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# Geo-engineering: A Roadmap Towards International Guidelines

Sacco, N
Janssens-Maenhout, G.
Galmarini, S.
Michel, Q.

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**Contact information**
Name: Greet Janssens-Maenhout
Address: Joint Research Centre, Via Enrico Fermi 2749, TP 124, 21027 Ispra (VA), Italy
Email: greet.maenhout@ec.europa.eu
Tel.: +39 0332 78 5831

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# Contents

## Foreword

This project explored future policy needs for geo-engineering with a traineeship. Nicoletta Sacco of the University of Liège, prepared a master thesis on this topic combining different disciplines. She has a background in environmental law and collaborated with JRC climate scientists to understand the impact and risks of geo-engineering actions. This work remained at the level of a scientific and therefore neutral exploration of the policy needs and regulations for geo-engineering.

## Acknowledgements

This project benefitted from an excellent collaboration between the University of Liège and the Joint Research Centre. Moreover, it is in an exemplary way illustrating how methodologies and lessons learned applied in the nuclear area serve also the non-nuclear area of climate change.

***Authors***

Sacco Nicoletta, Janssens-Maenhout Greet, Galmarini Stefano, Michel Quentin.

## Abstract

This report presents a first screening and analysis of the legal and political framework related to the potential deployment of geo-engineering interventions.

*Geo-engineering* (GE) can be defined as the process through which humans voluntarily manipulate the energy input to the Earth System deploying natural climate impacting processes by means of available technologies. It is brought to the attention by the *United Nations Intergovernmental Panel on Climate Change* (IPCC) authors as an alternative escape-valve to counteract the effects and impacts of global warming in the Summary for Policymakers (IPCC-XXX/Doc. 10) of the IPCC AR5 WGI (2014).

The IPCC 2012 meeting established criteria for assessing GE technologies: effectiveness, feasibility, scalability, sustainability, environmental risks, costs & affordability, detection & attribution. However, not explicitly addressed in the document are the legal and political aspects as well as the ethical and social implications.

The challenges to regulate geo-engineering are large: it took a decade of negotiations to conclude the Law of Sea Convention and the Protection of the Atmosphere is since 2013 taken up in the program of the UN International Law Commission (ILC).

This study aims at mapping the legal and political constraints related to geo-engineering within the extent of an international environmental legal framework.

Thereto, all UN legal documents were screened and confronted with a series of parameters set in the definition of geo-engineering. The legal documents most pertinent to geo-engineering (i.e. *the United Nation Framework Convention on Climate Change and the Convention on Biological Diversity*) were evaluated on their potential ability to rule geo-engineering interventions.

# 1 Introduction

## 1.1 Historical facts

The concept of *geo-engineering* (GE) can be traced back to the 1960s with a US report calling for research on "possibilities to deliberately bringing about countervailing climatic changes to that of carbon dioxide (CO2)" (Marchetti, 1977).

The idea of large-scale, voluntarily intervening on the environment is also not new. In the early 1970s, the US and the Soviet Union already cooperated in secrecy on world weather-engineering (e.g. Bering Sea experiments, the POLEX and AIDJEX projects), inclusive punching holes in the ozone layer with lasers. Small-scale geo-engineering experiments are recently more openly discussed in the scientific literature as well as in the legal and political arena (cfr. Royal Society 2009). When in 2012 iron fertilization of the ocean in Canada was performed, scientists noted that geo-engineering, also called climate engineering is at the door and need to be tackled.

In the IPCC-XXX/Doc. 10 of the IPCC AR5 WGI (2014), geo-engineering is described as an alternative response to counteract global warming and consequently climate change. GE interventions are very broad, encompassing a wide range of distinct technologies. Solar radiation management, carbon dioxide removal or modifications of the ocean albedo are considered as the main geo-engineering methods.

Even though the technology to implement geo-engineering exists nowadays, what remain unknown, are its side effects on the Earth system. Important interconnections exist among the various Earth system compartments (biosphere, hydrosphere, atmosphere, cryosphere, geosphere), and it remains so far unclear how such a drastic intervention could produce negative effects and how those could cascade down in the various parts of the system. Computer simulations of the effects of some GE technologies have been performed, but these remain uncertain and can not guarantee that the GE action produces benefits globally or only to some parts of the globe with negative consequences for others.

In addition, geo-engineering is not only controversial and influencing the broader public but it can be potentially misused. It has the potential to change the politics of the climate problem, by allowing States to deploy geo-engineering technologies on global commons (e.g. the high seas, atmosphere, or outer space) which might have planetary effects.

Therefore, geo-engineering raises a number of fundamental scientific, legal, political, ethical and social questions. Who has the authority to decide on tackling a geo-engineering action? Who can deploy geo-engineering? What are the conditions under which it could be deployed? Who is responsible for this action and its consequences? Who is liable for the damage that such action could create on the long-term?

As the issue of climate change gains urgency, these and other questions are at the core of a worldwide debate, which is involving scientific, political and academic communities.

Particularly, the legal and political concerns related to geo-engineering are dense and numerous since so far there are no legally binding international instruments that explicitly deal with geo-engineering applications. Within the existing framework of environmental laws, there are prominent avenues that would provide the basis for the governance of geo-engineering. Nevertheless, the lack of regulatory mechanism together with all the uncertainties related to the potential deployment of GE interventions is the major gap of the current legal framework.

With this background in mind, this report aims at providing a roadmap towards international guidelines for the governance of geo-engineering. A first screening and analysis of the legal and political documents so far adopted has been carried out to identify and assess the gaps and the future possibilities in the existing environmental law.

In the first part of the report, a brief literature review addresses the concepts of global warming, climate change, adaptation and mitigation. The exploration of geo-engineering methods and technologies are summarized into a broad definition of GE. That is then followed by the methodological approach with parameters extracted from the GE definition. The legal framework of UN environmental laws is then assessed with regard to its appropriateness to govern GE by evaluating the presence of the parameters in the laws. This constitutes the foundation for the second part, in which the methodology is applied and the legal concept proposal of geo-engineering is assessed with the identified parameters. Finally, the research findings and the empirical data are discussed in the last section, which offers an outdoor with some reflections on the future governance of geo-engineering.

## 1.2 Global Warming and Climate Change

In 2000, the Nobel Prize-winning scientist Paul Crutzen first advocated the beginning of the *Anthropocene* and the consequent end of the previous era, the *Holocene*. He conceived this term to describe a new geological epoch marked by the increasing influence of human beings on the Earth. *The Anthropocene* is an era in which humankind, by assuming similar power as Mother Nature, will take on an increasing "responsibility for the welfare and future evolution of life on the Planet" (A. Abelkop 2012: 102).

But, how did human beings alter the global natural systems so far? Certainly, humans influence on the Earth is clear, since we have changed it in a number of fundamental ways (e.g. urbanization, technological development, population growth, consumption, etc.) many of which are far less known than global warming.

Accordingly, global warming is one of the major challenges of the 21st century. It is the result of a change in the ratio between the energy entering and leaving the Earth system. The *United Nations Environmental Program's* (UNEP) Global Environment Outlook 5 (GEO-5 Report 2012) defines the Earth System as a complex social-environmental system, including the vast collection of interacting physical, chemical, biological and social components and processes that determine the state and evolution of the planet and life on it. The biophysical components of the Earth System are often referred to as spheres: these are atmosphere, biosphere, hydrosphere, cryosphere and geosphere (UNEP GEO5 Report 2012: 105).

Many factors, both natural and human, can alter the Earth's energy balance and consequently the global average temperature. Among them, the main cause for the current increase of temperature is unanimously attributed to greenhouse gas (GHG) emissions produced by human activities, as evidenced in the IPCC AR5 (2014).

Global warming has a direct and strong impact on the Earth System. Higher temperatures modify the atmospheric dynamics and produce on the long term important changes of the Earth's climate. This has serious implications on the ambient conditions, in which natural ecosystems live. Evidences of such changes over the past decades have been collected and reported by IPCC AR4 (2008) and AR5 (2014). The average sea surface temperature increased, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased (AR5 2014: 4).

Particularly, the long residence time of greenhouse gases in the atmosphere implies that should humans stop emitting today, it will take several decades to re-establish the pre-industrial conditions to be re-established.

### 1.2.1 Mitigation and Adaptation Measures

The *United Nation Framework Convention on Climate Change* (UNFCCC) formalizes two climate actions to face global warming: (i) adaptation and (ii) mitigation. *Adaptation* is the re-action, devising strategies that will allow to adapt societies and environment to the new living conditions considering that the latter will occur and will persist for a long time. *Mitigation* is the preventive action addressing the reduction of GHG emissions, the primary cause of global warming.

