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Item 11.2 of the provisional agenda\*

**ADDITIONAL INFORMATION ON OPTIONS FOR DEFINITIONS OF CLIMATE-RELATED  
GEOENGINEERING**

*Note by the Executive Secretary*

**INTRODUCTION**

1. The Executive Secretary is circulating herewith, for the information of participants to the eleventh meeting of the Conference of the Parties to the Convention on Biological Diversity, additional information on options for definitions of climate-related geoengineering.
2. The present note discusses the background to the definition of climate-related geoengineering developed by the Expert Group on the Impacts of Climate-related Geoengineering on Biological Diversity, and provides comments on the implications of the three other options noted by the sixteenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-16) in recommendation XVI/9.
3. The document is circulated in the form and language in which it was received by the Secretariat of the Convention on Biological Diversity.

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\* UNEP/CBD/COP/11/1.

## I. BACKGROUND

4. The use of the term “geoengineering” in a climatic (rather than geotechnical) context is relatively recent, mostly in scientific publications; it has yet to appear in many dictionaries.<sup>1</sup> Nevertheless, an agreed and well-understood terminology is crucial for effective, multilingual discussions and decisions at the intergovernmental level, particularly if regulatory issues are involved.

5. The tenth meeting of the Conference of the Parties (COP-10) to the Convention on Biological Diversity (CBD) provided only a provisional definition of climate-related<sup>2</sup> geoengineering, explicitly seeking further advice on this matter from the Executive Secretary and the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) (decision X/33, paragraph 8(w) and associated footnote). The definition in the peer-reviewed report “Impacts of Climate-related Geoengineering on Biological Diversity” (UNEP/CBD/SBSTTA/16/INF/28), prepared by an Expert Group,<sup>3</sup> was provided to the sixteenth meeting of the SBSTTA as the basis of that advice. Three other definitions were also noted by SBSTTA-16, with no preference expressed between them.

6. The present note was prepared by the authors of the report “Impacts of Climate-related Geoengineering on Biological Diversity” (UNEP/CBD/SBSTTA/16/INF/28) to provide supplementary information to complement the Expert Group’s discussion of definition-related issues.

7. If all four definition options noted by SBSTTA-16 were synonymous, i.e. different ways of saying the same thing, the choice between them would not matter. However, there are real differences in meaning, with important implications for their application. As a result, all other mentions of geoengineering in SBSTTA recommendation XVI/9 can be interpreted in alternative ways; for example, the invitation to Parties to report on their geoengineering activities, and the request to the Executive Secretary to compile and make available this information.

8. Whilst recognising that no single definition is likely to meet all purposes, the Expert Group considers that the CBD Secretariat should bring to the attention of COP-11 the additional information in this paper on definition options, as guidance to achieving a definition that is appropriate to CBD needs and interests.

## II. DEFINITION OF GEOENGINEERING DEVELOPED BY THE EXPERT GROUP

9. The Expert Group gave careful attention to the definition of geoengineering, not only because the consideration of definition options was included in the group’s mandate, but also because this issue was fundamental for planning and implementing its main work (assessment of impacts requires initial identification of causative agents). The following wording was agreed:

- *A deliberate intervention in the planetary environment of a nature and scale intended to counteract anthropogenic climate change and its impacts.*

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<sup>1</sup> Geoengineering was included in the Oxford Dictionary of English in 2010, defined as “the deliberate large-scale manipulation of an environmental process that affects the earth’s climate, in an attempt to counteract the effects of global warming”.

<sup>2</sup> The descriptor “climate-related” is hereafter assumed, if not explicitly stated.

<sup>3</sup> Members of the Expert Group on the Impacts of Climate-related Geoengineering on Biological Diversity: Paulo Artaxo, Ralph Bodle, Victor Galaz, Georgina Mace, Andrew Parker, David Santillo, Chris Vivian, Robert Watson and Phillip Williamson. These individuals contribute their expertise in a personal capacity, not as governmental or organizational representatives; none have any financial interests in the commercial development of geoengineering. A total of 47 other individuals and government representatives provided input to the report.

10. This is a relatively broad definition, recognising that geoengineering covers a wide spectrum of approaches, and that additional information on what is or is not covered by the term may be needed when the definition is applied for more specific technical, operational or legal purposes. Section 2.1 of the Expert Group's report (UNEP/CBD/SBSTTA/16/INF/28) discusses the scope and implications of the above definition; that text is reproduced here in the Annex.

