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The regulation of geoengineering technologies: the case study of cloud seeding

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ABSTRACT: Climate Change is not a foreseeable future anymore but a glooming present to which laws must react, rather than just prevent it from happening. The current legal framework in the European Union still reflects a preventive and precautionary approach towards the environment and specifically the challenges of Climate Change. This article argues that this preventive approach, based on a strong interpretation of the precautionary principle, hinders the research and development of technologies that can be used to mitigate the current and future effects of Climate Change. Using the case study of cloud seeding, the present paper demonstrates how geoengineering technologies can be seen as cost-effective measures to prevent environmental degradation from Climate Change and how the lack of scientific certainty regarding these technologies should not be a reason to not regulate them.

KEYWORDS: Climate Change – geoengineering technologies – cloud seeding – regulation – environment.

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1. Introduction

Cloud seeding is a form of weather modification, a way of changing the amount or type of precipitation that falls from clouds, by dispersing substances into the air that serve as cloud condensation or ice nuclei. The process itself alters the microphysical processes within the cloud. The usual intent is to increase precipitation (rain or snow), but hail and fog suppression are also widely practiced in airports, where harsh weather conditions are experienced.

This technology has been used for many years and by several different entities, particularly the ones who have financial conditions and resources to do so, due to the lack of regulation of these technologies and the lack of enforcement of international environmental law. It is important to address cloud seeding technology as a potential solution to several problems related to water supplies and the materialisation of the right to water.[1] The goal of this article is to demonstrate how geoengineering technologies like cloud seeding should be regulated by the European Union and the international community to ensure that the research and development process of these technologies and their use comply with international environmental law, as part of a mechanism to mitigate problems arising from Climate Change.

2. Cloud seeding as a solution to water scarcity

Water scarcity has been one of the most considerable and important issues in our society from ancient times until our current modern age. Nowadays, this issue is becoming more pressing, due to the ongoing pace of world population growth and, now more than ever, due to Climate Change.

According to the International Water Management Institute (IWMI), around 1.2 billion people or 20% of the world's 7 billion-population, are vulnerable to diseases due to water poverty and food shortage. In their report they also stated that from the two billion hungry people, 850 million are depending on agriculture. In Sub-Saharan Africa alone, 95% of farmers rely on rainfall and 56% of their crops will be affected by 2050. In Latin America, 90% of the farmers rely on rainfall, as well as almost 70% in the Near East and East Africa, in addition to 60% in South Asia. In Europe, on the other hand, although water scarcity does not represent a real and urgent threat as it does to the regions said before, it will be a real issue in the upcoming years as we will see an increase of irrigation demand by more than 40%.[2] The statistics reveal that most yields from crops have decreased significantly as people dependent on rain-fed agriculture are highly vulnerable to both short-term (2-3 weeks) and long-term (seasonal) droughts. In the short-term, if nothing changes, we will witness a never-before-seen humanitarian crisis, where we will have not only climate refugees but also water refugees, meaning people that not only lack water resources but that will move across borders in search for water.

[1] The right to water in mentioned in several legal instruments of international environmental law, such as: The International Covenant on Economic, Social and Cultural Rights; The International Bill of Rights; The Universal Declaration of Human Rights; The UN Committee on Economic, Social and Cultural Rights (ICESCR); The Convention on the Rights of Persons with Disabilities (CRPD).

[2] "Water Management Institute Report", Water for Food – Water for Life: A Comprehensive Assessment of Water Management in Agriculture, 2007, http://www.iwmi.cgiar.org/assessment/files_new/synthesis/Summary_SynthesisBook.pdf.

The scenario might become even darker, as Sandra Postel from the World Watch Institute mentioned, the possibility for potential water wars is real, as more than 1 billion people who live below the one dollar per day poverty line, inhabit regions with water scarcity.[3] Climate Change deteriorates the abovementioned conditions, as extreme weather conditions become more common, while temperature shifts and reduced water availability, will cause more pests, in the near future. The need to tackle the perils related to the lack of water and the long absence of rain are becoming more urgent. International law, as well, will face significant challenges in finding immediate and efficient solutions to these problems. One potential solution or, at least, a potential breakthrough in water management policies, could be done through the use of geoengineering technologies, such as cloud seeding. To figure out how cloud seeding might present itself as a potential solution to water scarcity problems, some details regarding the technology should be provided.