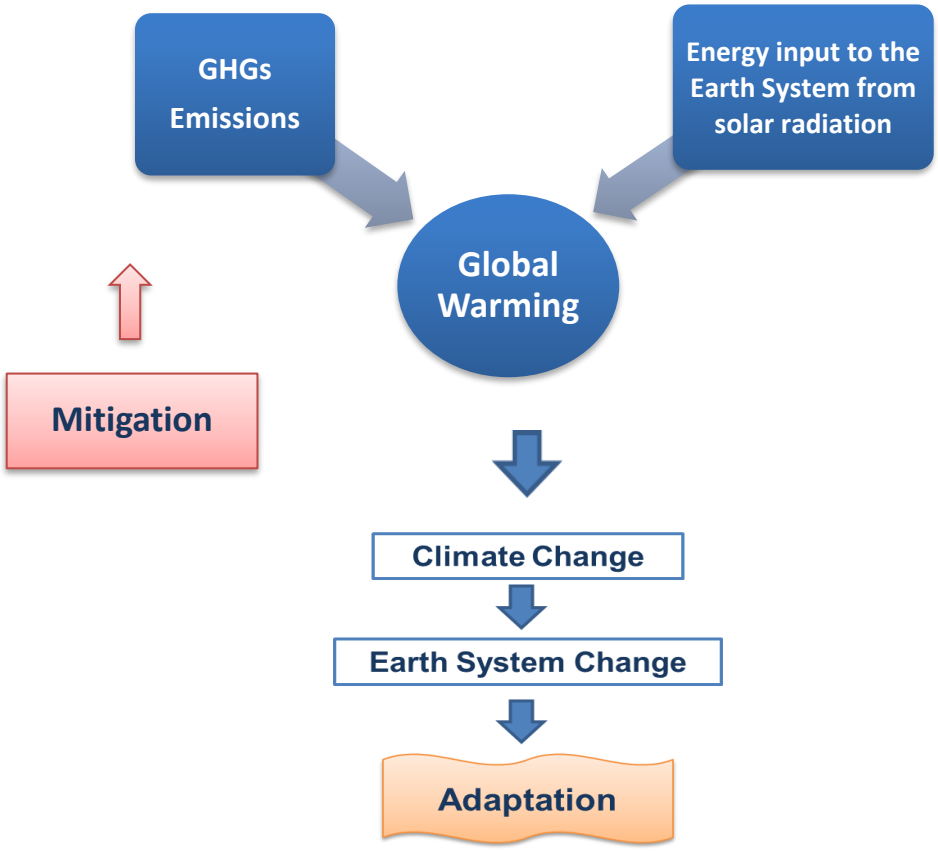
A clear definition of these measures is also provided by the IPCC in its Fourth Assessment Report:

***Mitigation*** refers to "technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce greenhouse gas emissions and enhance sinks" (IPCC, 2007: 84).

***Adaptation*** refers to "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive, private and public and autonomous and planned. Examples are raising river or coastal dikes, the substitution of more temperature-shock resistant plants for sensitive ones etc." (IPCC, 2007: 76).

On the basis of the above definitions, we sketched out the relationship between global warming, climate change, adaptation, mitigation (Figure 1).

**Figure 1:** The relationship between Global Warming, Climate Change and Adaptation and Mitigation




Although, so far adaptation and mitigation are considered as the major responses to tackle the problem of the global increasing temperatures and its effects, in the near future, such measures might be not sufficient to face the rapidly changing climate without catastrophic consequences.

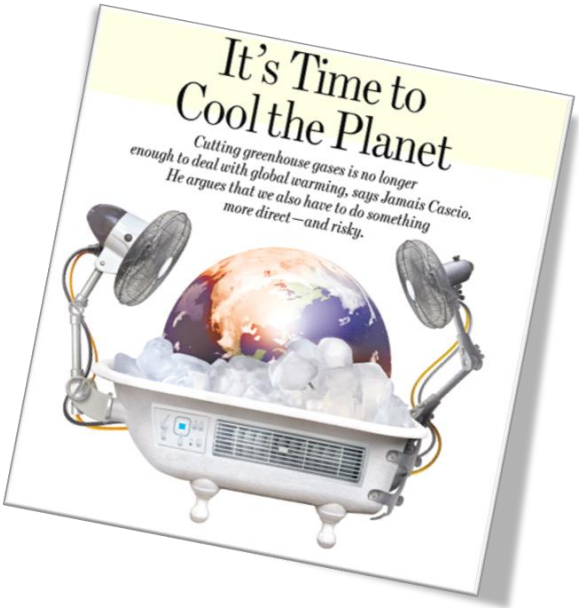
## 1.3 Geo-engineering: as a potential addition to the portfolio of climate response

Despite the efforts in reducing global greenhouse gas emissions, only limited progress has been achieved since the adoption of the Kyoto Protocol in 1992.

Scientists have been thinking of an alternative measure, called geo-engineering or climate engineering, which has the potential to be added to the portfolio of climate response.

Quoting Karen Scott (2013): "geo-engineering is qualitatively different from other mechanisms intended to mitigate or adapt to climate change. Geo-engineering technologies and techniques are designed to lower surface temperatures or deliberately alter the carbon cycle on a global scale; all states and all peoples are likely to be affected".

Therefore, geo-engineering encompasses a wide range of distinct technologies that can broadly be classified into solar radiation management, or carbon dioxide removal. The Royal Society defines them in the following manner:



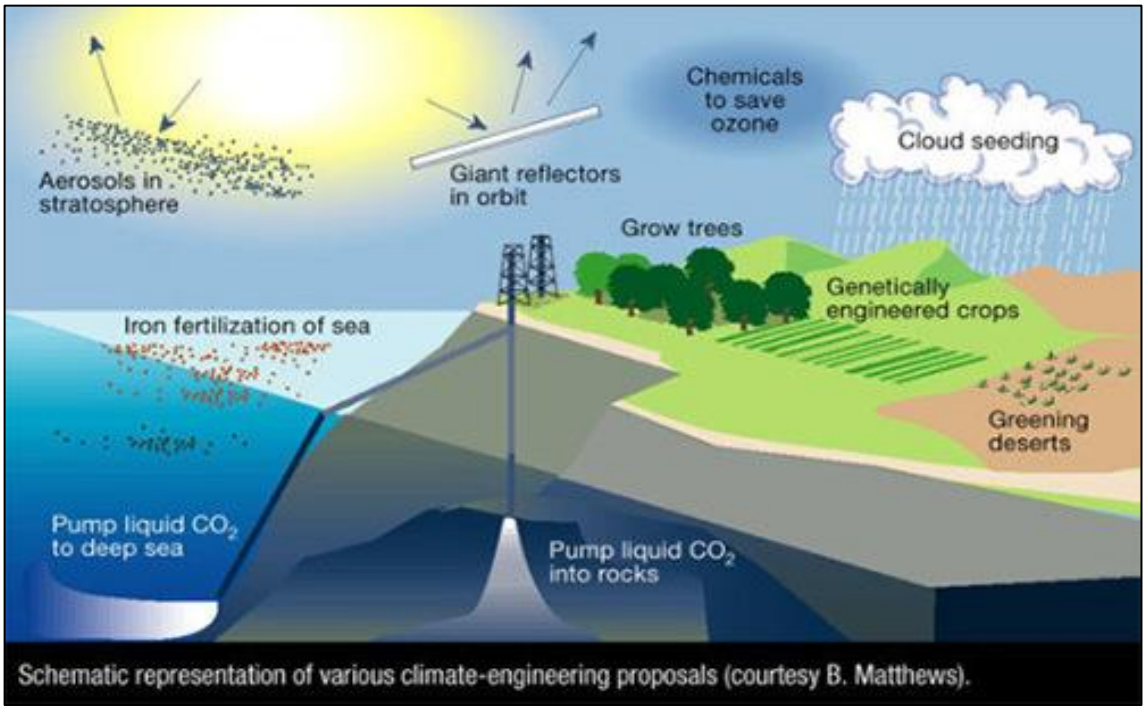

**Carbon dioxide removal (CDR)** addresses the root cause of climate change by removing greenhouse gases from the atmosphere (Royal Society, 2009).

**Solar radiation management** (**SRM)** attempts to offset effects of increased greenhouse gas concentrations by causing the Earth to absorb less solar radiation (Royal Society, 2009).

Despite the final aim of both methods to reduce the global warming, SRM and CDR differ in many aspects, concerning their deployments, effects and possible consequences as well as costs and feasibility. SRM methods include: albedo enhancement of urban and natural environments, and the oceans; stratospheric aerosol injections; marine cloud brightening; tropospheric cloud seeding; and the deflection of solar radiation using strategically placed mirror in space (Royal Society 2009). These techniques might be easy to implement and relatively cheap but quite risky: they could cause significant damages such as releasing of GHG into the atmosphere, changing weather patterns, changing rainfall etc.

