Forum: United Nations Environment Programme

Issue: Issue #29-01: Question on the use of geoengineering to combat climate change

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Introduction

Humanity has once again broken the record for the warmest year yet in 2016, with a temperature 0.1 ºC higher than 2015. Warming years have become a trend, and 2017 is set to follow. This increase in global temperature is directly related to the increase in carbon dioxide emissions, which grows with industrialization, the use of fossil fuels, and everyday pollution. This is also the reason why the polar ice caps are melting, sea levels are rising, natural disasters are augmenting, and biodiversity is declining. Climate change can be extremely dangerous if we continue the path we are on, and unless we find a quick solution for it, life in our planet will come to an end.

Current solutions to decrease CO_2 emissions include placing a tax on the production of greenhouse gasses or regulating private companies, however these actions are unlikely to reduce emissions enough, and it's improbable the public will support these actions. A much more promising solution is geoengineering: the intentional, massive altering of environmental processes. The main form of geoengineering that countries are considering is known as "solar radiation management". In this technique, sulfate particles are shot into the sky, reflecting light from the sun "back into space", and therefore reducing the global temperature of the planet. There are many other forms of geoengineering, known as "carbon dioxide removal" strategies, which involve altering the Earth's natural processes to deter climate change, ranging from massive efforts of reforestation to fertilizing the ocean to absorb "carbon dioxide from the atmosphere", but doing this can be very dangerous. The controversy stands in that even though these techniques could reduce climate change significantly and solve the ongoing issue, they could also have counteracting side-effects: unbalance in the global heat budget, altering of rainfall and wind patterns, decrease in ocean oxygen levels, and reversibility of CO_2 withdrawal, amongst others. As much as humans and the Earth's systems could adapt to these changes, they could also reject them and 'fire back', leading to dire consequences. This new technology could lead to moral and political

dilemmas, ethical and distributive justice issues, and much more controversies. Geoengineering is very powerful, but power can become harmful.

In October 2016, the United Nations ratified the Paris Agreement, which entered force in November of the same year. The agreement brings nations together for the first time in efforts to combat climate change. They agree, also, to aid developing nations in their efforts to combat climate change and to adapt to the effects that global warming brings. Amongst the key points of the agreements, it is stated that global temperature increase in the following century must remain well below 2 ºC, with further attempts to limit it to 1.5 ºC. How the goals of the agreement will be achieved is to be decided by each nation, with collective progress assessments every five years, but in order to achieve these goals, governments will have to take new and innovative measures to decrease CO_2 emissions. Geoengineering seems to be the only way to meet the goal of the Paris Agreement.

The idea of manipulating the atmosphere to reduce global temperature first arose after the volcanic eruption of Mount Pinatubo in 1991. So much volcanic ash was released, that from the debris an aerosol layer formed around the Earth and reflected sunlight for two days, reducing global temperature 0.9 ºC, which is the amount of degrees the temperature had increased for the past 100 years due to greenhouse gas emissions. This event led to the advocating of geoengineering research, especially to investigate the possibility of using aerosols to act as a shield against sunlight. Since then, geoengineering has been experimented with, proving it can be efficient, but also proving its dangers.

Definition of Key Terms

Greenhouse Gases

Greenhouse gases are gaseous compounds that trap heat from the sun within the Earth's atmosphere. These gases include Methane, Nitrous Oxide, and Carbon Dioxide, this one being known as the main contributor to the greenhouse effect, after which these gases receive their name. The greenhouse effect is the trapping of heat and solar radiation in the Earth's atmosphere due to the presence of greenhouse gases. It is called the greenhouse effect because the atmosphere acts like the walls of a greenhouse, letting radiation in, but not letting it out. Greenhouse gases are necessary to help maintain the Earth warm, but can be extremely dangerous in excess.

