agreement calls upon parties to incentivize and facilitate private participation in the mitigation of greenhouse gas emissions. In doing so, States should include adequate safeguards and take effective measures to protect human rights from business harms in line with their obligations as outlined by the Guiding Principles on Business and Human Rights.

[46] Office of the United Nations High Commissioner for Human Rights, "Response to the request of Ad Hoc Working Group on the Paris Agreement (APA) to provide information, views and proposals on any work of the APA before each of its sessions", 6 May 2017.

[47] Committee on Economic, Social and Cultural Rights, general comment No. 25 (2020), para. 74.

[48] See https://map.geoengineeringmonitor.org.

[49] In practice, the existing moratorium has not prevented violations from occurring (see annex below).

[50] United Nations Environment Programme, "Climate change and human rights" (2015), p. 10.

[51] A/74/161, para. 83; and A/77/549, para. 65.

impact on ecosystems[52] and would therefore be contrary to the principle of intergenerational equity.[53]

49. *Right to a clean, healthy and sustainable environment*. Some NTCPs may potentially have negative or catastrophic effects on weather patterns, biodiversity and ecosystems as a whole. At the same time, the anticipated diversion of efforts and resources from a rapid phasing out of fossil fuels may have major effects on the environment, amounting to a violation of the right to a healthy environment, which includes the rights to clean air, a safe and stable climate, access to safe water and adequate sanitation, healthy and sustainably produced food, non-toxic environments in which to live, work, study and play, and healthy biodiversity and ecosystems.[54] The testing and deployment of NTCPs in the current circumstances would further violate the procedural dimension of this right, namely: access to information, participation in decision-making and access to justice and effective remedies. States have positive obligations relating to good governance and democratic accountability.

50. *Right to information and public participation*. The International Covenant on Civil and Political Rights and other human rights instruments guarantee the right to information and to free, active, meaningful and informed participation in public affairs. According to article 6 of the United Nations Framework Convention on Climate Change, all States should promote and facilitate public access to information on climate change and its effects, and public participation in addressing climate change and its effects and developing adequate responses. The Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (1998) includes important standards concerning the right: (a) to receive environmental information; (b) to participate in preparing plans, programmes, policies and legislation that may affect the environment; and (c) to have access to review procedures should the rights on access to information or public participation be violated. A similar instrument has been adopted in the Latin American and Caribbean region, the Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean (Escazú Agreement, 2018). The General Assembly has also recognized the importance of public participation in addressing the impacts of climate change and the need to engage a broad range of stakeholders at the global, regional, national and local levels.[55]

51. *Right to an adequate standard of living and right to food and water*. NTCPs can be water intensive, change precipitation patterns and pollute freshwater resources and thus pose a threat to food and water security, imperil livelihoods and lead to mass displacements of persons. Most carbon dioxide removal technologies require vast swathes of land and extensive water resources, potentially increasing the demand for water and, therefore, affecting food production and access to water. Solar radiation modification could also reduce the availability of fresh water on islands that already face water shortages.[56] Solar radiation modification may have adverse impacts on the right to an adequate standard of living as a result of violations of the right to food and water through manipulation of regional weather and precipitation patterns. Because of the massive water demands of these technologies, they are likely to affect the availability of safe drinking water. The potential termination shock effect could undermine food production globally, specifically in vulnerable areas in the global South.[57]

52 *Access to justice and remedies*. The Universal Declaration of Human Rights, the International Covenant on Civil and Political Rights and other human rights instruments guarantee effective remedies for human rights violations. States should ensure the necessary

[52] United Nations Environment Programme, “One atmosphere”.

[53] Human Rights Committee, general comment No. 36 (2019), para. 62.

[54] A/HRC/43/53, para. 2.

[55] General Assembly resolution 67/210, para. 12.

[56] Similarly, the use of bioenergy with carbon capture and storage can result in displacement of agricultural production and higher prices, causing food insecurity and thus endangering livelihoods, particularly for subsistence farmers and the poor.

[57] William C.G. Burns, “Human rights dimensions of bioenergy with carbon capture and storage: a framework for climate justice in the realm of climate geoengineering”, in Climate Justice: Case Studies in Global and Regional Governance Challenges, Randall S. Abate, ed. (Washington, D.C., Environmental Law Institute, 2016), pp. 157 and 158.

governance framework to effectively protect persons against human rights violations and harms from the activities of technology companies. Very often, the actions of economic actors that cause severe, widespread, long-term damage to the environment go unpunished as the actors are not prosecuted and the victims receive no economic compensation.[58] States may, in certain cases, not be in a position to effectively enforce legislation against businesses. While it is necessary to better understand NTCP-related risks before the international community decides on a course of action, negotiations on a global governance framework should ensure accountability and remedy for business-related human rights harms connected with NTCPs.