CDR consists of the following techniques: chemical ocean fertilization; biological sequestration; enhanced weathering techniques; carbon capture and sequestration; oceanic upwelling and downwelling. These methods might demand more and global efforts but are less risky, even if the duration and the sequestration of CO2 in land and sea are so far mostly unknown. For these reasons SRM and CDR are clearly distinguished. Figure 2 provides a clear illustration of all the techniques explained above.

**Figure 2:** Geo-engineering methods




Bearing this in mind, one can easily notice that geo-engineering technologies have considerably evolved over the times. Originally conceived as a simple method for injecting CO2 into the ocean to reduce the atmospheric burden of this greenhouse gas (Marchetti 1977), today geo-engineering refers to a wide set of methods for voluntarily modifying the system at the large scale. Consequently, as geo-engineering discussions are taking place at national as well as international level, involving a great public, definitions of GE have increased in number and became more complex. Whether or not carbon capture and storage or other techniques are considered GE interventions is still controversial.

In this context, we find it useful and interesting to look at the different attempts of defining geo-engineering:

- **AR 4 of IPCC (2010***): Technological efforts to stabilize the climate system by direct intervention in the energy balance of the Earth for reducing global warming.*

- **Conference of Parties of Convention on Biological Diversity (decision X/33 of UN):** *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).*

- **Royal Society (2009):** *The deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change.*

- **Final Report EuTRACE (M. Lawrence *et al.* 2015)**[1]: *A collective term for a wide range of proposed techniques that could potentially be used to deliberately counteract climate change by either directly modifying the climate itself or by making targeted changes to the composition of the atmosphere, without seeking to reduce anthropogenic emissions of greenhouse gases or other warming agents.*

- **US National Academy of Sciences (1992)**[2]**:** *Large-scale engineering of our environment in order to combat or counteract the effects of changes in atmospheric chemistry.*

[1]Sources: Final report of the FP7 CSA project EuTRACE European Transdisciplinary Assessment of Climate Engineering Removing. Greenhouse Gases from the Atmosphere and Reflecting Sunlight away from Earth: The European Transdisciplinary Assessment of Climate Engineering (EuTRACE) Editors: Stefan Schäfer, Mark Lawrence, Harald Stelzer, Wanda Born, Sean Low.

[2] National Academy of Sciences: 1992, Policy Implications of Greenhouse Warming: Mitigation, Adaptation, and the Science Base, Panel on Policy Implications of Greenhouse Wanning, Committee
on Science, Engineering, and Public Policy, National Academy Press, Washington, DC, pp. 433-464.

In the light of the abovementioned definitions, we point out that *the scale* (large scale) and *the intent* (*deliberate intervention*) are key elements, common in each definition of geo-engineering. However, reaching an agreed understanding of the GE interventions is still an open-issue, due to the ambiguities embodied in the concept itself (not only technological and technical aspects but also socio-political), which pose complex challenges for appraisal.

A common and unanimous understanding of geo-engineering is of crucial importance for effective discussions, decisions and regulations at international, regional and national level. Also, a universal definition will be needed for the future governance of geo-engineering.

In what follows, we work out a legal concept proposal of geo-engineering with its associated parameters as well as an analysis of the legal and political framework related to the potential deployment of GE interventions.

## 1.4 Geo-engineering or Earth System engineering definition: what? how? why?

In view of drafting a broad legal concept proposal, we define GE with the *what, how* and *why*.

In general, we can define geo-engineering as:

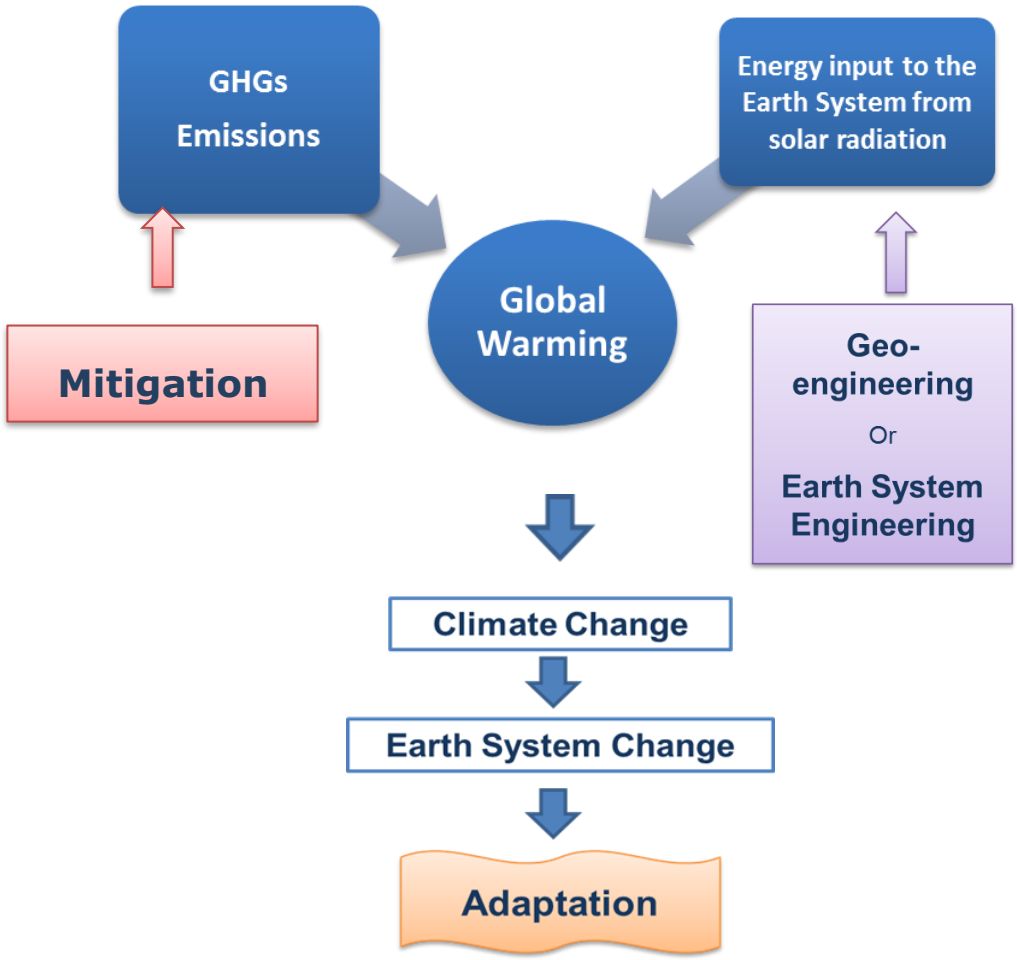
> ***the process through which humans voluntarily manipulate the energy input to the Earth System deploying climate impacting natural processes by means of available technologies.***

In line with the IPCC and the CBD, this definition focuses only on those GE technologies that might have a direct impact on the energy balance of the Earth system with the view of counteracting global warming and climate change. In other words, it includes solar radiation management methods but does not encompass other geo-engineering techniques.

Conceived in this manner, the idea and scope behind geo-engineering consists of reducing the input of solar energy into the Earth System so that temperatures can be kept under control. Such intervention could be realized either by seeding the upper atmospheric layers with reflecting aerosols that would prevent a portion of solar radiation to reach the ground or by deploying large mirrors in the outer space so that they can reflect back a portion of the sun light.

By looking at the portfolio of climate response measures, it can be argued that whereas *mitigation* addresses the reduction of GHG emissions and *adaptation* allows societies to adapt to the new living conditions produced by the changed environment, *actions of geo-engineering, climate engineering or Earth-System engineerin*g might be a third option to help managing the climate change, by lowering the global temperatures. Figure 3 illustrates all three actions and their respective interactions with the causes and the effects on global warming and climate change.

**Figure 3:** The relationship between Global Warming, Climate Change and Adaptation, Mitigation and Geo engineering




Geo-engineering applications are very broad in nature. As such a series of indicators are needed in order to distinguish them from other kind of human-induced actions. The identification of a set of parameters is of fundamental importance since they would be able to better characterize the concept itself.

## 1.5 Geo-engineering: dilemma and challenges

Geo-engineering proposals represent an interesting case study for assessing the extent, the limits and the possibilities of the existing international environmental law.

Due to the high degree of uncertainties surrounding GE methods, the potential hazards posed by their deployment are many and serious. Geo-engineering actions create a risk of grave harm to the transboundary and global environment, with potentially negative unknown economic and social impacts.

As David Victor (2008) argued, geo-engineering has the potential to change the politics of the climate problem. Unlike other kind of measures, GE technologies could potentially be implemented unilaterally by a small number of States or even by a single State pursuing what it considers being the best interests of the parties involved. Thus, by allowing States to deploy GE technologies on global commons, (e.g. the high seas, atmosphere, or outer space), the risk of carrying out local and unilateral actions with global impacts is one of the main concerns raised by geo-engineering that need to be tackled and governed.

