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THE GEOPOLITICS OF EXTREME CLIMATE RISK

IMPLICATIONS FOR NEGATIVE EMISSIONS TECHNOLOGIES AND GEOENGINEERING

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As the concentration of CO_2 in the atmosphere rises, so does the risk that critical and possibly irreversible climate tipping points will be breached. The risk rises significantly above 3°C, when it becomes likely that some of these tipping points will create feedback loops that would further accelerate warming. The consequences of breaching tipping points go beyond the direct physical impacts and would include major socio-economic disruption and increased likelihood of instability and conflict.

Mounting evidence and understanding of extreme climate risk is likely to fundamentally change political decision-making and broader geopolitics. But it is unclear whether this will catalyze climate action. Even in a scenario where extreme climate risk leads to stronger climate policies, the effect on global cooperation is uncertain. Tipping point risk could, for example, lead to crash mitigation scenarios, or to countries going it alone, by unilaterally deploying negative emission or geoengineering technologies. Governments and international institutions should prepare for different scenarios and work to reduce the risk of geopolitical tension or unintended consequences.

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Recent developments in the science and understanding extreme climate risk

Climate change has been treated by most governments as a concern for future generations. Actions taken to address climate risk have been informed by relatively high discount rates which lower the present value of benefits relative to the present value of costs, making it harder to justify stronger climate policies. Mid-range or even best-case emissions trajectories have often been favored at the expense of more extreme, but still plausible, scenarios. Consequently, the geopolitics of climate change has largely been driven by opportunities associated with new low carbon energy markets and technologies, as well as concerns about access to resources and the 'transition' risks associated with this wider economic shift - rather than by the consequences of physical climate impacts.

However, climate impacts are already hitting earlier and harder than expected, and recent research warns of tipping points being breached even below 2°C of warming.[1,2,3] For instance, the Greenland ice sheet has been losing ice six times faster than in the 1990s[4], due to increasing global temperatures, leading to slow sea-level rise and an increase of fresh water in the ocean. Some of the melting is already considered irreversible, which changes the regional landscape and has climate impacts not only in the northern hemisphere, but also in other regions, affecting for example the Atlantic Meridional Overturning Circulation (AMOC). The AMOC, a large system of ocean currents responsible for carrying warm waters towards the North Atlantic, has been weakened since the mid-20th century.[5] Changes in this system will disrupt ocean capacity to store heat and carbon, and affect precipitation patterns in the southern hemisphere, disrupting the African monsoon and transforming the Amazon rainforest.

As impacts worsen and the science of extreme risk and tipping points becomes more widely understood, climate geopolitics is likely to change in new and unexpected ways. One possible consequence is that the relative importance in

[1] IPCC (2021) *Special Report Global Warming of 1.5 ºC*, **chapter 4 *'Strengthening and implementing the global response'*.**

[2] Lenton, T., Rockström, J., Gaffney, O., Rahmstorf, S., Richardson, K., Steffen, W. and Schellnhuber, H. (2019) ***Climate tipping points — too risky to bet against***. Nature, 575(7784), 592-595.

[3] Ritchie, P.D.L., Clarke, J.J., Cox, P.M. et al (2021) ***Overshooting tipping point thresholds in a changing climate***. Nature 592, 517–523.

[4] OECD (2021) ***Managing Climate Risks, Facing up to Losses and Damages*.**

[5] Hutt, R. (2019) ***9 climate tipping points pushing Earth to the point of no return*.** World Economic Forum.

bilateral or international diplomacy and negotiations of protecting the value of existing high carbon fuels and infrastructure could fall, and the relative importance of deep decarbonization to avoid worst case physical impact scenarios could rise. This could prompt greater cooperation and coordination of climate policies, or it could add to tensions that are already simmering, for example over which countries bear most responsibility for reducing their emissions and paying the cost of impacts that are already baked into the system.

One likely consequence will be growing interest and importance of technologies that allow permanent net removal of CO2 from the atmosphere, or negative emission technologies (NETs) such as direct air carbon capture and storage (DACCS) or bioenergy with carbon capture and storage (BECCS). Another could be interest and investment in geoengineering approaches, like solar radiation management (SRM)[6]. This briefing considers the advantages and disadvantages of these approaches, and their possible geopolitical implications.

Negative emissions technologies and geoengineering

NETs are divided here into two groups: nature-based solutions (NBS) and artificial technologies. The first group includes afforestation and reforestation (planting more trees) or restoring and protecting wetlands and coastal ecosystems; while artificial technologies include processes like direct air carbon capture and storage (DACCS) or bioenergy with carbon capture and storage (BECCS).[7,8]

Nature-based solutions

Afforestation involves planting new trees and seeds to create a new forest, while reforestation consists of planting more trees in an existing forest.[9] Forests are critical ecosystems for both mitigation and adaptation to climate change, and usually yield benefits both at the local and international levels. For example, other than their natural CO2 capture and storage capacity, they also help promote biodiversity, contribute to local socioeconomic development, and to stable and sustainable water cycles.