Cloud seeding can create rainfall by targeting clouds. The method of seeding usually occurs from an aircraft or even from drones,[4] which can minimize the related costs, as has been stated by many scholars.[5] Otherwise, cloud seeding is possible from the ground, using specific generators for that effect. The purpose of this technology is to create an ice crystal by inserting silver iodide, dry ice, salt, or liquid propane, underneath or above a growing convective cloud rich with ice droplets. As the World Meteorological Organization (WMO) explained, not all types of clouds are prompt to cloud seeding. The type of clouds that are most prone to artificial rainmaking are known as Cumulus clouds, which is a type of cloud that is formed from updrafts of warm and moist air into an unstable atmosphere. These clouds alone are not enough though. Small cloud droplets, which are formed from the condensation of water vapor onto condensation nuclei when the supersaturation of air exceeds a critical value according to the Köhler theory, it must collide with other droplets enough times to create larger drops and eventually rainwater. The goal of inserting crystal composed by silver iodide, is to attract the small cloud droplets in a more efficient way because the vapor pressure created over ice is less than over water, meaning that the ice crystal transformation into a large raindrop occurs in a faster way than naturally expected. Then the raindrop, which is heavy enough to fall through the cloud mass, can create rainfall. With the use of aircrafts or drones, the chemical effect can be achieved in an easier and more efficient manner. The act of seeding a cloud is made either above the cloud top or below the cloud base using pyrotechnics, flares or a generator containing a solution made of acetone that contains the seeding material necessary for the effect. Cloud seeding with silver iodide gives a wide number of possibilities to grow rainwater, since one gram of silver iodide can supply as many as ten trillion artificial ice crystals.

It is therefore unequivocal that this technology presents a great potential in solving current and future problems related with water scarcity. However, the scientific

[3] Ibid.

[4] See all: https://www.thenational.ae/uae/environment/drones-and-rockets-could-be-used-for-cloud-seeding-say-experts-1.46453; http://www.techtimes.com/articles/199140/20170228/level-up-silver-iodide-laden-drone-brings-cloud-seeding-higher.htm; http://www.foxnews.com/tech/2017/03/01/making-it-rain-drones-could-be-future-for-cloud-seeding.html.

[5] Vittoria D'alessio, "A new method to trigger rain where water is scarce", Phys.org, May 6, 2021, accessed December 01, 2021, https://phys.org/news/2021-05-method-trigger-scarce.html. Also, H. A. Israr, M. F. Abdullah & S. Mat, "An overview of using unmanned aerial vehicle as an alternative solution for cloud seeding process", *Journal of Transport System Engineering*, v. 3, no. 1 (2016): 1-7.

uncertainty regarding this technology, specifically whether there is/are any potential side effect(s) on the climate, calls for the applicability of the precautionary principle, through one of its interpretations, as the present article will demonstrate in chapter 4.

3. Cloud seeding and the geoengineering legal paradigm

The law can regulate the use and application of this technology through a priority and fair use legal scheme that encompasses economical instruments, such as mandatory licenses, to deploy these technologies on an international level. This legal scheme should consider not just the global and regional aspects of the problem of water scarcity but also the impact on the agriculture industry, where Climate Change has, and will continue to have severe impacts on major crops in tropical and extreme temperature regions.

Any legal outline concerning the use of geoengineering technologies such as cloud seeding should consider the environmental principles contained in aforementioned declarations but also in other legal instruments like the Environmental Modification Convention and the European Transdisciplinary Assessment of Geoengineering (EuTRACE). The current legal framework established by the decision X\33 adopted by the 10th meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD), relating to the use of geoengineering technologies in ocean fertilisation, which is addressed by the London Dumping Convention & Protocol (2013), is also relevant, since it contains a more detailed patchwork of normative guidelines concerning a specific geoengineering technology.

Considering the legal principles contained in the Rio Declaration and in the United Nations Framework Convention on Climate Change (UNFCCC) and later encompassed in the Paris Agreement and the Green Deal, it is clear that international environmental law still holds a very preventive and conservative approach on these technologies, which ultimately stops the use of any technology that could have an unforeseeable impact on the climate.