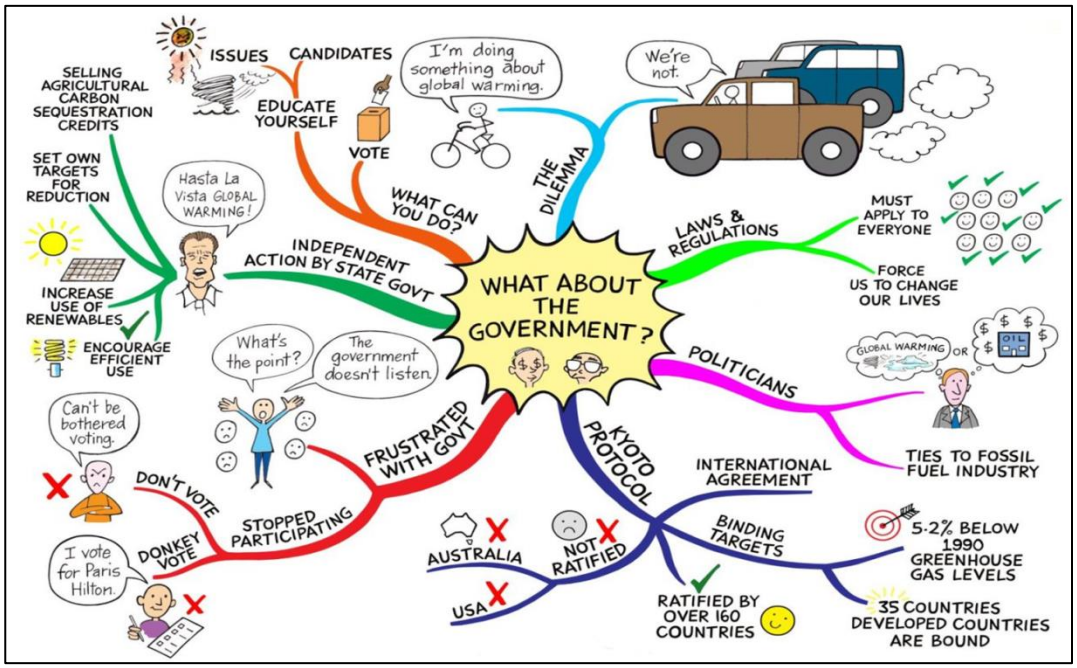
So geo-engineering, a controversial issue with technically viable and possible options which could encourage public as well as private actors to start GE projects, should be considered under the following dilemma:

- We know how to do it and we may have the means to do it, but the consequences might go beyond our prediction capabilities and side-effects might remain unknown. Important interconnections exist among the various Earth System compartments (biosphere, hydrosphere, atmosphere, cryosphere, geosphere), and it remains so far unclear how such a drastic intervention could produce negative effects and how those could cascade down in the various parts of the system.
- Over the past 100 years the global temperature has increased 0.8 °C and consequences are observed (increased frequency and intensity of storms or in general extreme weather events, ice caps and glaciers melting, migration of species, destruction of bio-diversity). What would be the conditions should we reach the 2 °C increase in 30 to 50 years or if we would reach 4°C? Those uncertainties would be overruled and most likely an attempt could be made to prevent an extinction.
- a geo-engineering action could be taken unilaterally as escape-valve by few countries. Should it be discussed by an international assembly? Under what conditions should the action take place, when, how and by whom? The picture below (figure 4) ironically illustrates the legal and political side and demonstrate that the geo-engineering governance is not a one-dimensional challenge, but rather a multi-dimensional and complex one.

So far, there are no legally binding international instruments that explicitly rule geo-engineering applications. Nonetheless, as advocated by scholars like R. Bodle (2010), certain general rules and principles of international law are applicable to govern some aspects of geo-engineering.

Thereto, a detailed analysis of the most relevant environment-related treaties so far adopted at international and regional level is needed with the view to identify and assess the existing gaps as well as the possibilities for future governance on geo-engineering within the existing legal framework.

**Figure 4:** The political and legal dilemma of geo-engineering



# 2 Methodology

## 2.1 Purpose of the work and method

This study has two purposes: i) drafting a legal concept proposal of geo-engineering; and ii) mapping the legal and political constraints within the existing international environmental law related to potential use of GE technologies.

A definition for GE interventions requires also the identification of a series of indicators, called parameters, which might help to reach a common understanding of the concept itself and to distinguish geo-engineering from other interventions on the environment.

The parameters allow us to carry out a first screening and analysis of the most relevant legal and political documents so far adopted at international and regional level, which could be able to rule geo-engineering. By using the *UN Treaty Collection Database*, treaties, conventions and protocols protecting the environment, the sea and the outer space were screened and confronted with the parameters set in the definition of geo-engineering.

The entire research has been conducted in a qualitative way. For the qualitative comparison of the presence of each parameter in the environmental laws we used the following quality assessment criteria: high, medium and law (defined in section section2.5).

## 2.2 Identification of parameters on geo-engineering of section 1.4

Bearing in mind the definition abovementioned, it is possible to identify the following elements as the defining parameters of geo-engineering:

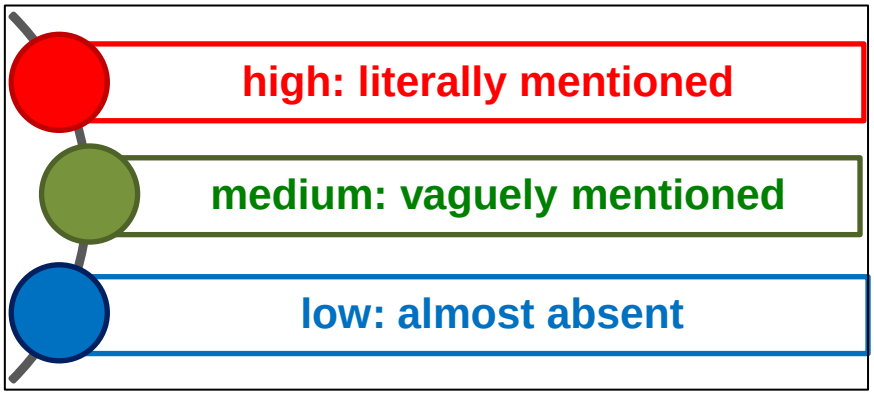
- ***Earth System***: including biosphere, hydrosphere, atmosphere, geosphere, cryosphere. Since GE activities might modify the climate, this could cause serious consequences on all the other subsystems of the Earth System due to the high level of interconnections that exist among them;
- ***Intent***: any action is intentional as far as it aims at to achieving a specific objective. Accordingly, GE technologies are intentionally designed to manipulate the energy input of the Earth System;
- ***Technological means***: GE interventions can be deployed by means of available technological measures and techniques;
- ***Scale***: the geographical extent of the deployed actions. Geo-engineering interventions are intended for changing the climate, which is only addressed for large areas or for the globe. At least large scale, deployment rather than local application is envisaged;
- ***Risk of irreversibility***: a process that could not be reversible. Even though GE interventions could be stopped at relatively short notice, it remains unknown both how long their side effects would last.

Hence, for the scope of the present study, these five parameters are considered as the key markers of geo-engineering, or climate engineering or Earth System-engineering. These will allow us in the next part to analyze, screen and confront the existing environmental norms.

## 2.3 Assessment criteria to value the presence of the parameters

As explained in the figure 5, the high value marked by the red color refers to those parameters that are literally mentioned in the legal documents; the medium value in green regards the parameters only vaguely mentioned and the low value in blue if they are almost absent in the legal document or only partly covered.

**Figure 5:** Explanation of the quality assessment criteria




## 2.4 Research Questions

Finally, the research questions addressed in the study are the following:

- *What is geo-engineering?*
- *Which parameters do we need to better conceptualize the definition itself?*
- *What are the international treaties of interest for the analysis?*
- *To what extent is a treaty relevant in terms of universality?*
- *To what extent does the existing environmental legal framework cover the defining parameters?*

In a first attempt to answer to these questions, this report contributes with the available descriptions of geo-engineering discussed in a multidisciplinary way with climatologists, engineers and socio-political scientists.

# 3 Assessment of the existing environmental legal and political framework

## 3.1 Overview

Before entering in the core of the legal and political study of geo-engineering, it is worth recalling here the two leading questions of this section:

- *To what extent are the defining parameters covered by the existing environmental legal framework?*
- *To what extent is a treaty relevant in terms of universality?*

The first question aims at understanding both: i) to what extent the parameters set in the definition of geo-engineering (mentioned above) are embodied by the legal documents in exam; and ii) how many of them are mentioned by each treaty. Therefore, it implies to carry out a quality analysis, based on the following assessment criteria defined in section 2.