B. Impact on specific groups

53. Specific technologies would affect regions and persons differently, disproportionately affecting the poor and others in vulnerable situations. Furthermore, the decisions about and impacts of NTCPs could significantly affect the ability of children and future generations to exercise and fulfil their human rights. Women, children and persons with disabilities, who are systemically more affected by climate change and the way climate action is performed, may be disproportionately exposed to the negative effects of geoengineering technologies, which would deepen intersectional discrimination.

54. According to the Intergovernmental Panel on Climate Change, marginalized socioeconomic groups, such as migrants, people of colour, peasants, Indigenous Peoples and other frontline communities, may be particularly exposed to the negative impacts of NTCPs.[59] They are at high risk of suffering the consequences of experiments or testing but do not have a say in the decisions that may hinder the enjoyment of their rights.[60] Negative effects could be compounded for women, who already suffer from harmful gender-based discrimination, which often excludes them from participating in environmental decision-making.[61]

55. The potential deployment of NTCPs would have a massive and disproportionate impact on Indigenous Peoples whose traditional lands and territories are particularly exposed and at risk of experimental uses. NTCPs may expose them to forced displacement and deprivation of their lands, culture and traditional livelihoods through changes in land use, agriculture or weather patterns. The United Nations Declaration on the Rights of Indigenous Peoples requires States to consult and cooperate in good faith with the Indigenous Peoples concerned through their own representative institutions. States should obtain the free, prior and informed consent of Indigenous Peoples before adopting and implementing any legislative or administrative measure that may affect them. Such consent must also be given before taking any measures that affect Indigenous Peoples' rights to land, territory and resources, including mining or other exploitation of resources.[62] Indigenous Peoples have not been systematically involved in technological planning or consulted about the testing of NTCPs. The annex below provides examples of cancelled solar radiation modification field experiments (Stratospheric Controlled Perturbation Experiment in the United States of America and Sweden) that are presumed to have been planned without respecting the requirement of free, prior and informed consent. Indigenous representative organizations underline that, in the context of geoengineering, the implementation of that obligation has to represent a "dialogue that fosters understanding and provides for a consultation process that reflects higher standards of care than we have previously seen. Otherwise, it risks

[58] An independent expert panel convened by Stop Ecocide International has defined the crime of "ecocide"; see www.stopecocide.earth.

[59] A/77/549. Carbon capture programmes, for example, are often carried out in the so-called racial sacrifice zones, which are already overburdened by the heavy concentration of toxic industrial pollution, increasing the emission of harmful air pollutants.

[60] See A/HRC/50/57.

[61] See A/HRC/52/33.

[62] United Nations Declaration on the Rights of Indigenous Peoples, arts. 19 and 32.

compromising the progress on Indigenous self-determination and increasing existing divisions on geoengineering research."[63]

56. Due to their special dependency and attachment to land, peasants, fisherfolk and other persons living in rural areas also risk being disproportionately affected by NTCPs. In particular, their lands are vulnerable to being grabbed and/or polluted (i.e. by NTCP-related mining), thus undermining their right to land and natural resources.[64] There is a high risk that NTCPs would negatively affect the food production of peasants due to interference with natural cycles, which are likely to affect their management systems by undermining their traditional knowledge, practices and innovations.[65] Importantly, land has not only an economic function for peasants and other persons working in rural areas, but also social, cultural and spiritual dimensions. In a similar way to Indigenous Peoples, they may understand themselves as caretakers and custodians of ecosystems and the earth. Consequently, many employ agroecological management practices based on respect for nature and its cycles, seeking to promote biodiversity and capture carbon in the soil.

VI. Building up a protective framework

57. The conclusion to be drawn from the aforementioned considerations is that the deployment of NCTPs today would be contrary to the human rights and environmental frameworks. Even in the hypothetical scenario that there is no choice but to deploy NCTPs to address climate overshoot, the potential magnitude of the adverse impacts and risks make it imperative that a strong global rights-based governance framework be set up well in advance. The only way to overcome the political, ethical and security risks posed by any potential deployment of climate engineering requires a governance framework that facilitates inclusive dialogue, transparent processes, accountability and the active participation of all persons in decision-making processes.[66] Such a framework, at a minimum, should include: (a) ex ante human rights and environmental impact assessments before climate altering technologies are deployed and continuous monitoring and evaluation thereafter; and (b) a clear understanding of the human rights obligations of duty bearers, including the obligation of States and private sector actors to exercise human rights due diligence.

A. Multilateralism and governance framework

58. Any decision related to the governance and deployment of new technologies for climate manipulation should be taken with regard being paid to the obligation of States to cooperate and within existing multilateral decision-making bodies.[67] Bodies tasked and endowed by the international community with such competences must be representative and act in accordance with the requested standards of democracy, transparency, independence and objectivity.[68] Cooperation to establish, maintain and enforce effective international legal frameworks is key and a legal duty to foster common understanding on the kind of solutions that are needed to prevent, reduce and remedy transboundary and global environmental harm that interferes with the full enjoyment of human rights.