Some legal instruments in international environmental law address geoengineering in general. For instance, the ENMOD multi-lateral agreement prohibits the use of geoengineering methods for military purposes and encourages its use for peaceful purposes, while the CBD Convention indirectly oversees the consequences of geoengineering. In addition to those two, the UNFCCC, although not mentioning explicitly the term of geoengineering, is the only legal instrument referring to geoengineering methods in a clear way. Specifically, it mentions CDR[6] and SRM[7] technologies related with carbon storing and solar radiation. Regarding cloud seeding, no reference is made throughout any of these legal instruments. This raises some questions, especially since this technology has been around since 1946,[8] as it can be seen in a CIA report dating back to the 1970s.[9] Being probably one of the oldest geoengineering technology available, it is almost astonishing how more information concerning cloud seeding has never been available to the public. This is

[6] Carbon Dioxide Removal.

[7] Solar Radiation Management.

[8] In 1946, researchers connected with the General Electric Research Laboratory in New York discovered the possibility for using both dry ice and silver iodide to trigger precipitation. In November of that year they tested in real time, causing snow to fall near Mount Greylock in Western Massachussetts.

[9] "Physical View on Cloud Seeding by Myron Tribus", accessed December 1, 2021, https://www.cia.gov/library/readingroom/docs/CIA-RDP80T01137A000200030004-2.pdf.

changing now that more countries and entities are using cloud seeding technology and other geoengineering technologies, in the face of the extreme weather conditions that they face due to Climate Change.[10]

In the last year, scholars have been pushing the subject of Geoengineering technologies to the center of discussion in terms of environmental policies to be taken into account by the EU.[11] Without taking a strong stance on the subject, the main idea that arises from these studies is that these new technologies[12] are seen as a potential solution for some of the challenges posed by Climate Change. In fact, even a preparatory research work has been made for the European Parliament regarding solar engineering technologies.[13] These latest references to the subject of geoengineering technologies definitely mark a new trend in the paradigm of Climate Law. In fact, it was even briefly mentioned in the European Green Deal, published in late 2019, where some of these technologies (Carbon Capture and Storage (CCS) and Carbon Capture and Utilization (CCU)) were cited as a potential technological source to invest in by 2030.[14]

Although this evolution should already be praised, the fact is that we have very little information about a lot of these technologies. Some of them are starting to appear in some places but others have been operating for a long time.[15] Since geoengineering is merely partially addressed by international laws, the private sector has been taking advantage of the lack of national regulations regarding these technologies, specifically cloud seeding. In fact, the cloud seeding industry is growing at an unprecedented pace with around 150 ongoing projects counted worldwide in 2012.[16] With no

[10] See: https://www.arabianbusiness.com/gcc/saudi-arabia/440076-saudi-arabia-approves-cloud-seeding-in-attempt-to-boost-rainfall-by-20#:~:text=Saudi%20Arabia%20has%20approved%20plans%20to%20implement%20cloud-seeding,amid%20heightened%20pressures%20on%20the%20country%E2%80%99s%20water%20supply; https://www.worldpoliticsreview.com/articles/29510/geoengineering-is-coming-whether-it-s-governed-or-not.

[11] F. Fleurke, "Future Prospects for Climate Engineering within the EU Legal Order", *European Journal of Risk Regulation*, v. 7, no. 1 (2016): 60-74, doi:10.1017/S1867299X00005407.

[12] European Commission, *EU Action Against Climate Change: Leading Global Action to 2020 and beyond* (Luxembourg: Office for Official Publications of the European Communities, 2009), http://ec.europa.eu/clima/sites/campaign/pdf/post_2012_en.pdf.

[13] Lieve Van Woensel and Marcos Fernández Álvarez, "What if we could engineer the planet to help fight climate change?", EPRS, European Parliamentary Research Service, February 2021, https://www.europarl.europa.eu/RegData/etudes/ATAG/2021/656339/EPRS_ATA(2021)656339_EN.pdf#:~:text=The%20EU%20and%20its%20partners%20could%20promote%20an,done%20for%20some%20at%20the%20expense%20of%20others.