The second question takes into account the relevance of each legal instrument analyzed. Its scope is to know the degree of inclusiveness of a treaty, protocol or convention (e.g. universal or a regional membership), by looking at the number of countries that have ratified it. Knowing that there are 193 Countries Members of United Nations[3], this number represents the maximum reference point for the treaties adopted by the UN.

Therefore, the legal and political documents analyzed are the following:

- The Outer Space Treaty (1967)
- The Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) (1977)
- The Convention on Long-Range Transboundary Air Pollution (CLRTAP) (1979)
- The United Nations Convention on the Law of the Sea (UNCLOS) (1982)
- The Vienna Convention for the Protection of the Ozone Layer (1985)
- The Montreal Protocol on Substances that Deplete the Ozone Layer (1987)
- The Protocol on Environmental Protection to the Antarctic Treaty (1991)
- The Convention on Environmental Impact Assessment in a Transboundary Context (Espoo) (1991)
- The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) (1992)
- The United Nations Framework Conventions on Climate Change (UNFCC) (1992)
- The United Nations Convention on Biological Diversity (1992)
- The Rio Declaration on the Environment and Development (1992)
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention, 1972) and London Protocol (1996)
- The Kyoto Protocol (1997)
- Resolution LP.4(8) (2013) LC 35/15 on the amendment to the London Protocol to regulate the placement of matter for ocean fertilization and other marine geo-engineering activities
- Convention on Biological Diversity – Decision X/16 on Biodiversity and Climate Change, Ninth meeting Bonn (19–30 May 2008)
- Convention on Biological Diversity – Decision X/33 on Biodiversity and Climate Change, Tenth meeting Nagoya, Japan (18-29 October 2010)

As far as the process of analysis is concerned, the table below provides an example of the manner in which the defining parameters were evaluated and the legal documents were ranked according to the assessment criteria.

[3] More information about the UN Member States are available at http://www.un.org/en/members/

**Table 1:** Comparison between the UNFCCC and CLARTAP

| | **Universality** | **Earth System** | **Intent** |
|---|---|---|---|
| **UNFCCC 1992** | **196/193** | **5/5** | ***Art 3*** **Adoption of polices and measures to protect the climate system against human-induced changed** |
| **CLRTAP 1979** | **51** | **1/5** **Atmosphere** | ***Art 2*** **Parties shall endeavor to limit and, as far as possible, gradually reduce and prevent air pollution including** **long-range transboundary** **air pollution** |

Accordingly, if we look at the ***UNFCCC*** and ***CLRTAP*** and we focus on their respective intent/scope, we can observe that Art. 3 of the UNFCCC requires to the States Parties to *adopt policies and measures to actively protect the climate system against human induced changed*. While Art. 2 of the LRTAP Convention requires Parties to *limit, reduce and prevent as far as possible air pollution*. As a result, by comparing these articles, we can conclude that the scope of the UNFCCC is of high value, marked in red, since it greatly covers the parameter, *the intent*, set in the definition of geo-engineering. Whereas the LRTAP Convention is of low value, highlighted in blue, since it is only partly related to the intent of Geo-engineering interventions. Additionally, having a broader mandate, the UNFCCC embraces the five elements of the Earth System, insomuch as the protection of the climate system is connected with to all natural systems. Finally, the UNFCCC has nearly a universal membership, including all the UN Members and even more, while the CLRTAP is a regional treaty (UNECE Members only).

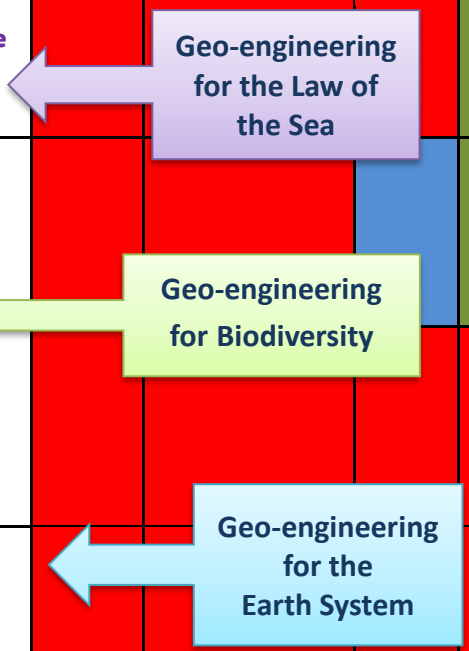
This example aimed to explain the entire process that has been carried out for the five parameters in all analyzed legal documents. For a comprehensive table, we refer to Annex I in which the most pertinent and relevant articles of each legal and political instrument listed above are mentioned.

Hereafter, the research findings are summarized in table 2, which includes the universality and the parameters, ordered according to their degree of importance. It has been chosen to sketch out the final results by coloring the table's boxes on the basis of the assessment criteria in order to a have a global overview. In fact the clear insight of Annex I facilitates not only the understanding of the single treaty but also their inter-comparison.

**Table 2**: Final Findings

| | Universality | Earth System | Intent | Technological means | Scale | Risk of irreversibility |
|---|---|---|---|---|---|---|
| **Vienna Convention** | **197/193** | **Atmosphere** | | | | |
| **Montreal Protocol** | **197/193** | **Atmosphere** | | | | |
| **UNFCCC** | **196/193** | **5/5** | | | | |
| **CBD** | **196/193** | **Biosphere**<br>**Hydrosphere**<br>**Geosphere** | | | | |
| **Kyoto Protocol** | **192/193** | **Atmosphere** | | | | |
| **UNCLOS** | **167/193** | **Hydrosphere**<br>**Cryosphere** | | | | |
| **The Outer Space Treaty** | **103/193** | **Atmosphere** | | | | |
| **London Convention** | **85** | **Hydrosphere** | | | | |
| **ENMOD** | **77** | **5/5** | | | | |
| **CLRTAP** | **51** | **Atmosphere** | | | | |

| | Universality | Earth System | Intent | Technological means | Scale | Risk of irreversibility |
|---|---|---|---|---|---|---|
| **London Protocol** | 51 | Hydrosphere | | | | |
| **The Espoo Convention** | 45 | 5/5 | | | | |
| **Protocol to the Antarctic Treaty** | 33 | Cryosphere Hydrosphere | | | | |
| **The Ospar Convention** | 16 | Hydrosphere | | | | |
| **Resolution LP.4(8) 2013** | Not legally binding | Hydrosphere | | | | |
| **CBD COP 2008 IX16, Biodiversity and CC** | Not legally binding | 5/5 | | | | |
| **CBD COP 2010 X/33, Biodiversity and CC** | Not legally binding | 5/5 | | | | |
| **Rio Declaration** | Not legally binding | 5/5 | | | | |




## 3.2 General Discussion

As already mentioned, not all the treaties in exam have as main aim the protection of the climate system. However, it is interesting to note that they are still related to it insofar as their mandate is still related to the protection of the biodiversity, the outer space, the sea, the atmosphere, the environment. Therefore, they might offer important avenue for future governance on geo-engineering.

In the light of this, by looking at the table above, one can easily recognize that all the documents highly cover at least two parameters: these are the scale and the technological means. Particularly, almost all of them have a global scope (e.g. the protection of the high seas) and strongly recommend the development and the exchange of information on scientific, technical and technological measures.

One multilateral agreement that might have specific but limited application to the realm of geo-engineering is the ***ENMOND Convention***, the only that directly tackles intentional climate interventions by human beings. It prohibits to its Parties "to engage in military or any hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction [...] (Art. 2). Accordingly, this convention would only apply directly to geo-engineering technologies if they were used as weapons to manipulate the weather or for other hidden purposes. Besides, the narrow number of the States Parties together with the lack of enforcement mechanisms makes the ENMOND a less know and "dormant" Convention.

As far as the safeguard of the sea is concerned, two conventions are remarkable, notably the ***UNCLOS*** and the ***London Convention*** with its related ***Protocol*** (LP/LC). With almost universal membership, the UNCLOS establishes clear obligations and aims at protecting and preserving the marine environment as well as at ruling the deployment of scientific research. These cannot undermine and unjustifiably interfere with other legitimate uses of the sea. These must use appropriate scientific methods and means and be exercised with due regard for the interests of other States (Art 143). Also, the London Convention and its Protocol deal with the issue of marine pollution, by prohibiting the dumping of wastes and other matters at the sea. Nevertheless, while their mandate is considered of low value (only partly related to the main intent of GE as conceived in this study), both UNCLOS and LC/LP leave room for ruling the emerging activities concerning marine geo-engineering. In addition to them, also the ***Ospar Convention*** and the ***Antarctic treaty*** may be relevant for the geo-interventions carried out respectively in the North-East Atlantic and in the Antarctic area, since they both have a regional scope of application.