Climate Change

Climate change is the large-scale, long-term change in the Earth's or a region's climate. Climate

change is much broader than global warming as it includes not only warming, but also cooling and other changes apart from temperature, such as changes in rainfall, sea levels, and natural seasonal patterns. According to the Intergovernmental Panel on Climate Change (IPCC), from 1880 to 2012, the overall global temperature rose more than 0.8 ºC, which may seem minimal, but leads to many more changes in nature, leading to devastating consequences. The most common belief is that this warming is due to human-related activities, such as the burning of fossil fuels, through which we produce energy, which releases greenhouse gases.

Geoengineering

Geoengineering is defined as the intentional, massive altering of environmental processes that affect the global climate with the purpose of counteracting global warming effects. Geoengineering is popular because it's seen as an easy solution to combat climate change, however, scientists and multiple organizations advocate against its deployment. First, these technologies could have side effects that could damage the Earth's systems, and second, it can't be relied on to stop global warming forever. Scientists argue that the global population must accommodate to and care for the planet they call home by reducing greenhouse gas emissions and increasing efforts to lessen climate change.

Biomass

Biomass is the total amount of living matter in a given area. It is also defined as organic matter that is used as a fuel, or source of energy. In this paper, biomass refers to the amount of living matter in an area that can be burned and used as a fuel, or the vegetation/flora of an area.

Ocean Acidification

Ocean acidification is the long-term diminution of the pH of the ocean and happens mainly due to the increase of CO_2 in the atmosphere. As the emissions of carbon dioxide increase, the concentration of CO_2 in the ocean increases as well, as it absorbs about 30% of the CO_2 released into atmosphere. When the ocean absorbs carbon dioxide, chemical reactions take place, increasing the ocean's concentration of hydrogen ions and therefore causing the ocean to become more acidic. With ocean acidification, the abundance of carbonate ions, the building blocks of sea shells and coral, in seawater decreases. Certain fishes' ability to detect predators is also decreased in acidic waters and the increase in CO_2 has also lead to a decrease in the concentration of oxygen in the ocean, making it hard for certain marine species to breath.

Agroecology

Agroecology is the study of ecological processes for its application in agriculture and production systems. It refers to bringing ecological principles and natural processes into the agricultural industry.

General Overview

The modification of Earth's environmental systems to combat climate change can be done through two methods of geoengineering: Carbon Dioxide Removal (CDR) and Solar Radiation Management (SRM).

Carbon Dioxide Removal

One of the possible forms of geoengineering is Carbon Dioxide Removal, or CDR, which consists of, as the name implies, physically removing carbon dioxide from the Earth's atmosphere. There are several techniques that if implemented at a global scale could largely reduce the amount of CO_2 in the atmosphere, directly countering for the amount of greenhouse gas emissions that make the Earth heat up.

Of course, the most obvious technique of carbon dioxide removal is increasing biomass through reforestation - replanting trees where they are being chopped - and afforestation - planting trees where there hasn't been trees before. Increasing biomass, however, can take decades, and the Earth has no time to lose. On the other side, there is biocharring, which consists of charring or burning biomass to turn it into charcoal and bury it mixed with soil, thus making it more fertile and at the same time trapping carbon in the ground. The CO_2 created in the charring process could be captured and used for bio-energy. Some estimates show that biochar could have huge potential in absorbing CO_2, but it's believed necessary to burn too much biomass to see results. Some even say that to counter half of the current carbon emissions, it would be necessary to burn up to 4% of the already existing forests. A high-tech approach to CDR is ambient air capture, or direct air capture, which is based on the idea of building machines that can directly absorb CO_2 emissions from ambient air to store it away elsewhere. The sustainability of this technology, however, is questionable. First, there has not been vast experimentation or research made on the long-term usage of ambient air capture, meaning there are still many areas that are not fully understood, at least not enough to make a decision as to whether it could be employed safely or not as a solution to CO_2 emissions. Currently, it's known that storing CO_2 could bring large risks of leakage that would negatively impact the environment, and perhaps it could be one of the most costly options. The risk of leakage could be avoided if the carbon captured was utilized instead of stored, and this would make it actually

beneficial, but not in the long-term because eventually, we would run out of fossil fuels to burn into CO_2.