11. The development of the definition by the Expert Group was based on five principles, all routinely used by lexicologists: i) usage (corpus linguistics), on the basis that it would be inappropriate for the CBD definition of geoengineering to differ significantly from the meaning currently assumed for the term by the "wider world"; ii) clarity, aiming to avoid any ambiguity in the definition overall or in any component of it that might give problems in interpretation, either within or between languages; iii) purpose, since the generality (or specificity) of a formal definition is relevant to its intended application; iv) brevity, on the basis that succinctness is preferable to superfluity, providing that essential meaning is expressed; and v) etymological consistency, although accepting that the meaning of words can evolve, depending on usage and purpose ("Earth manipulation" can be considered a good match to the Greek and Latin roots of geoengineering, although other transliterations are possible).

12. The first of the above criteria – usage – was considered to be of particular importance. For evidence of wider application, the CBD Secretariat provided the Expert Group with ten formal and informal definitions of geoengineering by national and international science organisations and other bodies (these definitions are given in Annex I of the Expert Group report). Members of the group also investigated additional online usage and identified more than 200 scientific publications, mostly produced within the past five years, that had "geoengineering" in either the title, abstract or as a key word. These publications provided the basis for the Expert Group's study, and many (but not all) are cited in the group's report.

13. The definition of geoengineering developed by the Expert Group, together with related text, was subject to two rounds of peer review involving CBD Parties and international experts. All comments on the definition (~15) were assessed and taken into account before the wording provided above was finalised. This formulation was considered robust and fit for purpose as a general descriptor of geoengineering for use by the CBD.

14. The scientific rationale for the Expert Group's definition is summarised in Table 1. In this table, the initial basis for grouping different geoengineering approaches is whether they achieve their effect on the Earth's climate system by increasing outgoing energy (i.e. lessening the greenhouse effect, primarily by removing greenhouse gases), or by decreasing incoming energy (by reflecting sunlight), or by spatially redistributing that energy. Subsequent sub-grouping is similar, but not an exact match, to the structure of the Expert Group report. Table 1 includes several geoengineering techniques that are speculative, not discussed in the report.

15. In principle, the CBD's definition of geoengineering could specify a subset of techniques, for example those that would seem to have the greatest likelihood of implementation; those that are considered to be novel or "technological"; those that have highest risk of adverse trans-boundary effects; or those that are likely to have the greatest impacts on biodiversity and ecosystems. However, given the large number of proposed techniques,<sup>4</sup> the wide ranges of scales for deployment and for impacts, and the lack of detailed understanding of direct and indirect consequences, it is extremely unlikely that any such distinctions can be drawn unambiguously.

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<sup>4</sup> For example, see Isomäki I. (2011) *66 Ways to Absorb Carbon and Improve the Earth's Reflectivity – from Reasonable Options to Mad Scientist Solutions*. Into Publishing, Helsinki; online at [www.info-ebooks.com/book/66\\_ways](http://www.info-ebooks.com/book/66_ways).

**Table 1. A proposed taxonomy of climate geoengineering techniques, based on the definition developed by the Expert Group on the Impacts of Climate-related Geoengineering on Biological Diversity (“deliberate intervention in the planetary environment of a nature and scale intended to counteract anthropogenic climate change and its impacts”)**

Reductions of greenhouse gas emissions, e.g. by at-source carbon capture and storage (CCS), are excluded from the definition. Techniques and processes that are considered to be geoengineering need to be at sufficient scale for significant climatic impact, and carried out with that intention. This structure potentially covers all specific techniques relating to changes in the Earth’s energy budget, but not all those that have been proposed are listed here. Note that: i) BECCS stands for bio-energy carbon capture and storage, considered as geoengineering because of its carbon capture from the atmosphere; ii) bracketed techniques and approaches are mostly speculative and may be unrealistic; they were not given detailed attention in the CBD Expert Group report *Impacts of Climate-related Geoengineering on Biological Diversity*; iii) techniques marked with an asterisk (\*) are storage-only.