[63] See www.thearcticinstitute.org/sami-council-resistance-scopex-highlights-complex-questions-geoengineering-consent.

[64] United Nations Declaration on the Rights of Peasants, arts. 5 and 17.

[65] Ibid., art. 20 (2).

[66] States should take steps to strengthen the governance framework in situations in which the existing instruments prove insufficient (A/HRC/37/59, annex, framework principle 13).

[67] The General Assembly has been recognized as a representative body in which this topic could be discussed in a transparent manner.

[68] Some private entities, such as the Global Overshoot Commission, have been criticized for not fulfilling these requirements. See www.geoengineeringmonitor.org/2022/05/geoengineering-supporters-plan-to-set-up-a-new-climate-overshoot-commission. The goal of the Commission is to recommend a strategy to reduce risks should global warming goals be exceeded through carbon dioxide removal and solar radiation modification.

B. Inclusiveness in decision-making

59. Ongoing NTCP projects have been researched, financed and/or implemented in the global North while the expertise of the global South has not been sufficiently included either in scientific production or in public debates on the topic of NTCPs. Some refer to the operation of international climate institutions "as a form of indirect colonization" as many of the projects are often envisioned and directed by international institutions that tend to privilege global North perspectives over global South contributions.[69] It has been observed in this regard that "the current scientific and political framework structurally lacks diverse and inclusive representation, rendering participation of those most affected by geoengineering highly unlikely".[70]

60. Access to information and public participation in global environmental decisions is of the utmost importance when approaching geoengineering proposals. The views and opinions of the most affected groups, such as Indigenous Peoples and frontline communities, have been ignored.[71] Such a lack of diverse and inclusive representation in science and governance is at odds with the obligation to ensure that everyone enjoys the benefits of scientific progress without discrimination.

61. Lack of informed consent sought from communities in which these technologies are being implemented is of the utmost concern. Local communities, professional associations and Indigenous Peoples, among others, are not informed about these technologies and their participation is often obstructed. States have a duty to clarify any assumption related to the use of NTCPs and prohibit misinformation from private actors so as to protect the right to information – in accordance with the conclusions of the High-level Expert Group on the Net-Zero Emissions Commitments of Non-State Entities.[72]

C. Ensuring accountability and oversight

62. Accountability and oversight in relation to research, development, patenting and deployment of geoengineering are critical but there is no way to ensure such responsibilities today. The risks and potential of technical advances and scientific research should be made public in order to enable society, through informed, transparent and participatory public deliberation, to decide whether the risks are acceptable.[73] As geoengineering offers great potential for economic profit from NTCPs, profit maximization could come in the form of engaging in political and economic corruption and lobbying to secure contracts and government-funded research, as well as participation in regulatory norm-making in a manner that constitutes a conflict of interest.[74] That may also become commonplace in the carbon offset markets (see annex below). The concentration of patent and geoengineering technology among a few individuals or corporate actors is the breeding ground for corruptive lobbying or influence in buying practices. In that area, most patents are held by a few corporate patent holders, including those in the renewable energy, manufacturing, oil and chemical industries. In addition, the process of granting patents may not be completely transparent, ultimately exacerbating inequalities among States in relation to patent ownership.

[69] A/77/549, para. 67.

[70] Submission by the network of academics for an international non-use agreement on solar geoengineering.

[71] Various international treaties and agreements, including principle 10 of the Rio Declaration and Agenda 21, provide the basis for public participation in sustainable development. Nine civil society groups are recognized as key actors, including Indigenous Peoples.

[72] See www.un.org/sites/un2.un.org/files/high-levelexpertgroupupdate7.pdf.

[73] Committee on Economic, Social and Cultural Rights, general comment No. 25 (2020), para. 57.

[74] Transparency International, "Climate geoengineering technologies: corruption and integrity gaps – policy position" (2022), p. 6.

D. Ensuring access to information, participation and access to justice in environmental matters

63. Inclusive monitoring and an independent grievance redress mechanism need to be established in order to track potential human rights impacts or risks and ensure access to remedies should NTCPs be deployed. Today, the exercise of those rights is key to avoid human rights violations and individuals being denied the enjoyment of their rights (to life, food, a healthy environment and health) in the future. Increasingly, individuals are petitioning human rights bodies to request protection against the impact of climate change on their rights and on behalf of a more general public interest. Those complaints strategically seek the adoption of urgent measures by States to curb emissions in accordance with the Paris Agreement. Recognition of the right to a healthy environment has empowered individuals and organizations to exercise that right, including by seeking access to information, participation in decision-making and access to justice in environmental matters.[75]

E. Operationalizing a human rights-based approach and assessments

64. Risks assessments are important tools to ensure that human rights are protected and that States adopt preventive and protective measures to address human rights risks. However, an important question is if existing tools allow a determination of whether NTCPs are human rights compliant and mitigation of potential impacts or whether a more institutionalized framework to carry out standardized human rights assessments is possible. Because of the speculative character of some NTCPs, such assessments need to be adjusted to the particular features and potential risks attached to each of these technologies.