The ***Vienna Convention***, the ***Montreal Protocol*** and the ***Outer Space Treaty*** are the main relevant treaties for ruling atmospheric proposals from an international law perspective. Since a number of existing technologies might be deployed into the atmosphere or in the outer space, the obligations posed by these treaties aim at protecting the environment from potential dangerous consequences. Particularly, the Vienna Convention and its related Protocol requires Parties to reduce as far as possible *activities that would cause harm to the environment due to the modification of the ozone layer* (Art. 2). While, the Outer Space sets out a framework to regulate the access, the usage and the exploration of the outer space. In fact, being this latter "a province of all mankind", activities, projects or research *shall be carried out for the benefit and in the interests of all countries* (Art. 1). Despite their potentiality to govern the deployment of GE technologies, these treaties provide only general rules and obligations. Furthermore, their mandate is not specific enough to greatly cover the five geo-engineering parameters, thus considered of low value for the scope of this study.

Among the legal instruments listed in the table 2, particular attention should be given to the ***Resolution LP 4(8) 2013*** and **the Decisions X/16** and **X/33**, recently adopted by the Parties of the LC/LP and of the Convention on Biological Diversity. Indeed, the content of these documents is extremely important since these documents directly addresses and discusses geo-engineering technologies, their potential deployments and effects. Regulating the dumping of material for ocean fertilization or other marine geo-engineering activities is the core issue of the ***Resolution LP.4 (8) (2013) LC 35/15 on the amendment to the London Protocol***. It provides a broad definition of "marine geo-engineering" which is not limited to ocean fertilization; rather it refers to any *deliberate intervention in the marine environment to manipulate natural processes, including those counteracting anthropogenic climate change and or its impacts* (LC 35/15Annex 4, p. 3). The Resolution also recognizes the relevance and the need to adopt a general assessment framework for marine geo-engineering activities. Notably, it requires Parties to use utmost caution in evaluating any proposal and its potential consequences and to provide a detailed description of the proposed dumping activity - including its purpose and covering all stages, a notification of "potentially affected countries and relevant regional intergovernmental agreements and arrangements", a consultation plan, the assessment of the exposure effects, risk characterization and management risks and the identification of a monitoring regime (Resolution LP.4 (8) 2013).

## 3.3 Discussion for the legal documents mentioning geo-engineering

As far as the Decisions X/16 and X/33 are concerned, they both were adopted by the *Conference of the Parties* (COP) of the CBD in 2008 and 2010 with the aim to go beyond ocean fertilization method, rather broadly addressing geo-engineering. Also called the *CBD geo-engineering decisions*, they appear to be the all-encompassing governance measures at this level to date (CBD COP10).

***Decision X/16 on Biodiversity and Climate Change*** requires Parties: *to ensure that ocean fertilization activities do not take place until there is an adequate scientific basis on which to justify such activities, including assessing associated risks, and a global, transparent and effective control and regulatory mechanism is in place for these activities; with the exception of a small scale scientific research studies within coastal waters* (UNEP/CBD/COP/DEC/IX/16 p. 7). In line and consistent with this statement, ***Decision X/33 on Biodiversity and Climate Change*** invites Parties to consider that*: no climate-related geo-engineering activities that may affect biodiversity take place, until there is an adequate scientific basis on which to justify such activities and appropriate consideration of the associated risks for the environment and biodiversity and associated social, economic and cultural impacts, with the exception of small scale scientific research studies*. It is interesting to note that while both decisions seem to establish a moratorium on geo-engineering, they however allow for an exception for controlled scientific activities tacking place on a smaller scale. Additionally, such interventions need to be subject to an accurate analysis about the potential risk for the environment and the related effects at economic, ethical, social and political level.

Although the CBD geo-engineering decisions as well as the LC/LP Resolution 4(8) are important for the global governance of geo-engineering, they do not impose any obligations to the Parties. While the content of these instruments is highly persuasive, they are not legally binding: the lack of enforcement mechanisms makes them only politically relevant statements, without establishing rules, provisions and principles for geo-engineering.

Here, it is worth considering another not legally binding yet suitable instrument for the governance of geo-engineering that is the ***Rio Declaration on Environment and Development.*** In its principle 7, the Declaration invites States to *cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem* (Rio 1992). By strongly recommending to preserve the life on and of our Planet, it could be assumed that the Rio Declaration embraces in a general way the realm of geo-engineering.

## 3.4 Concluding remarks

Coming back to the table 2 and looking more carefully at the red boxes (high value), among the legally binding instruments, we can notice that the ***UNFCCC*** and ***CBD*** are the only treaties which cover almost all the five selected parameters. Besides, in terms of membership, they are almost universal with 196 State Parties (all the UN Members and more).

From legal point of view, they are considered as the most comprehensive regulatory instruments adopted by the international community in response to the challenge of global warming and its potential effects on the natural ecosystems. Identifying climate change and the protection of the biodiversity and as a "common concerns of mankind", the UNFCCC and the CBD set out a very general framework into which all efforts to protect the Earth System can be taken up.

So, on the basis of the proposed legal concept of geo-engineering and the selected parameters, it could be argued that both treaties contain many provisions that could be relevant even if not specific to geo-engineering. In fact, although their scope concerns the stabilization of GHGs emission and the protection of the biological diversity, however the UNFCCC and the CBD have the potentiality to cover the intent of GE interventions. Specifically, Art 2 of the UNFCC strongly embraces the main goal of geo-engineering, by recommending to its Parties *the adoption of polices and measures to protect the climate system against human-induced changed*. As remarked by the EuTrace 2015 report, the potential role of CBD in the regulation of GE technologies is instead to identify "normative categories and procedures by which the potential effects

of climate engineering on biodiversity can be monitored, assessed, and evaluated, as well as establishing limits, which may not be exceeded, for the reduction or loss of biological diversity" (EuTrace 2015: 88). In order to achieve their main goal, both treaties suggest and encourage the transfer, the exchange and the development of new technologies, covering as a result another distinct element of GE-definition: the usage of technological measures. Both the UNFCCC and the CBD indirectly encompass in their content the most difficult and controversial parameter to identify and evaluate in the existing environmental law, notably the risk of irreversibility. Accordingly, they recognized the need to assess the effects and impacts of any kind of measures that could be dangerous for the global environment. To this end, special attention should be given to *the precautionary principle* mentioned by Art 3 of the UNFCCC:

> [...] *The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, the lack of full scientific certainty should not be used as a reason for postponing such measures* [...].

While this principle could legitimize the potential deployment of geo-engineering interventions, yet its role in the allowing or prohibiting them remains ambiguous. Consequently, it raises a real debate, involving scholars, scientist and lawyer with opposite opinions and concerns. In fact, on one hand looking at the risks and the hidden sides of geo-engineering, the precautionary principle could be considered as an argument against it due to its unclear and unpredictable consequences. On the other hand, looking at the risks posed by climate change, at the limited progress in reducing emissions, the precautionary principle could be used to call for and legitimize further geo-enegineering research. In that sense, the precautionary principle embodies the core arguments both for and against geo-engineering.

In a similar way, the preamble of the CBD presents the same ambiguities related the precautionary principle:

> [...] *Noting that it is vital to anticipate, prevent and attack the causes of significant reduction or loss of biological diversity at source, noting also that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat* [...].

These eighth and ninth recitals of the preamble cannot be interpreted as either prohibiting or authorizing geo-engineering activities.

In conclusion, it could be assumed that, among all the legal and document here analyzed, the UNFCCC and the CBD seems to be the most promising avenue for the governance of geo-engineering. They might offer the basis to include a future GE regulation. Nevertheless, the mandate of both treaties is broad enough to allow geo-engineering intervention but without imposing clear rules to govern it. The State Parties to these treaties are constrained by their obligations to act with precaution, to prevent serious harm and pollution, to cooperate in connection with information exchange and carry out environmental impact assessments, and to act with due regard to other States. Nevertheless, these basic environmental principles are not sufficient to properly govern the deployment, the impacts and the effects of GE-technologies.

The lack of a regulatory mechanism together with all the uncertainties related to the deployment of geo-engineering interventions is the major gap of the existing international environmental law.

# 4 Conclusions: What provisions do we need for the future?

This report focused on geo-engineering intervention as new potential policy response to the increasing threat of global warming and the consequent climate change.

Such interventions aiming at modifying the energy balance of the Earth systems raise important governance issues. The GE technologies could be quick fixes with global effects; could be deployed by a single actor or a small group of actors; and could have different impacts on the different regions of the world. In relation to the precautionary principal, geo-engineering could be considered as a valid and attractive option due to its potential to counteract global warming and to reduce harm to humans and the environment.