[6] While negatives emission technologies are often referred to as a type of geoengineering, we make a distinction between the two approaches as NETs addresses a root cause of climate change by removing CO2 from the atmosphere.

[7] Climate Analytics (n.d) ***Why negative CO2 emission technologies should not be classified as Geoengineering.***

[8] Cran-McGreehin, S. (2018) ***Negative emissions: why, what, how?***.

[9] Rueda, O., Mogollón, J., Tukker, A. and Scherer, L. (2021) ***Negative-emissions technology portfolios to meet the 1.5 °C target***. Global Environmental Change, 67, p.102238.

Restoring wetlands and coastal areas and ecosystems can also be considered negative emissions NBS, since by absorbing carbon dioxide, they also promote biodiversity, healthier soils and oceans, and help moderate temperatures and precipitation patterns.

NBS are often cheaper than other hard infrastructure or technology-based approaches and can be implemented relatively quickly, but they also come with challenges. It can take a long time for benefits to be fully achieved; the number of actors involved (local, regional and national governments, CSOs, industries) can lead to conflicts on which areas should be prioritized and how; and there is a physical limit to their storage capacity, which is vulnerable to both climate and human-induced disturbances.[10, 11] Even comparing afforestation and reforestation, there are differences in their CO2 capture and storage capacity, and in their biodiversity benefits – the latter being the better option, but being dependent on an already existing forest-area.

Artificial technologies

The two artificial technologies considered here are DACCS and BECCS. DACCS consists of a chemical process which extracts CO2 directly from the atmosphere and stores it underground; while BECCS is a combination of two processes – the burning of plant matter to produce bioenergy, and the capturing and storage underground of the CO2 released during this procedure, which makes the soil more fertile and increases the flora, which will then also absorb CO2 and could be used for bioenergy.[12] These technologies are considered mature, feasible and effective. Both extract carbon dioxide emissions from the atmosphere and store it geologically.

The advantages of DACCS include its possible scalability and the fact that its placement is not dependent on the source or timing of emissions.[13,14] However, it requires a large amount of energy, a challenge that would need to be addressed without increasing emissions if DACCS was to be deployed widely.

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[10] Reynolds, J. (2018) ***The politics and governance of negative emissions technologies***. Global Sustainability, 1.

[11] Kartha, S. and Dooley, K. (2016) ***The risks of relying on tomorrow's 'negative emissions' to guide today's mitigation action***. Working Paper 2016-08. Stockholm Environment Institute.

[12] Cran-McGreehin, S. (2018) ***Negative emissions: why, what, how?***.

[13] Rathi, A. (2018) ***The ultimate guide to negative-emission technologies***. Quartz.

[14] Houses of Parliament (2013) ***Negative Emissions Technologies***. Post Note 447.

With respect to BECCS, the fact that it produces energy is an advantage and could increase the use and production of biofuel. It also has high potential for decarbonizing sectors and industries where carbon abatement is more difficult.[15] Nevertheless, to be truly effective, it needs to be scaled up significantly, which will depend on the availability of land and will increase the demand for biofuel, putting a lot of pressure on ecosystems. Another challenge of BECCS and DACCS relates to storing CO2; there is a storage limit capacity underground, which is vulnerable to external factors, such as earthquakes, fires, or land clearing, and could potentially release the CO2 back into the atmosphere.

Geoengineering

Geoengineering is included here as distinct from negative emissions technologies, as it focuses on manipulating aspects of the environment to address climate change rather than reducing GHG emissions. One of the most frequently cited geoengineering methods is solar radiation management (SRM). SRM can have multiple applications, such as aerosol particle injection, increased reflectivity of the Earth through mirrors put in space, or alteration of the amount and elements of clouds.[16,17]

While proponents of SRM point to evidence of its theoretical affordability and feasibility, it would not resolve other adverse effects of continued GHG emissions, notably ocean acidification, which in turn has consequences for food security and biodiversity. There are also concerns about unintended environmental consequences that could cross borders, as discussed in more detail below.

Geopolitical implications: cooperation or competition?

The decision to use NETs or SRM will have local, national, and regional consequences, but these are also likely to have broader geopolitical implications. The consequences would likely vary depending on which technology was deployed, and how and where it was used.

Implications for BECCS

BECCS would require an enormous amount of territory to make a significant contribution to limiting global warming. According to the IPCC SR1.5 report, an

[15] Consoli, C. (2019) ***Bioenergy and Carbon Capture and Storage***. Global CCS Institute.