[14] "EU industry needs 'climate and resource frontrunners' to develop the first commercial applications of breakthrough technologies in key industrial sectors by 2030. Priority areas include clean hydrogen, fuel cells and other alternative fuels, energy storage, and carbon capture, storage and utilisation. As an example, the Commission will support clean steel breakthrough technologies leading to a zero-carbon steel making process by 2030 and will explore whether part of the funding being liquidated under the European Coal and Steel Community can be used. More broadly, the EU Emissions Trading System Innovation Fund will help to deploy such large-scale innovative projects.", on the Access to resources is also a strategic security question for Europe's ambition to deliver the Green Deal, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions the European Green Deal, p.8. (2019). https://ec.europa.eu/info/sites/default/files/european-green-deal-communication_en.pdf.

[15] "UAE weather: More rain hits Dubai as cloud-seeding planes take to the skies", *The National*, January 3, 2022, https://www.thenationalnews.com/uae/2022/01/02/uae-weather-rain-and-warmer-temperatures/.

[16] Owlcation blog Article: "The growing industry of cloud seeding". (2019): https://owlcation.com/

explicit regulation, there is potential for the misuse of this technology, or at least for sedition and subversion to the wrong stimuli when considering the general principles of Environmental law and the potential benefits and drawbacks of cloud seeding.[17]

Some examples can be seen in countries using cloud seeding operations to increase annual rainfall for drinking and agricultural purposes like Saudi Arabia and the Chinese government, which invests more than 90 million per year for that purpose.[18] The dispersal of fog in airports and metropolitan city roads, the increase of hydro-power generation at the cheapest cost, the suppression of hailstorms to reduce damage, mitigation of devastating impacts of recurring droughts through financing water districts like the Metropolitan Water District of Southern California did in Colorado. Or even preventing the damaging impacts of global warming and excessive summer temperatures, as well as, the increase of annual rainfall for saving forests, wildlife and the environment.

This notwithstanding, not all uses of cloud seeding are driven by humanitarian or environmental concerns. One of the downsides of not having a strict regulation on the use of such technology is that the private sector can use this technology for profit-related and aesthetic purposes. The Ski and Sports Industry have been using this kind of geoengineering to ascertain their profitability. For instance, several private companies in the Ski Industry, in the US, have been using cloud seeding to ensure sufficient snow, during ski-season, such as the Weather Western Consultants in 2011, when they carried out a cloud seeding project in the Vail and Telluaride Ski resorts.[19] The Chinese government in 2007 also took a leap into the private industry of cloud seeding when they started "selling clouds" to private companies holding outdoor events, who wanted to seed for fresh air.[20] China also used cloud seeding not to originate rainfall but to prevent it, during the Olympic Games of 2008[21] in Beijing. The methods used are not quite clear. This further shows how the lack of regulation also affects the scientific transparency of this phenomenon.

The variety of agendas regarding the use of this technology show, on one hand, that the development of this technology and its research is far more advanced than what it might seem in the opinion of the public, especially when compared with other more mainstream methods of geoengineering. Furthermore, the potential positive outcomes of this technology obviously surpass any abuse of it for speculative purposes.

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stem/The-Emerging-Industry-of-Cloud-Seeding.

[17] Recently an article from the Guardian made a piece on how the chinese government was deploying cloud seedings technology to disperse clouds for aesthetic reasons related with governmental celebrations, see Helen Davidson, "China ′modified` the weather to create clear skies or political celebration – study", *The Guardian*, December 6, 2021, https://www.theguardian.com/world/2021/dec/06/china-modified-the-weather-to-create-clear-skies-for-political-celebration-study.

[18] Lieve Van Woensel and Marcos Fernández Álvarez, "What if we could engineer the planet to help fight climate change?"; Kevin Lui, "China is splashing $168 million to make it rain", *Fortune*, January 24, 2017, https://fortune.com/2017/01/24/china-government-artificial-rain-program/.