As many scholars such as J. Reynolds or Y. Bodansky pointed out, geo-engineering is especially challenging because it presents many and controversial dynamics for the international environmental law and its related principles:

- *Prevention Vs. deterioration*: geo-engineering technologies could both prevent and cause environmental harm;
- *State Responsibilities Vs. States Sovereignty*: states have to act with due diligence in order to minimize transboundary environmental effects and to balance States' interests, benefits and risks. However at the same time, States' Sovereignty allows them to govern their people and to manage their resources within their territory, as they deem appropriate, provided that such actions do not harm other countries (Rio Declaration Principle 2).
- *Geo-engineering Vs. Mitigation:* with the risk to be considered as a less costly substitute of the mitigation option, geo-engineering might reduce the incentive for States to engage in mitigation and adaptation efforts. This is the so-called "moral hazard" raised by GE technologies, which may divert the will of States', private actors' and big companies' away from GHGs emission reductions.

In the near future the potential deployment of GE interventions may constitute a critical threat to the global environment, and call for a science-based and transparent, control regulatory mechanism.

The existing international treaties do not explicitly cover the intent, the scope and the effects of geo-engineering nor do they establish clear obligations about the potential usage of environmentally sound technologies. They are incomplete to govern geo-engineering.

Open questions remain:

- ❖ What should be the limits or the conditions to allow or prohibit the deployment of geo-engineering activities?
- ❖ Who is entitled to decide?
- ❖ How to solve the existing gaps of the international environment-related law? How should it be improved?
- ❖ Duty to inform other states prior to conducing geo-engineering activities, rules for the decision-making, public participation…Should these aspects be taken into account in a new regulation about geo-engineering?

So, governing geo-engineering requires a multi-dimensional approach and the proposal for a new legal regulatory mechanism that provides decision-making rules and institutions. The latter cove many different tasks, among others: i) developing norms to guide scientific research; ii) allocating jurisdiction among states to regulate individuals; iii) elaborating rules that constrain state behavior; vi) establishing procedures to set out a system of compensation as well as to limit conflict among States.

To appropriately judge on whether a geo-engineering project, the decision-maker should consider what the best solution is for the humankind and for the Earth system itself. Hence, the ultimate question or dilemma we face is: *should we bear the risk of harm from the climate modification technique or the risk of harm from climate change?*

It is evident this study reveals the tip of an iceberg and invites for further researches towards new governance for the deployment of geo-engineering actions.

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The Outer Space Treaty, 1967

United Nations Convention on Biological Diversity, 1992;

United Nations Convention on the Law of the Sea (UNCLOS), 1982

United Nations Framework Conventions on Climate Change (UNFCC), 1992

Vienna Convention for the Protection of the Ozone Layer (1985)

## List of abbreviations and definitions

AR4: Fourth Assessment Report IPCC

AR5: Fifth Assessment Report IPCC

CBD: Convention on Biological Diversity

CDR: Carbon Dioxide Removal

CLRTAP: Convention on Long-Range Trans-boundary Air Pollution

CO2: Carbon dioxide

COP: Conference of the Parties COP

ENMOND: Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques

GHGs: Greenhouse gases

IPCC Intergovernmental Panel on Climate Change

IPCC Intergovernmental Panel on Climate Change

OSPAR: Convention for the Protection of the Marine Environment of the North-East Atlantic

SRM: Solar Radiation Management

UNCLOS: The United Nations Convention on the Law of the Sea

UNECE: United Nations Economic Commission for Europe

UNFCCC: United Nations Framework Convention on Climate Change.

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## Annexes

**Annex 1.**

| | Universality<br>n° Parties | Earth System | Intent | Technological means | Scale | Risk of<br>Irreversibility |
|---|---|---|---|---|---|---|
| **Vienna Convention for the protection of Ozone Layer<br>1985** | **197/193** | **1/5<br>Atmosphere** | **Art 2.1<br>Parties…shall take appropriate measures to protect human health and the environment against adverse effects resulting… from human activities which modify or are likely to modify the ozone layer** | **Art 1<br>Alternative technologies or equipment" means technologies or equipment the use of which makes it possible to reduce or effectively eliminate emissions of substances which have or are likely to have adverse effects on the ozone layer.** | **Art 2.1<br>Parties…shall take appropriate measures to protect human health and the environment from human activities which modify or are likely to modify the ozone layer** | **Art 2.2 (b)<br>reduce or prevent human activities under their<br>jurisdiction or control should it be found that these activities<br>have or are likely to have adverse effects resulting from<br>modification or likely modification of the ozone layer** |
| **The Montreal Protocol** | **197/193** | **1/5<br>Atmosphere** | **Determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of** | **Article 9:<br>The Parties shall co-operate, […] , in promoting research, development and exchange of information on: (a) best technologies for improving the containment, recovery,** | **Recognizing that world-wide emissions of certain substances can<br>significantly deplete and otherwise modify the ozone layer<br>Determined to protect** | **Art 6<br>The Parties shall assess the control measures** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **1987** | | | **substances that deplete it** | **recycling, or destruction of controlled substances or otherwise reducing their emissions; (b) possible alternatives to controlled substances** | **the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it** | |
| **UNFCCC 1992** | **196/193** | **5/5** | **Art 3**<br>**The Parties have a right to, and should, promote sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each Party** | **Art 4**<br>**(c) Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases** | **Art 2**<br>**avoid dangerous anthropogenic interference in the climate system**<br>**Art 4**<br>**All Parties shall: Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change** | **Art 3**<br>**Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures….**<br>**(Precautionary principle pro or cons Geo?)** |
| **Convention On Biological Diversity**<br>1992 | **196/193** | **3/5**<br>**Biosphere**<br>**Hydrosphere** | **Art 1**<br>**The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological** | **Art 16**<br>**Each Contracting Party, […], undertakes to provide and/or facilitate access for and transfer to other Contracting Parties of technologies that are relevant to the** | **See Art 4 and 5**<br>**Each Contracting Party shall […] cooperate in respect of areas beyond national jurisdiction** | **Art 14**<br>**Each Contracting Party, as far as possible and as appropriate, shall: (a) Introduce appropriate procedures requiring environmental impact assessment of its** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | **Geosphere** | **diversity, the sustainable use of its components** | **conservation and sustainable use of biological diversity or make use of genetic resources and do not cause significant damage to the environment** | **and on other matters of mutual interest, for the conservation and sustainable use of biological diversity** | **proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimizing such effect** |
| **The Kyoto Protocol** to the UNFCCC 1997 | **192/193** | **1/5 Atmosphere** | **Art 3 (4):** **The Conference of the Parties [...] shall [...] decide upon modalities, rules and guidelines as to how, and which, additional human-induced activities related to changes in greenhouse gas emissions [...] shall be added to the assigned amounts** | **Art 2 a (iv):** **Research on, and promotion, development and increased use of, new and renewable forms of energy, of carbon dioxide sequestration technologies and of advanced and innovative environmentally sound technologies** **(See also art 10)** | **Art 2** **1. Each Party included in Annex I, in achieving its quantified emission limitation and reduction commitments under Article 3, in order to promote sustainable development, shall:** [...] **strive to implement policies and measures under this Article in such a way as to minimize adverse effects, including the adverse effects of climate change** | **Art 3.14** **The COP shall, consider what actions are necessary to minimize the adverse effects of climate change and/or the impacts of response measures [...]** **See also Art 2 (4) and 13.4** |
| UN Convention on the Law of | | **2/5** | **Article 192** **States have the obligation to protect and preserve the** | **Art. 266** | **Art 145** | **See art 195 and 204 and** |

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| the Sea<br>**UNCLOS**<br>1982 | **167/193** | **Hydrosphere**<br>**Cryosphere** | **marine environment.**<br>**Art 87**<br>**The high seas are open to all States, whether coastal or land-locked. It comprises [...] freedom of scientific research** | **States shall cooperate to promote the development and transfer of marine technology** | **Necessary measures shall be taken to ensure effective protection for the marine environment** | **206:**<br>**State shall, as far as practicable, assess the potential effects of such activities on the marine environment [...]** |
| **The Outer Space Treaty 1967**<br>*Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* | **103/193** | **Atmosphere** | **Art 1**<br>**[...] There shall be freedom of scientific investigation in outer space, including the Moon and other celestial bodies** | **Art 4:**<br>**[...] the use of any equipment or facility necessary for peaceful exploration of the Moon and other celestial bodies shall also not be prohibited.** | **Art 3**<br>**States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies** | **Art 9**<br>**States Parties shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose** |
| | | | **Art 1** | **Art 2** | | |