VII. Conclusions

65. **Human rights standards and obligations apply to all climate action and should guide decision-making and risk assessment related to the potential deployment of NTCPs. In the current circumstances, those provisions, which also reflect the fundamental principles of humanity, advise a precautionary approach and justify the imposition of a moratorium on speculative technologies for as long as scientific uncertainty and the risk of causing serious, extensive and irreversible environmental and human damage remain high. The scope of such a regime should be defined by the pertinent expert bodies.**[76]

66. **NTCPs interfere with the enjoyment of human rights and can cause physical, political and social risks to frontline communities, including Indigenous Peoples, and harm the environment. There is scientific uncertainty about their scalability and side effects and there exist less risky alternatives. It is urgent to underscore that, at present, the development of any such technologies and policies to support them would not be in accordance with the protective standards of the human rights regime. Without an adequate protection framework, it is hard to envisage how technologies aimed at manipulating climate could be developed and used for the good of humankind. At this stage of their development, given the lack of sufficient knowledge of their risks and adverse impacts, it might be better to presume that all NTCPs are generally harmful to human rights and that their deployment would be contrary to the existing obligations of States. Because of the moral hazard risk, they limit emission cuts and systemic changes.**

67. **Restrictive regulations, including potentially a moratorium, should be adopted and implemented when large and foreseeable negative impacts can be reasonably expected. Such regulations should remain in force for as long as the claims about the**

[75] A/73/188, para. 42.

[76] Decision XIII/14 of the Conference of the Parties to the Convention on Biological Diversity, para. 2.

risks and negative impact of each technology have not been shown to be false.[77] **Such an approach is in accordance with the United Nations Framework Convention on Climate Change, according to which, in the context of action to combat climate change, States are called upon to respect, promote and consider their respective obligations on human rights. The Intergovernmental Panel on Climate Change has warned against overreliance on unproven technologies that could disrupt natural systems and disproportionately harm the communities of the global South and underscored the central role of the principle of transparency in climate action. Human rights bodies and mechanisms have expressed concerns about large-scale projects that may have a massive impact on human rights, severely disrupting ocean and terrestrial ecosystems, interfering with food production and harming biodiversity. Calls from experts, scientists and civil society for a complete ban on certain large-scale geoengineering projects – in relation to solar radiation modification, specifically stratospheric aerosol injection, which can endanger human rights in the most extensive and unimaginable way – cannot be ignored. Solar radiation modification is ungovernable, which warrants a ban on its development and implementation, as well as regulation of related research.**

68. **Given the current international circumstances, the adoption of a multilateral treaty to regulate NTCPs or geoengineering more broadly is unlikely, however, it is crucial to underscore the human rights norms and standards, which should guide policymakers and decision makers, that remain applicable to the development of NTCPs. A set of principles could be drawn from relevant texts, such as the Guiding Principles on Business and Human Rights, the framework principles on human rights and the environment and general comment No. 25 (2020) of the Committee on Economic, Social and Cultural Rights.**

69. **Building confidence among the public and ensuring participation of the most affected communities is an indispensable requirement in making a decision about a specific NTCP. Such decisions should be informed by scientific knowledge, cultural values, and Indigenous and local knowledge to adequately address adaptation gaps and avoid maladaptation. In practice, the opposite has often been true. Lack of informed consent of the communities affected by NTCPs and general obstruction of participation go against the principle of transparency and the duty of States to prohibit misinformation from private actors so as to protect the right to information and other human rights.**

70. **There are positive and feasible alternatives to NTCPs. Existing proposals and low-cost technologies that address climate change and its drivers should be considered. Many of them have been tested, carry little risk and provide benefits for people and the planet. The existence of such proven low-risk approaches should make the use of NTCPs untenable under human rights and environmental law, including the rigorous application of the precautionary principle.**

VIII. Recommendations

A. States, policymakers and the international community

71. **The main way for States to be human rights compliant is to rapidly phase out fossil fuels through viable, scientifically proven technologies and approaches. Rapid emission cuts, minimization of the negative impacts of livestock farming and some nature-based solutions, such as peatland, mangrove and forest management, should**

[77] Various respondents to the Advisory Committee's questionnaire considered that NTCPs distracted from the goals undertaken by States under international agreements on climate change, in particular, the Paris Agreement, and carried a wide range of human rights risks. Suggesting that NTCPs may contribute to the promotion and protection of human rights is misleading. Far from addressing the root causes of climate change, they are likely to have unintended and potentially catastrophic effects on planetary processes, resulting in great risks to the enjoyment of human rights. Submission by the network of academics for an international non-use agreement on solar geoengineering.

form the core of a sustainable, rights-based pathway to mitigate climate change. Proposals to phase out fossil fuels, including those for a fossil fuel non-proliferation treaty, are in accordance with the obligation of States to respect and protect human rights from the adverse effects of climate change.