Carbon Dioxide Removal can also be applied in the ocean. Ocean Fertilisation or nourishment is the process of adding nutrients to the ocean to increase the primary production of phytoplankton. Phytoplankton would absorb carbon dioxide from the atmosphere and when the plankton dies, they would sink to the bottom of the ocean, burying with them the carbon dioxide. Carbon emissions can also be hidden by releasing minerals that will react with it and turn it into a compound that will be stored in the ocean, and finally, through ocean alkalinity, which consists of dissolving certain compounds in the ocean, directly increasing its ability to store carbon. A problem with these techniques, is that these nutrients could drastically decrease the concentration of oxygen in the water, and already, rising levels of CO_2 and ocean acidification are making it hard for marine species to survive.

Solar Radiation Management

On the other hand, geoengineering can also be aimed at mitigation rather than adaptation. Solar Radiation Management, or SRM is based on controlling sunlight and radiation by reflecting it back into space before it enters the atmosphere, this way it won't even have the chance to be trapped by the growing amount of greenhouse gases that would otherwise absorb it and increase the global temperature.

A proposed technique for SRM is the albedo enhancement, which consists of altering clouds to make them more reflective of sunlight, especially through marine cloud brightening. In marine cloud brightening, sea water is sprayed up at stratocumulus clouds, which cool the globe, to make them thicker and brighter and therefore more able of reflecting sunlight. Space reflectors are another way of managing solar radiation: their purpose is to block and reflect certain amounts of sunlight before they reach the Earth, but at the same time affecting rainfall patterns. If Solar Radiation Management is employed and then discontinued, global temperature would start increasing even more rapidly. The most popular form of SRM is using Stratospheric Aerosols.

Stratospheric Sulfate Aerosols

Stratospheric sulfate aerosols are the most economic and practical form of SRM. Releasing sulfate aerosols into the stratosphere can be used in geoengineering projects as it can create a global dimming effect, reflecting sunlight before it enters the Earth's atmosphere. Stratospheric sulfate aerosols can limit the increase of global temperature that is caused due to the increase in greenhouse gases by limiting the amount of sunlight that comes into the atmosphere in the first place. Studies show that only one kilogram

of sulfur, strategically placed in the atmosphere, could counter the effect of thousands of kilograms of CO_2 emissions. These aerosols can be delivered via balloons, artillery, or aircraft, whether they be sulfur dioxide (SO_2), or hydrogen sulfide (H_2S), and they can keep the Earth at a safe temperature for 20 years. However, after this period, it would be necessary to cut down on greenhouse gas emissions to a great extent.

Scientific models and predictions indicate that over a long-term period, the use of stratospheric sulfate aerosols would have negative impacts, like ozone depletion and putting ecosystems in danger. Furthermore, it can result in regional temperature and precipitation disparities, meaning that the longer that stratospheric sulfate aerosols are used, the more climates, especially rainfall, in different regions will be altered. However, the altering might not be even everywhere. Some regions might have much more drastic changes than others and the changes are completely out of the hands of humans, meaning that by using these aerosols, we can't control how certain areas will be affected and it would even be easy to lose control of which areas will be affected. This makes the decision as to whether or not use sulfate aerosols highly regionally dependent. If the use of stratospheric sulfate aerosols isn't paired with drastic measures of mitigation, temperature disparities will increase. In regions that haven't made large contributions to mitigation of climate change, such as Africa, South America and southeast Asia, change in precipitation patterns from use of this technology are likely to be larger, putting large populations that already struggle at even more risk.

Because of these disparities, issues of justice arise distributively and intergenerationally. From the use of stratospheric sulfate aerosols, the harms and benefits to come will not come equally, and if anything, the regions worse off wouldn't have more benefits and less harms and the ones better off, but instead vice-versa. Also, looking at the temporal aspect of how the harms and benefits will come, they may differ from the current generation to the future generations, leaving a gap of uncertainty and inequality between them. Issues of justice and ethics can lead to international disputes and controversy, seen as different nations will have different views on the morality of geoengineering.

