International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Geoengineering: An Overview

Ema Ridhi Gowri Shankar

Highschool student, The Camford International School

Abstract

Geoengineering describes the manipulation of specific processes central to the earth's climate as a means of offsetting the effects of climate change. Initially thought of as a scientific taboo, the case for this manipulation technique is getting increasingly approved by scientists and organizations due to its growing necessity. This paper will cover what exactly geoengineering is, the cases for and against the technique, the science behind it, and whether it has scope for making a real change in the environment.

Keywords: climate change, taboo, manipulation, technique

In 1965, President Lyndon Johnson's Science Advisory Committee cautioned about the need to increase the reflectivity of the Earth to tackle the elevated emissions of greenhouse gases in the near future. This committee went so far as to propose sprinkling reflective particles like sulfur dioxide across the oceans as a measure. The idea continued to be discussed in academic journals and at conferences over the subsequent decades, but didn't really catch on until late summer 2006, when Paul Crutzen, an atmospheric chemist and Nobel Prize winner, brought the geoengineering research into light in a publication for the journal Climatic Change. That was particularly noteworthy as he had won his Nobel for research on the hazards of the growing ozone hole, and one of the known effects of sulfur dioxide is ozone depletion. Over decades of abusing the planet with toxins like greenhouse gases and chemicals, humans have noticed the adverse effects this ignorance has built up and are trying to suck out two decades worth of carbon dioxide with this technique. The term "geoengineering" implies a technology on a planetary scale. However, several researchers have considered the potential of conducting it locally as well [1].

Geoengineering is divided into two techniques, namely, Solar Radiation Management (SRM) and Greenhouses Gas Removal (GGR). Solar Radiation Management is also referred to as Solar Geoengineering. In order to counterbalance the temperature rise brought on by rising quantities of greenhouse gases in the atmosphere, SRM aims to reflect a small fraction of sun's energy back into space. Increasing the ground-level albedo or surface reflectance helps redirect energy, preventing it from getting absorbed by the earth's atmosphere and surface. At regional scales, the greatest changes in albedo execution have been demonstrated to occur in areas undergoing desertification and deforestation. One suggestion is to make use of an aircraft to scatter minute hollow glass beads across the sea ice, which could increase the amount of reflected radiation from 60 to even 90 percent. Another technique, stratospheric aerosol injection. By making use of canons, balloons, or aircraft, aerosols would be shot up into the stratosphere. The artificial aerosol layer would also increase the scattering of incoming solar radiation. As more radiation is scattered in the stratosphere, less will be absorbed by the troposphere which meets the intended goal. Next, space reflectors. With the same goal in mind, spraying devices would be placed on land or even mounted on oceangoing vessels rather than making use of aircraft to expel a mist of pressurized seawater droplets and dissolved salts at altitudes up to 300 meters. As the water droplets evaporate, bright salt crystals would remain in the atmosphere to reflect incoming solar radiation. Greenhouses Gas Removal is also referred to as carbon geoengineering and further consists of minor techniques. Carbon burial involves the pumping of pressurized carbon dioxide into suitable geological structures deep under the earth's surface into geological formations, where it can be stored for an extended period of time. The idea is that CO2 emitted by the combustion of fossil fuels could be isolated from other industrial emissions before they are discharged into the atmosphere. Next, ocean fertilization is another way to boost the uptake of carbon dioxide from the air by phytoplankton miniscule plants that reside at or near the surface of the ocean. The idea here is that after blooming, the phytoplankton, would perish and descend to the bottom of the ocean, taking with them the carbon dioxide that they had photosynthesized into new tissues. Another technique includes the production of biochar. When manufactured, biochar, a type of charcoal made from animal waste and plant residues, can store carbon by avoiding the regular breakdown process or serving as a fertilizer to increase the sequestration rate of developing biomass. Direct air capture is another method that yields the same results through a series of physical and chemical reactions. The pulled carbon dioxide is foreseen to get captures into geological formations or used to make durable products like cement or plastic [2].

In the absence of drastic action, climate change is predicted to kill an estimated 500,000 people annually by the middle of this century, through famine, flooding, heat stress, and even human conflict. Due to our dire current situation, a good handful of researchers have argued that we should begin deploying geoengineering anytime soon. Climate models have repeatedly demonstrated that this technique, when used in moderation and combined with emissions cuts, has the ability to reduce climate changes around the globe for good, including handling extreme temperatures, changes in water patterns, and the severity of tropical storms. Since late summer 2006, since Crutzen's paper was published, more and more researchers have studied geoengineering. They primarily made use of computer simulations or small lab experiments to explore whether this technique would work on large scales, how it might be done, what sorts of particles could be used, and what environmental side effects they might have to endure. Although computer modeling consistently proves to reduce global temperatures, sea-level rise, and certain other climate impacts, some researchers think risking the plant we live on isn't worth the trouble. These researchers have found that these risks can be reduced, if not eliminated, by using other proponent aerosols and by limiting the extent of execution. With the use of high doses of certain particles, the protective ozone layer could get damaged. In addition, the undesirable alteration of global precipitation patterns and the reduction of crop growth in certain areas are predicted. Large-scale geoengineering to prevent catastrophic global warming could not only be ineffective but would have severe unforeseen consequences. Without a measure to be safely stopped, it could lead to chaos. Even if executed globally, the most anticipated outcome, researchers say, is a temperature drop of merely 8%, not enough to handle this issue entirely. The potential side effects would be potentially disastrous, as voiced by the writer in the journal Nature Communications. The global heat budget would be thrown out of balance by ocean upwelling, which would lower surface water temperatures and lessen sea ice melting, but iron or lime additions would change ocean oxygen levels. Moreover, reflecting the sun's rays into space would disrupt rainfall patterns and reforesting the deserts could change wind patterns and slow down tree growth in other regions [1,3,4].

In conclusion, geoengineering is a controversial and highly sophisticated topic to counteract the effects of climate change. With the improvements taking place, researchers hope to come up with a foolproof plan. Researchers must seek to delve into the intricacies of this global phenomenon to prevent undesirable outcomes and make informed decisions.

References

1. James T., "What is geoengineering- and why should you care?", MIT Technology Review, August 2019. https://www.technologyreview.com/2019/08/09/615/what-is-geoengineering-and-why-should-you-care-climate-change-harvard/
2. Philip B., "geoengineering", Britannica, October 2021. https://www.britannica.com/technology/electrical-and-electronics-engineering
3. Harvard's Solar Geoengineering Research Program, "GEOENGINEERING", Harvard University. https://geoengineering.environment.harvard.edu/geoengineering
4. John V., "Geoengineering side effects could be potentially disastrous, research shows", The Guardian, February 2014. https://www.theguardian.com/environment/2014/feb/25/geoengineering-side-effects-potentially-disastrous-scientists