[16] Climate Analytics (n.d) ***Why negative CO2 emission technologies should not be classified as Geoengineering.***

[17] Morton, O. (2020) ***The Geopolitical Challenges of Geoengineering—and Geoengineering's Challenge to Geopolitics.*** Wilson Center.

emissions pathway that is compliant with the Paris Agreement means an average amount of BECCS that requires up to 46% of arable and permanent crop land by the end of the century[18]. In addition to implications for food security and biodiversity, competition over land use could increase conflicts over the rights of indigenous people in certain territories and lead to changes in different sectors, like the food and agricultural industries, including the possibility of resource price spikes. The overuse of land, fertilisers and monocultures will also increase biodiversity degradation and loss, contributing to climate change. It is also possible that BECCS would be deployed in countries that have contributed relatively little to climate change, but are economically dependent on agriculture, and particularly small-scale farming[19]. Further, the additional production of biofuels involved in BECCS means that any inefficiencies in carbon capture could have implications for achieving global temperature targets and could lead to disputes about countries failing to meet their emission reduction commitments.

Implications for SRM

SRM remains unproven and carries a high risk of unintended consequences. These could include adverse localized climate implications such as changes in regional precipitation patterns, as any cooling would be uneven across the globe[20]. Concerns have been raised about the lack of an international architecture for governing these kinds of interventions, considering that unilateral deployment could result in adverse consequences beyond national borders. For the technology to be effective, it would need to be implemented and governed uniformly, requiring international cooperation and coherence among countries and international organizations[21].

Implications for DACCS

While the largescale deployment of DACCS would probably require less territory than other approaches, such as forestation or BECCS, it would still require significant amounts of land for the permanent storage of carbon dioxide, with the

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[18] IPCC (2021) *Special Report Global Warming of 1.5 ºC*, **chapter 4 *'Strengthening and implementing the global response'*.**

[19] Kreuter J., Lederer M. (2021) ***The geopolitics of negative emissions technologies**: **learning lessons from REDD+ and renewable energy for afforestation, BECCS, and direct air capture.*** Global Sustainability 4, e26, 1–14.

[20] Harvard (n.d) ***Solar Geoengineering Research Programme***.

[21] Keith, D. (2020) ***The world needs to explore solar geoengineering as a tool to fight climate change.*** Boston Globe.

potential for conflict if this burden was distributed unevenly or unsafely. [22] Similarly, the energy required for largescale deployment of DACCS would be substantial and would need to be low carbon to ensure climate benefits, which would also require territory. This would raise questions about where DACCS would be located and who would be responsible for paying the cost. For example, a country that was interested in deploying DACCS might want to install it abroad due to limited capacity at home, leading to geopolitical tensions.

Implications for NBS

The largescale use of NBS carries relatively low geopolitical risk, beyond the fact that, as with other approaches like DACCS, a failure of NBS to deliver negative emissions could also result in an international 'blame game'. There could be other more indirect implications – for example, if a country that had previously relied on clean technology imports to meet its emission reduction targets decided to shift attention and resources to NBS, it could impact existing trade relations with some geopolitical ripple effects. The more likely consequences to NBS are socioeconomic and geographic within national borders. For example, reforestation or restoring a coastal area might lead to increased local management and empowered local populations; but if those areas are economically important, their restoration and protection status might lead to conflict over scarce livelihood resources and involve trade-offs with other industries such as logging and fisheries. In transboundary areas, tensions over regional governance may also arise.

Emerging recommendations

As the physical impacts of climate change continue to cause devastation and loss of life around the world and the science and understanding of climate risk continues to improve, countries are likely to consider the use and deployment of NETs or geoengineering approaches as part of a climate risk management strategy. While carbon dioxide removal has the potential to play a critical role in limiting global average temperature rise to 1.5°C, the pursuit of these options in response to extreme climate risk will have consequences for international cooperation on climate change and on broader geopolitics. Unilateral deployment of these technologies could impact other actors and affect their national interests and

[22] Kreuter J., Lederer M. (2021) ***The geopolitics of negative emissions technologies: learning lessons from REDD+ and renewable energy for afforestation, BECCS, and direct air capture.*** Global Sustainability 4, e26, 1–14.

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ambitions. As a basic principle, the use of NETs or geoengineering should be seen **as complementary to, rather than a substitute for, the transition to clean energy sources and energy efficiency improvements**. Assumptions about the future use and availability of these approaches must not be used as an excuse to delay the deployment of clean energy technologies that already exist and are cost effective.

Potential options for managing the risks associated with the deployment of NETs or SRM include:

> Informal and formal dialogue between the major emitters and most vulnerable countries on the management and the governance of NETs and geoengineering.

> Encourage cooperation and data exchange on the development and use of these technologies, so their application is based on local needs and avoids possible tensions or conflicts over, for example, land use.

> Differentiate between national emissions reduction and carbon capture targets, so reporting and analysis of data is more transparent, and ensure that carbon reduction is prioritized.

> Create an international taskforce on geoengineering, composed by different stakeholders, which would be responsible for gathering information from ongoing research projects worldwide, and would help shape the governance of these technologies.

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About E3G

E3G is an independent climate change think tank accelerating the transition to a climate-safe world. E3G builds cross-sectoral coalitions to achieve carefully defined outcomes, chosen for their capacity to leverage change. E3G works closely with like-minded partners in government, politics, business, civil society, science, the media, public interest foundations and elsewhere.

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