72. **States should rigorously apply the precautionary principle and develop and conduct meaningful, comprehensive risk, human rights and environmental impact assessments. Such assessments should be conducted by independent and impartial bodies (paying particular attention to avoid conflicts of interest) and with public participation and oversight. Their results should be made public and inform measures to prevent any potential harm resulting from the development and use of NTCPs or those to halt the use of such technologies and remedy their effects where applicable.**

73. **States should adopt and implement restrictive regulations on solar radiation modification experiments, where necessary, including a ban on outdoor experiments, while only allowing conditional and controlled research. The lack of a mechanism to prevent the development of harmful solar radiation modification techniques should be addressed in a manner that includes the global South and climate vulnerable States and communities.**

74. **States should consider disincentivizing the development and deployment of carbon dioxide removal techniques by withholding public support (including funding) for them and requiring research to be non-profit based, while showing transparency, including by disclosing any finance provided by the fossil fuel industry.**

75. **States should put in place effective procedures to seek the free, prior and informed consent of Indigenous Peoples and meaningfully consult peasants, local communities and other affected or particularly interested groups.**

76. **In cases in which the effects of research on NTCPs transcends a State's jurisdiction, under all circumstances, the entity carrying out such research should ensure that human rights assessments are integrated into their work, specific protocols to assess human rights impacts are developed in advance and they accept responsibility for any damage done.**

77. **Given the limited financial and human resources available, research on greenhouse gas emissions reductions should be given the utmost priority. Expert bodies should be entitled to monitor and evaluate such assessments and to address recommendations to relevant decision-making bodies.**

78. **States should enhance public participation in the scientific and broad public debate about NTCPs by including voices from the global South, women, people of colour, Indigenous Peoples and frontline communities.**

B. Human Rights Council and special mechanisms

79. **Human rights treaty bodies, special rapporteurs and the universal periodic review should address the impacts and risks posed by deployment of NTCPs and the adequacy of national frameworks to effectively regulate and approach those risks.**

80. **The Special Rapporteur on the promotion and protection of human rights in the context of climate change, the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes and the Special Rapporteur on human rights and the environment lead the process of a holistic and coherent interpretation of environmental and human rights frameworks in the context of NTCPs.**

81. **Measures should be proposed to enhance the protection of the rights of potentially affected communities and groups, including Indigenous Peoples and other rights holders, in the context of decisions regarding the development, testing and deployment of NTCPs.**

82. **The Special Rapporteur on the rights of Indigenous Peoples should consider the elaboration of a thematic report on the impact of climate engineering on their rights.**

83. **The possibility of establishing an ad hoc mechanism to coordinate the action of relevant special rapporteurs in connection with NTCPs should be explored.**

C. Office of the United Nations High Commissioner for Human Rights

84. **The Office of the United Nations High Commissioner for Human Rights should:**

(a) **Identify a set of international guidelines or operative standards on the development, testing and potential deployment of all speculative technologies in relation to human rights that allows States to implement the precautionary principle;**

(b) **Support the right of potentially affected communities and groups, including Indigenous Peoples, to have access to information about NTCPs;**

(c) **Organize a multi-stakeholder meeting on human rights impacts of NTCPs.**

Annex

Technological component and additional information

1. The annex provides additional information on the technological components relevant to the study of the impact of NTCPs on the enjoyment of human rights. Some of the information from the main report is reproduced here in order to provide for a standalone reading.

2. Easing the climate crisis adequately requires immediate carbon dioxide emission cuts. Progress towards this goal has been very slow – global emissions keep rising and fossil fuel corporations have recorded historically highest profits in 2022. According to IPCC reports and UN Secretary General mitigating the crisis requires limiting temperature rise to 1.5 degrees by achieving global net-zero emissions by 2050.

3. Cutting emissions is the only scientifically and logically certain way of coming close to achieving real zero emissions – a term advocated for by several civil society organizations – since methods and technologies to remove carbon dioxide from the planetary system are currently not only insufficiently developed, inefficient and financially unsustainable but may also be used as excuse not to cut emissions.[1,2] NTCPs present a moral hazard and dangerous distraction from emissions reductions and quite notably are regularly advanced by the fossil fuel industry to justify continued exploration and exploitation of fossil fuels.