[19] Washington Post, 'Cloud seeding' may make it snow, but will it reduce droughts in the West? - "I'm just trying to make more snowflakes at a ski resort," said Joe Busto, who oversees Colorado's cloud seeding program. Taken from an article by Michael Bengwayan on Mon 02 October 2017 - 05:00". February, 2018.

[20] Susette Horspool, "The growing industry of cloud seeding", Owlcation, February 20, 2019, https://owlcation.com/stem/The-Emerging-Industry-of-Cloud-Seeding.

[21] Clifford Coonan, "How Beijing used rockets to keep opening ceremony dry", *The Independent*, August 11, 2008, https://www.independent.co.uk/sport/olympics/how-beijing-used-rockets-to-keep-opening-ceremony-dry-890294.html.

Nevertheless, the need to legally address this technology has risen. Specifically, both normative guidelines from international environmental law, and national top-down policies, and bottom-up initiatives capable of ensuring proper and fair use, and transparency, in accordance with the international environmental principles, are needed. Through the interpretation of these principles and by trying to see in which way they can relate to this technology, a future legal framework, entangled with the political process of international agreements and national jurisdictions, could form the necessary measures and policies concerning the problem of management and exchange of information about cloud seeding and water resources.

4. The international environmental law principles and geoengineering technologies

International environmental law principles must play a crucial role regarding geoengineering technologies. The need for a clear legal framework is present and the implementation of normative guidelines in regulating this technology should move towards the objectives of other relevant environmental legal instruments.

The first convention dealing with climate engineering was the 1976 Convention on Environmental Modifications (ENMOD Convention), as previously mentioned. This convention had a clear intention of prohibiting any environmental modifications for military purposes.[22] Nonetheless, it also allowed environmental modifications under certain conditions but only for peaceful purposes. One main condition set by this Convention is international cooperation, as mentioned in its Article III and Article V. Article III also states that the deployment must contribute to international economic and scientific collaboration, aimed at improving and preserving the environment, while the members must consider the needs of developing areas of the world. Although cloud seeding technology is not mentioned in any Treaty or Convention, as CDR or SRM technologies are, the ENMOD Convention broadly referred to geoengineering technologies under the term of environmental modification, in Article II. Respectively, these two technologies (CDR and SRM) are addressed by the Decision X\33 on Biodiversity and Climate Change adopted by the Conference of the Parties to the CBD (Convention on Biological Diversity) at its Tenth Meeting. Based on Article 8 (w) this decision entails a framework with some normative guidelines that could serve as a regulatory approach for a potential legal scheme on cloud seeding technologies, together with the other technologies already considered as climate-related geo-engineering. According to this provision, the Parties *"Ensure, in line and consistent with decision IX/16 C, on (...) climate change, in the absence of science based, global, transparent and effective control and regulatory mechanisms for geo-engineering (...) no climate-related geo-engineering activities*[23] *that may affect biodiversity take place, (...) with the exception*

[22] In the 1960s the U.S. military used cloud seeding technology to gain an advantage over their enemies by flooding supply routes in Vietnam, see Seymour M. Hersh, "Rainmaking is used as weapon by U.S.", *The New York Times*, July 3, 1972, https://www.nytimes.com/1972/07/03/archives/rainmaking-is-used-as-weapon-by-us-cloudseeding-in-indochina-is.html.

[23] COP 10 Decision X/33, subparagraph 8 on Reducing biodiversity impacts of Climate Change mitigation and adaptation measures, w): "*Without prejudice to future deliberations on the definition of geo-engineering activities, understanding that any technologies that deliberately reduce solar insolation or increase carbon sequestration from the 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) should be considered as forms of geo-engineering which are relevant to the Convention on Biological Diversity until a more precise definition can be developed.*". https://www.cbd.int/decision/cop/?id=12299

of small scale scientific research studies (...) until there is a thorough prior assessment of the potential impacts on the environment". This provision sums up the fundamental environmental principles which can apply in regulating potential solutions to Climate Change and its related problems.

The *no harm principle* for instance, is one of the most relevant principles regarding a future regulation of climate engineering, as it limits the use of technological methods that may have an irretrievable negative effect on the environment. In fact, this principle requires that an assessment over the potential negative effect of any technologies on the environment must be done as part of the subsequent duties of monitoring and preventing.[24] This normative guideline derives from the Principle 2 of Rio Declaration as it articulates that states' "*sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility 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*". In the case of cloud seeding technology, since it works in aerial space with all the complexity inherent to the water cycle, this principle demands clear cooperation and coordination between neighboring states.