Techniques that increase energy loss from the Earth’s climate system [through change in output of long-wave radiation (heat)]	Removal of greenhouse gases from the atmosphere: negative emission techniques	Carbon dioxide removal: CDR	Carbon dioxide	Biological CO <sub>2</sub> capture and carbon storage	Ocean fertilization
					Afforestation/reforestation
					Enhanced soil carbon
					Biomass production, incl BECCS
					Ocean storage of land biomass
				Chemical/geochemical CO <sub>2</sub> air capture and storage	Increased ocean alkalinity
					Land-based enhanced weathering
					Direct chemical air capture of CO <sub>2</sub>
					CO <sub>2</sub> storage in ocean*
					Geological CO <sub>2</sub> storage - sub-surface*
Methane	(CH <sub>4</sub> removal from atmosphere)				
Other greenhouse gases	(Removal of other greenhouse gases, e.g. N <sub>2</sub> O or H <sub>2</sub> O)				
Other means of enhanced heat escape	(Reduction in cirrus cloud cover)				
	(Removal of black carbon from atmosphere)				
Techniques that decrease energy gain by the Earth’s climate system [through change in input of short-wave radiation (light)]	Sunlight reflection methods or solar radiation management: SRM	(Space-based increased reflection, e.g. via space mirrors)			
		Increase in stratospheric aerosols			
		Cloud brightening: Increased cloud reflectivity			
		Increased surface reflectivity	Land surface, e.g. crops, desert, buildings		
			Ocean surface/inland seas		
Techniques that redistribute energy within the Earth’s climate system	(Via increased ocean heat storage, e.g. by enhanced downwelling, or by actions to promote sea-ice formation, e.g. blocking Bering Strait to restrict water flow in Arctic Ocean)				

### III. OTHER DEFINITION OPTIONS NOTED BY SBSTTA-16

16. In SBSTTA recommendation XVI/9, the Expert Group definition was noted as paragraph 4 (b). SBSTTA-16 also noted three other definitions of climate-related geoengineering in paragraphs 4 (a), (c) and (d), without explicitly expressing a preference between them:

- *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) (decision X/33 of the Conference of the Parties);*
- *Deliberate large-scale manipulation of the planetary environment (IPCC 32nd session);*
- *Technological efforts to stabilize the climate system by direct intervention in the energy balance of the Earth for reducing global warming (IPCC Fourth Assessment Report). With footnote: “Noting that this definition includes solar radiation management but does not encompass other geoengineering techniques”.*

17. There are substantive differences between these definitions and their implications. As discussed below, the main concerns with regard to their suitability for CBD purposes is that they exclude techniques that it would seem appropriate to include, whilst inadvertently including activities that were not apparently intended to be covered.

### IV. COMMENTS RELATING TO THE COP-10 PROVISIONAL DEFINITION

18. The Expert Group has a number of comments and concerns regarding the first definition in paragraph 16 above, identified as “decision X/33 of the Conference of the Parties”, as follows:

i) The inclusion of “technologies” is potentially problematic unless that term is itself carefully defined; “techniques” would seem more appropriate. Nevertheless, it is recognised that some Parties (and NGOs) consider that “technologies” is a key part of the definition, on the basis that that term provides an important criterion for what is or is not considered to be geoengineering. For example, large-scale afforestation/reforestation (even if explicitly for the purpose of atmospheric CO<sub>2</sub> drawdown, i.e. for carbon credits) could be excluded, on the basis that such approaches are considered to be “natural” rather than “technologies”. However, this differentiation is semantically questionable: the meaning of “technology” is very broad, covering the use of any tools, techniques, or (scientific) methods. Use of the term as the basis for regulatory distinctions is likely to be fraught with legal complexities (with an initial problem being the difficulty of reaching agreement on an unambiguous definition of the word itself).

ii) “... reduce solar insolation or increase carbon sequestration ...”. The restriction of geoengineering to processes that achieve one of these two effects excludes from the definition a number of other approaches that have also been proposed to counteract anthropogenic climate change (e.g. see Table 1), and that are also widely considered to be geoengineering. For example:

- Removal from the atmosphere of greenhouse gases other than those containing carbon (e.g. N<sub>2</sub>O);
- Changes to the upper atmosphere that would increase planetary heat loss (e.g. reduction in cirrus cloud cover);
- Large-scale increases in land or ocean surface albedo (no reduction in the energy reaching the Earth’s surface, but more of that energy is reflected back to space);

- Re-distribution of heat energy once received at the Earth's surface, that could achieve global cooling by increasing ocean heat storage (e.g. by large-scale changes in ocean circulation).