5. The offset carbon market, however, allows states and companies to balance unchanged or only slightly reduced emissions with purchasing carbon offsets, that is investment in emission reduction projects. As a result of these tendencies the need for emission reduction technologies has been growing. All the more so that, increasingly, carbon dioxide removal (CDR) technologies have become the focus of states' policies to reach the so called "net zero emissions," while still continuing to emit. New private actors, or public-private partnerships, are involved in development and implementation of these technologies. In the near future CDR technologies will most likely expand the carbon market and become a major source of carbon credits, which in turn will provide more funding for these technologies' expansion.

6. If emissions are not cut and some of the worst future scenarios are to be realized, another cluster of technologies of the solar radiation modification (SRM) kind is being researched. In its most advanced currently form in research and the most controversial in terms of effects on the environment and human rights it envisages stratospheric aerosol injection (SAI): in essence a continuous spray of aerosols in the upper atmosphere to partially block sunlight.[3]

Carbon dioxide removal

7. CDR technologies durably store carbon dioxide on land, in the ocean or in geological formations.[4] They can be grouped into artificial and natural methods. Currently, natural methods,[5] which primarily include reforestation, afforestation, improved forest management, agroforestry and soil carbon sequestration as the most popular ones, make up 99.9% of all

[1] The term "net zero emissions," defined as emissions achieved when anthropogenic carbon dioxide emissions are balanced globally by anthropogenic carbon dioxide removals over a specific period, implies a two-fold action: cutting emissions and removing carbon dioxide.

[2] *Statement*, Real Zero Europe, https://www.realsolutions-not-netzero.org/real-zero-europe.

[3] Several private initiatives already propagate including SAI and other SRMs in international strategies for the future.

[4] "Products" are another kind of storage. However, the definition of a "product" is broad and unclear for a human-rights based perspective.

[5] The Fifth Session of the UN Environment Assembly defined nature-based solutions as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits".

carbon dioxide removed. These technologies are not new, however, and even if they are currently the cheapest and most prevalent ones, they fall outside the scope of the study.[6]

8. Artificial methods include pre- and post-combustion Carbon Capture and Storage, Bioenergy with CCS (BECCS), Direct Air Capture (DAC), Enhanced Weathering (EW) and Ocean Fertilization (OF). With the exception of the first two, which are also either an energy production method or play a supplemental role to the production of other goods, the latter three kinds of artificial CDR technologies (DAC, EW, OF), satisfy the definition of NTCPs.

9. **Direct air capture (DAC)**. Out of artificial CDRs, DACs in particular have recently developed rapidly without equal consideration of their human rights implications, which needs to be attributed to the small scale of implementation and relatively narrower spectrum of possible risks to human rights that certain DACs pose as opposed to other CDR technologies. In Europe, the United States and Canada 18 DAC plants are now operational, although they are small scale, and capture carbon dioxide for utilisation, including enhanced oil recovery (EOR), except for two plants storing the captured carbon dioxide in geological formations for removal. DACs under consideration in this report are not paired with EOR– a method of using DAC to extract the remaining oil from oil wells – because such a technology is a fossil fuel producing technique, which is used by fossil fuel companies and cannot be considered a NTCP. Apart from being currently very expensive at the moment, DACs face biophysical constraints subject to geological storage underground, environmental side effects (see table 1) and surface area.[7]

10. **DAC case study.** The largest DAC facility of this kind, operating since 2021, consists of CO_2 collectors that capture it from the atmosphere with a low carbon footprint and nominal capacity of 4000 tCO_2 per year, powered by 100% geothermal energy, with carbon dioxide being permanently stored underground through mineralization.[8] The facility is said to be almost 1000 times more efficient than trees on the same land area, yet the current amount of carbon dioxide captured annually amounts to less than five return transatlantic flights emissions. The developers of the technology claim they advance it in order to defossilize in the vain of conventional mitigation, neutralize unavoidable emissions, and realize negative emissions. In the initial phase of research, it was publicly funded (through EU research funds).[9] New DAC installations are being built in the Middle East, where there are potentially good conditions for mineralization and large abundant supply of renewable energy. The human rights implications from current DAC projects, apart from land and water usage (although unintense in relation to other CDR methods) also include production of chemicals in the process and waste utilization, industrialization of the landscape, which is connected with identity of communities living in areas that had previously been untouched by industrial buildings and facilities.

11. **Enhanced weathering (EW)**. The process, both terrestrial and oceanic, aims to simulate natural weathering (rock decomposition via chemical and physical processes) in an artificial way to speed up chemical reactions that permanently sequester carbon dioxide in carbonate minerals or ocean alkalinity. Rock material is ground into powder to maximize the

[6] When it comes to direct impacts on human rights special consideration should be given to land-related CDR that does not qualify as a nature-based solution, esp. biomass-reliant CDR at large scale such as BECCS. Those approaches can increase land usage conflicts and lead to a reduction of food supply and loss of biodiversity and ecosystem services thereby increasing global injustice and inequality and creating resource based civil conflict potential. Unsustainable production and transport of biomass could even result in additional net emissions instead of carbon dioxide removal.