The most relevant principle, with respect to this technology and geoengineering in general, is the *precautionary principle*, expressed in several international environmental agreements. Specifically, the UNFCCC refers to this principle in Article (3), where it states that "*The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects"*. Based on this, the precautionary approach stresses that if an action or policy has a suspected risk of causing harm to the public, or to the environment, in the absence of scientific consensus and certainty, the action should not be carried out. Concerning climate engineering technologies, and specifically cloud seeding, this principle is crucial in outlining the approach that the political and legal institutions should follow in regulating this technology.

Moreover, the precautionary principle entails a double dimension, as stated by some scholars,[25] regarding the deployment of technologies such as cloud seeding or other geoengineering technologies. Based on this double dimension, the precautionary principle follows a spectrum from "strong" to "weak".[26] These variations occur as they fall within different processes of decision-making, when confronted with uncertainty regarding the risks of a certain technology. The strong dimension of the precautionary principle takes only into account the existence of risk of serious harm and merely allows a potential deployment of a technology, if scientific evidence proves it does not harm the environment. This interpretation places the burden of proof on those who invest in taking action or, in this case, of deploying a certain technology. In order to do so, unequivocal scientific evidence proving there is no risk of serious harm must be demonstrated. Some critics of the strong precautionary principle scrutinize this interpretation as being too vague, leading to unrealistic solutions, which do not correspond to the threshold of adaptability demanded in face of the current perspectives on Climate Change. In other words, the precautionary principle as it is currently interpreted and employed, does not allow new solutions to come into place

[24] International Court of Justice, Gabčíkovo-Nagymaros Project (Hungary/Slovakia) case, 1997, https://www.icj-cij.org/en/case/92.

[25] Anthony E. Chavez, "Using Legal Principles to Guide Geoengineering Deployment", *SSRN Electronic Journal*, 2015, https://doi.org/10.2139/ssrn.2600938.

[26] Multi-Case Review of the Application of the Precautionary Principle in European Union Law and Case Law by Garnett K1, Parsons DJ1.

due to the lack of scientific certainty regarding the effects of a certain technology. This approach not only discourages the research and development of technologies that can mitigate some of the environmental effects of climate change, but also delays any kind of regulation of this industry both at an international and state level.

The "weak" interpretation of the principle, on the other hand, considers other factors, such as cost, effectiveness and efficiency. It works as a balancing system that manages the risk of use and deployment of a certain technology considering the potential need for adaptiveness in tackling the urgent and immediate needs to adapt to Climate Change. In line with Principle 15 of the Rio Declaration, this interpretation states that the lack of scientific certainty regarding these technologies should not be a reason to not regulate them.

This paper stresses the need of adopting this interpretation, embracing the adaptability present in the precautionary principle itself. Under this weak interpretation of the precautionary principle, the international community could incite the research and development of geoengineering technologies and the regulation of their access and use.[27] In fact, this need to recognize the urgency in adapting certain instruments and measures in the face of climate change is also recognized as an objective by international legal instruments such as NAPAs, created by the UNFCCC to help the Least Developed Countries (LDCs).[28] Whether through the Adaptation Fund, that finances many agricultural adaptation projects or by implying a duty of Cooperation in the preparation for adaptation in face of *'immediate need and priority'*, this "reactionary" view of the precautionary principle is a reality that the international community has recognized, especially to favor developing countries, in the face of the already existing consequences of Climate Change.

5. Cloud seeding and developing countries

Cloud seeding falls within the 'moral hazard' argument against geoengineering, as the user of this technology is more inclined to adopt a risky behavior, since compensation is available.[29] This economical drive facilitates the growth of private interests in altering the global climate, when its purpose and functionality exist to manage a global public good, like the water cycle. Besides this drawback, the lack of scientific certainty regarding this technology cannot be clear since transparency and the information exchange are neither existent nor reliable. A different approach, based on the weak interpretation of the precautionary principle, can improve decision making and guarantee the obtainment of the best scientific information and therefore, the most reasonable and sustainable ways of dealing with climate engineering technologies, like cloud seeding.