Major Parties Involved and Their Views

United States of America

The United States of America has been a leader in geoengineering research and experimentation. At a NASA Conference in 2006, for the first time a plan was proposed to spray sulfate aerosols in the

north pole stratosphere to protect the arctic circle from sunlight, allowing the ice to build up and therefore cool the planet. In 2013, the National Academy of Sciences and the CIA funded a two-year evaluation of geoengineering techniques for $630,000. Two engineers from Harvard launched the largest geoengineering experiment yet, releasing aerosols into the stratosphere with a goal to cool the planet and reverse geoengineering. They might be receiving further endorsement from President Donald Trump, whose administration advocates for and is looking to use solar geoengineering technologies. Further experimenting with cloud whitening and other forms of geoengineering can be expected to follow. Recently, the United States withdrew itself from the Paris Agreement.

China

Geoengineering was first used in Beijing, China in 2008, hours before the opening of the Beijing Olympics. Silver iodide was successfully shot into the sky using rockets to hold back a storm predicted to hit on the day of the ceremony until two days later. With climate change being an issue of social unrest in China, geoengineering is appealing to the government. In 2012, it was listed amongst the scientific research priorities by the National Natural Science Foundation of China. The country spends around $100 million yearly on climate modification technologies, to avoid rain and hailstorms mostly.

United Kingdom

In 2011, the first large-scale geoengineering experiment was planned to be carried out in Britain under the name Stratospheric Particle Injection for Climate Engineering, but it never did due to multiple calls for a halt from NGO's around the world and pressure on the British government.

Canada

With smaller prior experiments, in 2002, Canada released a small-scale project of ocean fertilization off the coast of British Columbia called Subarctic Ecosystem Response to Iron Enrichment Study. Iron was released into the ocean, hoping that phytoplankton would bloom and absorb carbon emissions from the atmosphere. This would allow for carbon emission to be trapped at the bottom of the ocean once the phytoplankton died and sank.

Netherlands

In 2006, Paul Crutzen, Dutch Nobel Prize winner in chemistry, published an article advocating for research on geoengineering and SRM. His article sparked debate and controversy, with scientists arguing

that geoengineering might become an excuse for governments to not reduce their countries' CO_2 emissions.

ETC Group

ETC Group is a nongovernmental organization that advocates against geoengineering. They monitor new technologies, and ecological and global governance issues as well as their impacts on the environment and the more vulnerable populations. They work closely with social movements and civil society organizations, especially in Africa, Latin America, and Asia. ETC Group calls for a ban on geoengineering and any experimentation of it, and supports agro ecological agricultural systems.

Timeline of Events

Date	Description of event
June 15, 1991	Mount Pinatubo, Philippines, erupts and debris from the tons of volcanic ash released into the atmosphere form an aerosol cloud around the Earth, which reflected sunlight and reduced the amount of it that reached the Earth by 10% for two years, reducing the global temperature 0.9 ºF, as much as it had risen in the past 100 years due to human activity.
August 2006	Paul Crutzen, Dutch Nobel Prize winner in chemistry, publishes an article advocating for research on geoengineering and SRM, sparking debate and controversy around geoengineering.
August 8, 2008	Geoengineering is used in Beijing before the opening of the Olympics to hold back a storm predicted to hit on the day of the ceremony until two days later.
October 29, 2010	UN Convention on Biological Diversity (CBD) adopts decision X/33, de facto moratorium, banning governments from using geoengineering to combat climate change. This is not ratified by the USA.
July 2012	American businessman, Russ George, performs a geoengineering experiment off

	the Canadian west coast, releasing 100 tons of iron sulphate into the Pacific Ocean and generating an artificial plankton bloom more than 3,000 sq. mi. large. This violates the UN decision to ban the use of geoengineering.
2012	National Natural Science Foundation of China places geoengineering as a priority in scientific research.
2013	The CIA and the US National Academy of Sciences fund and carry out an evaluation of several geoengineering techniques.
April 2014	The United Nations considers geoengineering options to combat climate change for the first time when the Intergovernmental Panel on Climate Change (IPCC) evaluates certain geoengineering technologies.
November 4, 2016	The Paris Agreement enters force. By ratifying this agreement, 147 parties of The United Nations Framework Convention on Climate Change (UNFCCC) agree, amongst other things, to maintain the global temperature increase in the following century well below 2 ºC.
December 4, 2016	CBD Decision X/33 is reaffirmed in the Conference of the Parties (COP) 13.
April 2017	Group of Harvard engineers launch the largest geoengineering experiment yet, injecting sulfate aerosols 20 km into the stratosphere to study the effects of Solar Radiation Management.
June 2, 2017	The US withdraws from the Paris Climate Agreement.