[7] The potential is estimated at 0.5-5GtCO2 annually by 2050, or 40GtCO2 by 2100, but there are doubts about its scalability. Unlike other CCSs DAC facilities can be located close to storage facilities and sources of renewable energy.

[8] Mineralization into calcite, argonite, magnesite, depending on local circumstances in the reservoir. The storage is to be permanent, counting in thousands of years.

[9] Later, private investors joined in, including large international corporations, while recently again large public investment was made into the project (US Department of Energy invested $3.5bln in Climeworks projects in US). Local regulations in the United States theoretically require that DAC sites are safe and suitable for storage. The Safe Drinking Water Act stipulates that injecting CO2 underground requires monitoring and characterization of the site. It needs to be a Class VI well, which there are few.

reactive surface area and applied to soils, open ocean and coastal zones. It has the potential to improve soil quality in tropical regions but field experiments at scale are missing in order to evaluate EW impact on biogeochemical circles, biomass and carbon stocks in soils and plants.[10] Side effects are enumerated in table 1 below. EW is permanent meaning geological residence times. EW can be simultaneously used with other land-based technologies – afforestation, soil carbon sequestration and bioenergy – because of its effect on additional biomass production. The main carbon penalty of EW is created by the energy demand for rock grinding.

12. **Ocean fertilization (OF)**. London Convention and London Protocol defines ocean fertilization as any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans, not including conventional aquaculture, or mariculture, or the creation of artificial reefs. It entails deliberately adding nutrients (often iron) to the upper ocean waters to increase biological production (mostly algal bloom) or upwelling of nutrient-rich deep ocean water. It requires acting upon large surfaces and velocities. Side effects are discussed in table 1. OF is considered a low efficiency technology given wide impact on ecosystems, logistical costs, uncertain permanence of CO_2 storage and side effects. Marine geoengineering activities are banned (see paragraph 33 of the report above).

Solar radiation modification

13. SRM attempts to modify the reflectivity of the Earth system (albedo) to reduce incoming solar radiation. Unlike CDR, it does not act on the causes of climate change (concentration of carbon dioxide in the atmosphere) but on its impacts. It needs to be adequately stressed that SRM is a unique technology that has to be analysed in separation as it "contrasts with climate change mitigation activities, such as emissions reductions and carbon dioxide removal (CDR), as it introduces a 'mask' to the climate change problem by altering the Earth's radiation budget, rather than attempting to address the root cause of the problem, which is the increase in greenhouse gases in the atmosphere."[11]

14. Some forms of SRM, notably stratospheric aerosol injection (SAI), may result in regionally and globally unpredictable changes in hydrological patterns, harm to the ozone layer, dimming, reduced photosynthesis, crop growth changes and associated with the aforementioned further cascading risks in the social and political systems and relations. Despite the presumed average global temperature decrease, all these risks would be amplified by the fact that, once applied at scale, SAI could be irreversible and cause geographically uneven, potentially international conflict provoking consequences and would have to be continued to avoid the rapid and extensive warming after cessation ("termination shock"). There are other forms of SRM currently tested. The first field experiment of marine cloud brightening was conducted over the coral reef in Australia in 2021. Nano-sized droplets engineered to brighten clouds and block sunlight were dispersed over the reef.[12] Another method is used by the Arctic Ice project, which aims to improve the Arctic's ice cap reflectivity by dispersing silica microbeads over the ice sheet. The project is criticized by indigenous communities.[13] SRM marine engineering technologies (as well as CDR marine technologies: ocean alkalinity enhancement and electrochemical CDR or biomass cultivation for carbon removal) have the potential to cause deleterious effects that are widespread, long-lasting or severe.

15**.** **SAI case study**. In 2021 Harvard's Solar Geoengineering Research Program, the most advanced in stratospheric aerosol injection (SAI) technology research group, attempted to conduct a stratospheric controlled perturbation experiment (SCoPEx) test at the Swedish

[10] The highest sequestration potential is reported to be ca. 88 GtCO2 yr^{-1} when spreading pulverized rock over large areas in the tropics, although depending on place, rock kind, and methods employed the potential varies greatly, as does the global cost assessment (US$50-200/$tCO_2^{-1}$). Median future sequestration potential is set at 2-4$GtCO_2$ yr^{-1} from 2050.

[11] IPCC AR6 WGII.

[12] https://www.nature.com/articles/d41586-021-02290-3.