Another guiding principle that must be considered when regulating cloud seeding technology is *the principle of intra and intergenerational equity*, present in Article 1 of the UNFCCC. This principle fundamentally states that each generation is required to conserve the diversity and maintain the quality of natural and cultural resources, ensuring that they do not restrict the options available to current and

[27] On the need to start using solar engineering technology: https://www.cio.com/article/201907/why-we-need-geoengineering-now.html.

[28] See: http://adaptation-undp.org/national-adaptation-programmes-action-napas.

[29] William C.G. Burns, "Climate Geoengineering: Solar Radiation Management and its Implications for Intergenerational Equity", *Stanford Journal of Law, Science & Policy*, v. 4 (2011), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1837833.

future generations in solving their problems and fulfilling their own values or in accessing their legacy. Under this principle, certain technologies like cloud seeding could be part of a mechanism to mitigate the environmental degradation as a result of Climate Change.

Moreover, the UNFCCC also recognizes the urgent needs of developing countries, especially, the least developed countries, in the provision of financial support technical assistance, to address the challenges of Climate Change, especially with regards to vulnerability and adaptation. The aforementioned assistance could come from developed countries and from the private sector, whether through the application of the same legal framework applied in the Doha Declaration,[30] regarding the granting of licenses to Developing Countries for the use and distribution of pharmaceutical products, or through the exchange of information and cooperation in trading know-how and distributing technology. Additionally, through the *principle of common but differentiated responsibilities*, contained in Art. 3(1) of the UNFCCC, the developed countries-Parties should take the lead in combating Climate Change and the adverse effects thereof. This means, according with Art. 4 [1(c)], that the developed countries-Parties commit to assist the developing countries in meeting the costs of adaptation by developing and sharing technologies and know-how to face the challenges of Climate Change.

Finally, intellectual property assumes a great role in the life cycle of geoengineering technologies, such as CDR or cloud seeding. In fact, intellectual property law can establish normative guidelines for the distribution and use of these technologies as an economic incentive and as a regulatory basis for a framework that contemplates a system of compulsory licenses that ensure the recognition of principles contained in the UNFCCC and other legal instruments. Applying the reasoning of the Doha Declaration to climate engineering patents is a process to consider, especially regarding cloud seeding patents. This way, the international community could ensure that by meeting the terms of certain criteria, mandatory licenses could be granted to developing countries to mitigate certain effects of Climate Change. Other mechanisms can also be used to create a priority use scheme and deployment over this technology, enhancing international cooperation and exchange of information. By transferring the resulting knowledge and by establishing a platform of communication for regular global monitoring and assessment of geoengineering technologies, national and international institutions become one step closer to regulating the use and distribution, in a sustainable way, of a potential solution to mitigate effects of Climate Change like water scarcity.

6. Conclusion

This article stresses the need to update some of our environmental principles in the face of the climate challenges that we are already seeing today. Principles like the precautionary principle encompass two different interpretations that follow the need for adaptation to present and future circumstances that arise from Climate Change. When most of these principles were created, the environmental context was very different than the one of today because above all else, it required a preventive

[30] A special Ministerial Declaration at the WTO Ministerial Conference in Doha to clarify ambiguities between the need for governments to apply the principles of public health and the terms of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).

approach to future environmental challenges that were emerging and others that were already foreseeable. Climate change was one of those foreseeable futures that required preventive measures to be taken into account. Recognizing the fact that the international community failed to adopt those preventive measures should be the first step to reform the international legal framework in a way that could create a real impact in the world. The world of today needs real enforceable environmental laws and needs a realistic approach in face of climate change challenges.

Technologies like cloud seeding reveal a great potential in solving current and potential problems related with water scarcity, especially in developing countries. Other technologies can also represent a true change or at least a real opportunity for many states to address extreme weather conditions that are becoming more pervasive each year. But in order to do that, the current legal framework in environmental law must change. That change should entail a more reactive and aggressive approach, because Climate Change is no longer a foreseeable future but a glooming present.