Climate Geoengineering

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1. Overview of Technologies (15 points)

The purpose of Climate Geoengineering is to use large-scale technologies to intervene in the earth's natural processes and planetary environment in order to counter the effects of climate change. (Burns, 2016)

Climate geoengineering technologies are divided into two categories:

Solar radiation management (SRM): Schemes that fall under Solar Radiation Management aim to reduce the level of solar radiation by increasing the earth's reflectivity of sunlight, thus cooling the planet and offsetting the effects of global warming. However, SRM cannot be labelled a direct solution to climate change since it does not affect the amount of GHGs or GHG emissions in the atmosphere. (Burns, 2016)

1. ***Sulphur Aerosol Injection (SAI)****:* SAI technology seeks to increase the earth's planetary albedo (light reflected from the surface) by injecting gas particles such as sulphur dioxide into the earth's stratosphere. These sulphur particles react chemically in the atmosphere to form sulfate aerosol, hence cooling the planet and offsetting the effect an increased amount of CO_2 has on the global temperature. (Burns, 2016)
2. ***Marine Cloud Brightening:*** These geoengineering technique aims to increase the brightness of clouds by dispersing large droplets of salt water and other aerosols, promoting cloud condensation, and increasing cloud albedo. This in turn would increase the proportion of incoming solar radiation reflected back into space, substantially cooling the planet. (Burns, 2016)
3. ***Space-based Systems:*** These methods try to affect the level of solar radiation reaching the earth by positioning solar mirrors or sunshields in space to reflect or deflect incoming radiation. (Burns, 2016)

Carbon Dioxide Removal (CDR): CDR options try to address the root problem of climate change - the amount of carbon dioxide already present in the atmosphere. CDR strategies seek to extract CO_2 from the atmosphere by enhancing natural biological processes or by using man-made chemical engineering technologies that remove carbon dioxide from the atmosphere. (Burns, 2016)

1. ***Ocean Iron Fertilization:*** A process in which iron particles are introduced into the ocean waters artificially to stimulate phytoplankton production, thus accelerating carbon dioxide sequestration during photosynthesis by these organisms. (Burns, 2016)
2. ***Bioenergy with Carbon Capture and Sequestration (BECCS):*** BECCS is a carbon dioxide removal technology by which carbon capture and sequestration occurs during the conversion of biomass into electricity, heat, or liquid/gas fuels. (Burns, 2016)
3. ***Direct Air Capture (DAC):*** DAC technologies aim to remove CO_2 directly from the ambient air by using artificial systems that take advantage of closed-loop industrial processes that utilize carbon dioxide. (Burns, 2016)

2. Controversies and Deployment (40 points)

According to American environmentalist Bill McKibben, the global "carbon budget" of 565 gigatons estimated by scientists has become irrelevant ever since we have increased the planet's temperature by 0.8 degrees. This is because computer models project that with the existing CO_2 levels in the atmosphere, the temperature would likely rise another 0.8 degrees, taking the carbon level in the atmosphere to 1.6 degrees, already 75% of the way to the goal set by the Paris agreement.[1] (McKibben, 2012)

In his article *The Uninhabitable Earth,* journalist David Wallace-Wells claims that even if we completely switch to clean energy by the next decade, scientists still give us very slim chances of hitting the target, which Wallace-Wells has called the "threshold of catastrophe". According to him, global warming will result in permanent extreme droughts, a food crisis, a perpetual heat wave, poisoned oceans, decline in air quality and permanent collapse.[2] (Wallace-Wells, 2017) Although scientists contest that his article paints an overly bleak picture, one can't help but wonder the seriousness of the implications of climate change.

Now more than ever, the use of geoengineering technologies to combat climate change is imperative to adhering to the global carbon budget as well as meeting the targets set by the Paris agreement of limiting the average temperature rise to 2 degrees. This is because according to estimates, the current level of GHG emissions in the atmosphere guarantee about 1.5 degrees of warming above pre-industrial levels. As a result, SRM techniques as well as *negative emissions* (CDR) technologies would prove vital to offsetting the effects of existing GHG emissions as well as removing the CO_2 in the atmosphere that already exists. (Parson, 2017)

According to scientific models which project emissions and other socioeconomic conditions, called "Integrated Assessment Models (IAMs)", these ambitious goals put forward by the Paris

[1] http://www.rollingstone.com/politics/news/global-warmings-terrifying-new-math-20120719
[2] http://nymag.com/daily/intelligencer/2017/07/climate-change-earth-too-hot-for-humans.html

agreement cannot be met by practical or cost-effective mitigation strategies. These climate engineering technologies could therefore somewhat neutralize the cost of delaying serious mitigation by a few decades. (Parson, 2017)