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| **London Convention** 1972 | **85** | **1/5**<br>**Hydrosphere** | **Contracting Parties shall individually and collectively promote the effective control of all sources of pollution of the marine environment, and pledge themselves especially to take all practicable steps to prevent the pollution of the sea by the dumping of waste and other matter**<br><br>**Dumping Definition: as any deliberate disposal….** | **Contracting Parties shall [...] take effective measures individually, according to their scientific, technical and economic capabilities, and collectively to prevent marine pollution** | **Art 1**<br>**Contracting Parties shall individually and collectively promote the effective control of all sources of pollution of the marine environment [...]** | |
| **ENMOD 1977** | **77** | **5/5** | **Art. 2**<br>**[..] through the deliberate manipulation of natural processes –**<br>**Art. 3 1.**<br>**The provisions of this Convention shall not hinder the use of environmental modification techniques for peaceful purposes ...** | **Art. 2**<br>**The term "environmental modification techniques" refers to any technique for changing the dynamics, composition or structure of the Earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space.** | **Art. 1**<br>**1. Each State parties undertakes not to engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effect [...]** | |
| The Geneva | | | **Art 2**<br>**Parties [...]** | **Art 7**<br>**{..} Development of: (a)** | **Art 2:**<br>**[...] to protect man and** | **Art 7**<br>**The Contracting** |

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| Convention on Long-range Trans-boundary Air Pollution<br><br>**CLRTP 1979** | **51**<br><br>**Regional Treaty** | **1/5**<br><br>**Atmosphere** | **shall endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution** | **existing and proposed technologies for reducing emissions [...]**<br><br>**Art 4:**<br><br>**{..} Policies, scientific activities and technical measures aimed at combating air pollutants...** | **his environment against air pollution and shall endeavor to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution** | **Parties,shall initiate the development of**<br><br>**The economic, social and environmental assessment of alternative measures for**<br><br>**attaining environmental objectives including the reduction of long-range transboundary air pollution;** |
| **London Protocol**<br><br>2006 | **45** | **1/5**<br><br>**Hydrosphere** | **Art 2**<br><br>**Contracting Parties shall individually and collectively protect and preserve the marine environment from all sources of pollution and take effective measures, reduce and where practicable eliminate pollution caused by dumping or incineration at sea of wastes or other matter.** | **Art 13**<br><br>**.3 information and technical co-operation relating to waste minimization**<br><br>**.4 and to the disposal and treatment of waste and other measures**<br><br>**.5 access to and transfer of environmentally sound technologies and corresponding know how,**<br><br>**Art 14**<br><br>**1 Contracting Parties shall take appropriate measures to promote and facilitate scientific and technical research on the prevention, reduction and where practicable** | **Art 2**<br><br>**Contracting Parties shall individually and collectively protect and preserve the marine environment from all sources of pollution** | **Art 3**<br><br>**Contracting Parties shall act so as not to transfer, directly or indirectly, damage or likelihood of damage from one part of the environment to another or transform one type of pollution into another** |

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| | | | | **elimination of pollution by dumping and other sources of marine pollution** | | |
| The Convention on Environmental Impact Assessment in a Transboundary Context (**Espoo**) 1991 | **45** | **5/5** | **Art 2**<br>**1. The Parties shall, either individually or jointly, take all appropriate and effective measures to prevent, reduce and control significant adverse transboundary environmental impact from proposed activities.** | **Art 9**<br>**The Parties shall give special consideration to the setting up, or intensification of, specific research programmes aimed at:**<br>**(a) Improving existing qualitative and quantitative methods for assessing the impacts of proposed activities; (b) Achieving a better understanding of cause-effect relationships and their role in integrated environmental management** | **Appendix II**<br>**[...] Size of the proposed activities which are large for the type of the activity**<br>**[...] activities which are located close to international frontier or could give rise to transboundary effects** | **Art 2 (7)**<br>**[...] environmental impact assessment is undertaken prior to a decision to authorize or undertake a proposed activity listed in Appendix I that is likely to cause a significant adverse transboundary impact.** |
| Protocol on Environmental protection to the **Antarctic Treaty 1991**<br><br>While the | **33** | **2/5**<br>**Cryosphere**<br>**Hydrosphere** | **Art 2**<br>**The Parties commit themselves to the comprehensive protection of the Antarctic environment and dependent and associated ecosystems and hereby designate** | **Art 6**<br>**promote co-operative programmes of scientific, technical and educational value, concerning the protection of the Antarctic environment and dependent and** | **Art 2**<br>**[...] the comprehensive protection of the Antarctic environment and dependent and associated ecosystems and hereby designate Antarctica as a** | **Art 3 (c)**<br>**activities in the Antarctic Treaty area shall be planned and conducted on the basis of information sufficient to allow prior assessments of, and** |

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| | Treaty 52 | | **Antarctica**<br><br>**as a natural reserve, devoted to peace and science.** | **associated ecosystems** | **natural reserve, devoted to peace and science.** | **informed judgments about, their possible impacts on the Antarctic environment** |
| The Convention for the Protection of the marine Environment of the North-East Atlantic 1992<br><br>**OSPAR** | **16**<br><br>**Regional Treaty** | **1/5**<br><br>**Hydrosphere** | **Art 2.5**<br><br>**No provision of the Convention shall be interpreted as preventing the Contracting Parties from taking, individually or jointly, more stringent measures with respect to the prevention and elimination of pollution of the maritime area or with respect to the protection of the maritime area against the adverse effects of human activities.** | **Art 3.a**<br><br>**Contracting Parties shall adopt programmes and measures which [...] take full account of the use of the latest technological developments and practices designed to prevent and eliminate pollution fully.** | **Art 2. 1 [...]**<br><br>**[...] shall take the necessary measures to protect the maritime area [...] to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected.** | **Art 2.2**<br><br>**The Parties shall apply:**<br><br>**(a) the precautionary principle, by virtue of which preventive measures are to be taken when there are reasonable grounds for concern that substances or energy introduced, directly or indirectly, into the marine environment may bring about hazards to human health, harm living resources**<br><br>**and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea** |
| **Resolution LP.4(8)** LC 35/15 on the | **No legally binding** | **1/5**<br><br>**Hydrosphere** | **Art 1**<br><br>**[...] a deliberate intervention ...in the marine environment** | **the placement of matter from unregulated ocean** | **Art 1**<br><br>**...in the marine environment to manipulate natural** | **Assessment of potential effects**<br><br>**It shall define the nature,** |

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| amendment to the LP to regulate the placement of matter for Ocean Fertilization and other Marine Geo-engineering activities 2013 | | | **to manipulate natural processes, including to counteract anthropogenic climate change and or its impact** | **fertilization activities and other proposed marine geoengineering techniques…** | **processes,… and that has the potential to result in deleterious effects, especially where**<br>**those effects may be widespread, long tasting or severe."** | **temporal and spatial scales and duration of expected impacts based on reasonably conservative assumptions**<br>**the rationale, goals, methods, scale, timings and locations as well as predictedbenefits and risks are stated as a clear justification for the proposal;** |
| Decision Adopted by the **CBD COP 2008 IX/16,** Biodiversity and climate change | **No legally binding** | **5/5** | **The Conference of the Parties**<br>**1. Decides that, in conducting future in-depth reviews of the programs of work of the Convention, climate change considerations should be integrated into each programme of work where relevant and appropriate** | **(e) Enhancing scientific tools, methodologies, knowledge and approaches to respond to the impacts of climate change,** | **Small scale scientific research** | **[..] in accordance with the precautionary approach, to ensure that ocean fertilization activities do not take place until there is an adequate scientific basis on which to justify such activities, including assessing associated risks, and a global, transparent and effective control and regulatory mechanism is in place for these activities;** |

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| Decision Adopted by the **CBD COP 2010 X/33,** Biodiversity and climate change | **No legally binding** | **1/5**<br>**Biosphere** | **(j) Recognizing that ecosystems can be managed to limit climate change impacts on biodiversity** | **(w) Ensure, in the absence of science based, global, transparent and effective control and regulatory mechanisms for geo-engineering, and in accordance with the precautionary approach and Article 14 of the Convention, that no climate-related geo-engineering activities3 that may affect biodiversity take place, until there is an adequate scientific basis on which to justify such activities** | **Small scale scientific research** | **Compile and synthesize available scientific information, [...], on the possible impacts of geo-engineering techniques on biodiversity [...]** |
| **Rio Declaration**<br>on Environment and Development<br>1992 | **No legally binding** | **1/5**<br>**Biosphere** | **Principle 7**<br>**States shall cooperate in a spirit of global partnership to conserve, protect and restore**<br>**the health and integrity of the Earth's ecosystem. In view of the different contributions**<br>**to global environmental degradation, States have common but differentiated responsibilities.** | **Principle 9**<br>**States should cooperate to strengthen endogenous capacity-building for sustainable development [...] by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.** | **Principle 7**<br>**States shall cooperate in a spirit of global partnership to conserve, protect and restore**<br>**the health and integrity of the Earth's ecosystem** | **Principle 15**<br>**The Precautionary approach**<br>**[...] Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.** |

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