UN involvement, Relevant Resolutions, Treaties and Events

In October 2010, the United Nations Convention on Biological Diversity took place in Nagoya, Japan. Here, 193 nations approved a global biodiversity treaty, banning any form of geoengineering research or deployment that may affect biodiversity. In October 2016, 147 parties ratified the Paris

Agreement during The United Nations Framework Convention on Climate Change (UNFCCC). The agreement states nations will cut down on greenhouse gas emissions to combat climate change and will strive to maintain the global temperature increase for the next 10 years under 1.5 ºC. The agreement does not specify, however, how this will be achieved and scientists doubt it will be possible to meet what was established without using some sort of geoengineering. A month later however, The UN Convention on Biological Diversity (CBD) at the 13th Conference of the Parties (COP 13) reaffirmed their moratorium against geoengineering, stressing the lack of knowledge about the potential impact of it on the Earth and biodiversity, and the fact that recent research shows the dangers and risks of geoengineering the climate. The Convention reiterates that seen as geoengineering entails altering the global climate, it must remain a topic of discussion amongst UN negotiations and all decisions concerning it must be mandates of the Convention on Biological Diversity.

- UN Convention on Biological Diversity (CBD), October 30, 2010, Decision X/33
- The Paris Agreement, November 4, 2016
- UN Convention on Biological Diversity (CBD) COP 13, December 16, 2016, reaffirms Decision X/33

Evaluation of Previous Attempts to Resolve the Issue

The UN has come to agreements on banning geoengineering, but these agreements have not had unanimous support. Countries, such as the US, have not yet ratified the convention and have actually had geoengineering experiments carried out within the country. Another hole in the decision is that it specifies a ban only on forms of geoengineering that could affect biodiversity, not an absolute ban on it, meaning nations could still find ways to experiment with the technology without breaking the ban. However, seen as there hasn't been much experimentation within the countries that ratified the ban, it has been followed quite thoroughly, with the exception of the American experiment off the coast of Canada. Apart from in the 2010 and 2016 UN Conventions on Biological Diversity, geoengineering has not been widely discussed by the nations.

Possible Solutions

To solve this issue the international community must come to an agreement as to whether geoengineering is a viable solution to global warming and whether it should or not be implemented. They

should also go into depth as to what types of geoengineering and how they will be implemented, or what would be the limits in the implementation or restriction. This is, considering that a large part of the controversy is not only around deciding if the technology is good or bad, but around finding the ways to implement or restrict it safely. Possible solutions could include setting guidelines or restrictions for how specifically geoengineering can be used and under what circumstances, what types of geoengineering can be used, and creating an agreement between all countries to follow these guidelines. If the committee decides against the use of geoengineering, discussion about other measures to keep the global temperature increase below 2 ºC in the following century would be appropriate, as well as a question on whether further research and development should be implemented to improve the safety and reliability of these.