State actors, global non-state actors, environmental assessment organizations, as well as policy assessment bodies must immediately start examining geoengineering technologies and their implications. This is because CE might prove to be a useful tool when used in combination with mitigation strategies to combat climate change. In addition to this, as the effects of climate change start increasing in severity, vulnerable nations might begin deploying CE technologies individually. So, is it essential that states start researching potential CE strategies well in advance. (Parson, 2017)

Studies also show how SRM schemes could restore temperatures to pre-industrial levels after a few years of deployment. Many proponents contend that SRM climate geoengineering options might need to be deployed to respond to climate emergencies. The most frequently cited scenarios are those in which there is the imminent threat of temperatures exceeding critical climatic thresholds and other potential non-linear changes in the climate system. However, there may also be alternatives to climate geoengineering that can help us avoid passing critical thresholds as we make a transition to a decarbonized world economy without having many of the short-term and long-term costs of climate geoengineering. (Burns, 2016)

In contrast to SRM options, CDR technologies, which directly affect the underlying cause of global warming, could also be vital in the fight against climate change and could restore the CO_2 levels back to pre-industrial levels by counterbalancing the increase in carbon dioxide emissions through carbon dioxide extraction from the atmosphere. (Burns, 2016)

It is also essential to assess the potential risks associated with Climate Geoengineering. SAI geoengineering could adversely impact the globe's hydrological cycle. Thus, the deployment of SAI geoengineering could result in a decline in mean global precipitation, and its impacts could be far more severe in the global south, affecting developing countries' food, agriculture and water needs in a drastic way. This would threaten the food security of billions and constitute a violation of The Right to Food. Marine cloud brightening geoengineering and space-based systems could also pose dangers in this context. (Burns, 2016)

Deployment of SAI geoengineering options could also delay recovery of the ozone layer for 30-70 years or more. Injection of sulphur dioxide particles into the stratosphere would substantially increase the frequency of heterogeneous reactions in which inactive forms of chlorine and bromine could be converted to forms that could facilitate catalytic destruction of the ozone layer. This could increase skin cancer cases in the world, imperiling the health of millions and violating people's Right to Health. (Burns, 2016)

A sudden termination of a SRM technology due to a natural disaster, technological failure or policy decision could have catastrophic ramifications on the environment. According to studies, temperatures could increase by 60-100% due to the buildup of carbon dioxide in the atmosphere and its suppressed effects. This could also affect precipitation patterns in the earth's lower latitudes, hence disproportionately affecting the world's most vulnerable and impoverished regions. (Burns, 2016)

On the other hand, CDR options could also have significant negative impacts. Ocean iron fertilization could pose several risks to ecosystems and humans who rely on ocean resources. Assuming that fertilization spurs the proliferation of phytoplankton, there is a real danger that it could result in shifts in community composition that could threaten the integrity of ocean ecosystems. (Burns, 2016)

Large-scale deployment of BECCS could pose both socioeconomic and environmental risks. One striking feature of BECCS is the potential amount of land that might be required to be diverted from other uses, including food production and livelihood-related activities, to provide bioenergy feedstock. As a result, BECCS could endanger the existence of biodiversity, threatening species at both a local and global level. In addition to this, BECCS needs a lot of land for its implementation, which could considerably raise prices for basic necessities such as food. This could affect the food security in the world's *Global South*, with most families in developing countries spending more than half their income on food. BECCS would also have "a very large water footprint", consuming as much water as current agricultural water withdrawals. (Burns, 2016)

3. Governance (25 points)

The two questions we will be elaborating upon are:

1. What would an effective approach by the international community to govern Climate Geoengineering look like?
2. How does one prevent rogue states or actors from developing and deploying Geoengineering technologies?

It is essential to devote resources towards the research and development of geoengineering since it can be a vital tool in to respond to climate change. As the adverse affects of climate change accelerate, individual nation actors may undertake and implement geoengineering projects. Hence, it is essential to establish a system of governance to oversee research efforts, add a human rights component to the ramifications of CE techniques, address potential CE technology deployment strategies and make collective judgements on climate geoengineering efforts. (Hamilton, 2014)

The sheer immensity of the task at hand of keeping the temperature rise at 2 degrees, warrants a closer look at Climate Geoengineering, either as an alternative, as a complement to mitigation strategies or as an emergency option. Geoengineering projects, by their very virtue, are large-scale and have the tendency to affect a large number of regions, ecosystems, environments, and hence would require unprecedented level of international cooperation amongst state and non-state actors. (Hamilton, 2014) The real or perceived impacts of deployment could further destabilize a world already going through rapid change. For example, one rogue actor attempting to implement a geoengineering project could trigger environmental or natural disasters such as droughts or heat waves in another region, leading to global conflicts. However, effective global governance frameworks could reduce this risk. (Pastzor, Scharf and Schmidt, 2017)