[13] One of the test sites is in North Meadow Lake, on Indigenous Iñupiat territories near Utqiagvik, Alaska. https://www.geoengineeringmonitor.org/2022/05/support-alaska-native-delegation-to-stop-arctic-ice-project/.

Space Corporation in Kiruna, northern Sweden. It would entail dispersing a small amount (100g-2kg) of calcium carbonate or sulfates, material to "make quantitative measurements of aspects of the aerosol microphysics and atmospheric chemistry that are currently highly uncertain in the simulations" and, according to the testers, would "pose no significant hazard to people or the environment".[14] However, there had not been any consultations with Indigenous Peoples conducted prior to the experiment, nor had they been informed if it.

16. The Saami Council learned in February 2021 of the plans for the experiment in Sápmi, Sámi land, and previous unrealized SCoPEx attempts in the United States from indigenous contacts from north America. In 2018 there was a field test to be conducted in Tucson, Arizona, which did not materialize. Communities of Indigenous Peoples opposed to it.[15] In February 2021, the Saami Council together with Swedish environmental organizations sent an open letter to the SCoPEx advisory committee, copying the Swedish Space Corporation and three ministers in the Swedish government, saying that "SAI is a technology that entails risks of catastrophic consequences, including the impact of uncontrolled termination, and irreversible sociopolitical effects that could compromise the world's necessary efforts to achieve zero-carbon societies. There are therefore no acceptable reasons for allowing the SCoPEx project to be conducted either in Sweden or elsewhere."[16] The letter focused on the physical risks of SRM and on the problematic ethics, responsibility and decision making, and – predominantly on the risk of deterring the necessary climate action.[17] The Swedish Space Corporation contacted the Saami Council after receiving the letter, wanting to know more of the Saami Council position. Later the Swedish Space Corporation informed the Saami Council of the Corporation's withdrawal from the experiment. After the cancellation of the test in Kiruna, the Saami Council initiated a letter to Harvard University reiterating the position of opposing to the development of solar geoengineering technology and invited other Indigenous Peoples organizations to sign the letter showing their support for the position. The letter gained the support of 36 Indigenous Peoples organizations from different regions of the world.

17. The case study shows lack of consideration for Indigenous Peoples rights in SRM field tests, the need for free prior and informed consent of Indigenous Peoples, lack of broader consultations with the government, local authorities, civil and scientific society and local communities.

Table 1
Positive and negative side effects of NTCPs

CDR Technology	*Positive side effects*	*Negative side effects*
DACCS Potential: 0.5-5 $GtCO_2\ yr^{-1}$ Cost: 100-300 US$/$tCO_2$	certain applications can improve indoor air quality	CO_2 penalty if high (thermal) energy demand satisfied by fossil fuels (**not NTCP**); currently high front-up capital costs; insufficiently studied; material/waste implications (the chemical footprint of the processes: production of chemicals, production of waste, and for hydroxide-based

[14] https://www.keutschgroup.com/scopex.

[15] From TONATIERRA input: "Upon learning of the SCoPEx project in Tucson, we communicated with our networks of kinship and traditional cultural alliances as Indigenous Peoples of the territory to inquire what they knew of the project. There was a complete lack of information. We then communicated with the traditional ancestral leadership of the O'otham Nations upon whose land the city of Tucson is situated and asked for a consultation. We accompanied the Nukutham (Traditional O'otham guardians of the Sacred Sites) to visit the compound where the project was to be launched. Afterwards, the Nukutham stated that not only were they not informed of the nature and scope of the experiment, but they could not consent to such a project on any O'otham lands."

[16] https://static1.squarespace.com/static/5dfb35a66f00d54ab0729b75/t/603e2167a9c0b96ffb027c8d/1614684519754/Letter+to+Scopex+Advisory+Committee+24+February.pdf.

[17] Ibid.

CDR Technology	*Positive side effects*	*Negative side effects*
		DAC, the amount of chlorine produced); spacial requirements
Ocean fertilization Potential: extremely limited	Potential increase in fish catches, enhanced biological production	Limited potential; possible adverse impacts on marine biology and food web structure; deep water oxygen decline; changes to nutrient balance; anoxia in surface ocean; probable enhanced N_2O and CH_4 production
Enhanced weathering Potential: 2-4 $GtCO_2\ yr^{-1}$ Cost: 50-200 US$/$tCO_2$	Increase in crop yields; improved plant nutrition, soil fertility, nutrient and moisture; increase in soil pH	Human health risks from fine grained material (it may contain asbestos-related minerals); ecological impacts of mineral extraction and transport on a massive scale; direct and indirect land use change if biomass sourced from dedicated crops, potential heavy metal release (e.g. Ni and Cr) in case of inappropriate material use; changes in soil hydraulic properties

Table based on Jan C Minx et al 2018 Environ. Res. Lett. 13 063001, amended.