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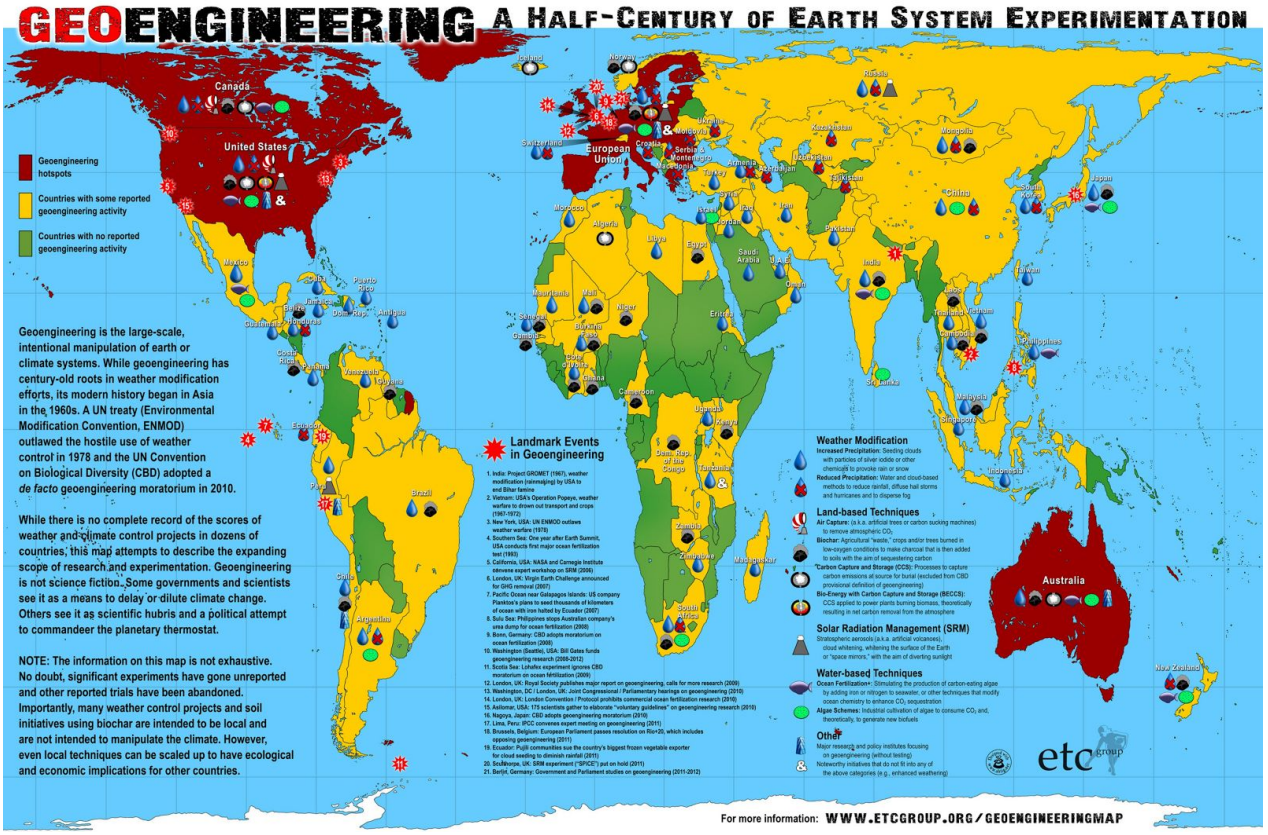
Appendices

- Agenda Item from the Convention on Biological Diversity from 2012: Impacts of Climate-Related Geoengineering on Biological Diversity: https://sustainabledevelopment.un.org/content/documents/1740cbd2.pdf
- Further on geoengineering: https://ourworld.unu.edu/en/the-frightening-politics-of-geoengineering
- More about the history of geoengineering: http://foreignpolicy.com/2013/09/03/geoengineering-a-short-history/
- Explanation of ethical controversies surrounding stratospheric sulfate aerosols: https://geoengineeringourclimate.com/2013/06/11/the-ethical-dimensions-of-geoengineering-solar-radiation-management-through-sulphate-particle-injection-working-paper/#_ftn5
- Explanation of SRM techniques, the Albedo Enhancement: https://www.youtube.com/watch?v=szGebMdXpF8

- Ocean Fertilisation experiment: https://www.theguardian.com/environment/2012/oct/15/pacific-iron-fertilisation-geoengineering

- China's Perspective on Geoengineering: https://geoengineeringourclimate.com/2014/02/04/a-chinese-perspective-on-geoengineering-opinion-article/ https://www.theguardian.com/environment/2013/mar/22/geoengineering-china-climate-change

- The figure below shows important events in the history of geoengineering. A numbered list shows how the technology has been used in many different countries, what research has been made and what decisions have been taken.



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