Even though parties are not bound individually or collectively to meet the limits set by the United Nations Framework Convention on Climate Change and it contains no enforcement mechanisms, CE governance should fall within the purview of the FCCC since it boasts near universal membership by nearly all the countries of the world. In addition to this, the FCCC has established technical bodies such as the IPCC and Subsidiary Body for Scientific and Technological Advice under the Conference of the Parties forum, which can act as advisory and review bodies for discussion, review and development of geoengineering research. (Lin, 2009)

An important feature of this governance framework would be to develop mechanisms to prevent rogue actors and "managing the risk of unilateral geoengineering". Although deployment of geoengineering technologies should come in the category of *collective effort*, consensus based decision making would not be ideal for this situation since a rogue nation, out of desperation, could implement a project unilaterally, disregarding its impact on other nations and regions. (Lin, 2009)

According to research scientist Albert Lin, "One possibility would be to develop a protocol that treats geoengineering governance as a series of adaptive management decisions, rather than as a single binary choice to be made once and for all." Due to the scale of geoengineering as an option, multilevel adaptive governance could actually prove useful in breaking up large decisions on research and deployment into smaller, incremental, more manageable decisions that would involve interactions between state actors, non-state actors, organizations and institutions within non consensus processes. This system of governance would account for sufficient flexibility to manage and implement a complex solution like geoengineering as well avoid decisions that can have disastrous effects on the planet. (Lin, 2009)

In conclusion, the global community must start researching and exploring the potential feasibility of geoengineering technologies, as well as focus our attention to issues of geoengineering governance as a part of our response against global warming.

4. Themes Relating to Course (20 points)

Unless stringent and efficient measures are taken to counter this, Climate Geoengineering could deepen the North-South divide that exists between the richer more-developed countries such as the US, countries in Western Europe and developing countries in Africa, Latin America and Asia.

This is evident due to two factors. Firstly, geoengineering techniques such as SRM methods, Marine Cloud Brightening and Space-based radiation deflecting systems might only be available and feasibly deployable by technologically-advanced and economically developed countries. It is important to get the global South get involved in geoengineering research and start developing projects under the aegis of developed countries.

Secondly, there might be significant pressure from the global South to setup and deploy large-scale Geoengineering projects since the worst impact of climate change are expected to hit them. However, the implementation of Geoengineering technologies come with significant side effects on the Earth and its resources. These effects could disproportionately have adverse effects on regions such as Latin America, Africa and Southern Asia. For example, deployment of SAI geoengineering could result in a decline in mean global precipitation, it could alter African and Asian monsoons, causing humanitarian disasters in these regions. (Burns, 2016)

Additionally, the role of technology and scientific research is imperative to the success of geoengineering projects. Since these projects are intrinsically at a large-scale and have the tendency to affect a large number of regions, environments and ecosystems along with the natural resources attached with each of them, it's essential to incorporate institutions that can act as centers for coordinating research as well as forums for carrying out discussions on geoengineering technologies. These advisory bodies should conduct their research and present their findings independent of the decision-making policy-based organizations and institutions in order to present an unbiased view of the advantages and disadvantages of deploying various technologies.

As a result, the framework deployed for Geoengineering governance should ensure that actors, irrespective of their status as developing or developed, receive their "fair" share of benefits and burdens.[3]

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[3] http://onlinelibrary.wiley.com/doi/10.1111/raju.12154/full#raju12154-sec-0004

How has doing this assignment informed your views on the mock climate negotiations (you may answer from your own point of view as a participant or from the point of view of your country)?

My country: Mexico

This assignment has opened my eyes to a variety of questions as a representative of my country for the mock climate negotiations. For example, it has made me think about how vulnerable my country is to new technologies and approaches to combat climate change, and how will climate change impact my country's natural resources and the country's food, water and air quality? It has also made me aware of alternatives to mitigation strategies which can be researched and deployed by Mexico, or other allied nations in a similar situation in case of contingencies. From a Climate Geoengineering governance perspective, it has also shown me how my country fits into the development continuum gap and what are the measures it can take to contribute to the response against climate change, despite not being part of the *Global North*. For the benefit of my country, which is still categorized as developing, what are the protocols that should be enacted in a governance framework to ensure appropriate compensation for loss and damage. It has also informed me on consensus and non consensus based processes in decision-making and which one is more suitable for my country, in the context of climate change negotiations.

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