The above ideas are mostly conceptual/theoretical, and may be unrealistic; nevertheless, their exclusion from the definition would seem arbitrary and unintended.

iii) "... sequestration ...". This term is subsequently defined within decision X/33 as "the process of increasing the carbon content of a reservoir/pool other than the atmosphere". No time-scale is indicated, nor is there any mention of the stability of the carbon within the non-atmospheric reservoir or pool. On that basis, all plant photosynthesis involves carbon sequestration – and hence all agriculture (considering that to be a technology and large-scale) would be geoengineering, since it involves the "sequestration" of carbon within food, fuel and fibre. That interpretation was presumably not intended by COP-10, nor SBSTTA-16.<sup>5</sup>

iv) "... on a large scale ...". This phrase is potentially ambiguous, since it is not clear what constitutes "large scale". A few hundred km<sup>2</sup>? A few thousand km<sup>2</sup>? On the basis that large-scale is not necessarily the same as regional or global-scale (otherwise that could have been stated) then relatively local – and short-term – weather modification techniques, such as cloud seeding, would seem to be included in the COP-10 provisional definition of geoengineering. Whilst this might or might not have been intended, such ambiguity would be problematic for information-gathering and regulatory purposes.

v) "... that may affect biodiversity ...". The use of "may" here is inherently ambiguous, either implying that geoengineering *must* affect biodiversity in order to be within the definition (hence a geoengineering approach is not considered to be geoengineering unless effects on biodiversity occur), or that it *might* do (but does not have to). The scale of the possible effect on biodiversity is not stated: it could therefore be extremely local and ecologically trivial, whilst including many activities that would not normally be considered as part of climate geoengineering. The phrase could anyway be considered as unnecessary within a definition of geoengineering in a climatic context: if climate is significantly affected, then biodiversity will inevitably also be affected.

vi) The COP-10 provisional definition of geoengineering does not mention why there should be any effort to either reduce insolation or remove carbon from the atmosphere. For any definition intended to be climate-related, some reference to overall purpose (climate remediation) would seem an essential element. Whilst a definition of geoengineering that is broader than climate could also be legitimate (as pointed out in footnote 30 of the Expert Group report), that meaning was presumably not intended by COP-10.

## V. COMMENTS AND CONCERNS RELATING TO THE IPCC DEFINITIONS PRESENTED FOR CONSIDERATION

19. The noting of two definitions of the Intergovernmental Panel on Climate Change (IPCC) within paragraph 4 of SBSTTA recommendation XVI/9 is presumably intended to assist the alignment of the CBD's definition of geoengineering with the terminology used by the IPCC. Scientifically, such alignment is highly desirable. Unfortunately, neither of the "IPCC definitions" provided as options would seem to be fully appropriate for this purpose.

20. The definition ascribed to the IPCC 32nd session ("Deliberate large-scale manipulation of the planetary environment") has the advantage of brevity. However, its suitability as a formal definition would seem limited for the following reasons:

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<sup>5</sup> For discussion of 'sequestration' in the context of long-term carbon storage – its more usual scientific meaning – see Section 5.1.2 of the Expert Group report, UNEP/CBD/SBSTTA/16/INF/28.

i) The meaning of “large scale” is not specified; hence potentially involving the problems already discussed under paragraph 18 (iv) above.

ii) The purpose of the manipulation is not specified. Thus measures to counteract (say) ozone depletion or ocean acidification would also be included in this definition, together with all other large-scale manipulations of the planetary environment – for example, all major geotechnical and civil engineering interventions, such as mineral extraction and freshwater management, together with all agriculture, urban development and other anthropogenic land use changes.

iii) IPCC did not intend this wording to be used as a definition. Instead, the phrase was provided for explanatory purposes, occurring within the part of the report of the IPCC 32<sup>nd</sup> session (Busan, October 2010)<sup>6</sup> that established an expert meeting on geoengineering. Additional information within that report made clear that the IPCC expert meeting (held in Lima, June 2011) was expected to focus on global-scale interventions to counteract anthropogenic climate change, for further consideration by the author teams of the IPCC’s Fifth Assessment Report (AR5).

21. The second IPCC definition option included in SBSTTA recommendation XVI/9 is sourced from the glossary of IPCC WG III’s 4th Assessment Report (AR4; 2007):<sup>7</sup> “Technological efforts to stabilize the climate system by direct intervention in the energy balance of the Earth for reducing global warming”. In recommendation XVI/9, the following footnote has been added: “this definition includes solar radiation management but does not encompass other geoengineering techniques”. The Expert Group’s main concerns with this definition and its associated footnote are that:

i) The concept of geoengineering and associated literature has developed greatly since 2007, with most publications on the topic occurring since then. Confirmation that IPCC still considers this wording to provide the most appropriate definition would therefore be desirable; otherwise there is risk that COP-11 might adopt an “IPCC definition” that IPCC itself no longer uses.

ii) As discussed under paragraph 18 (i) above, the descriptor “technological” is potentially problematic, indicating that there might also be non-technological efforts to stabilize the climate system (and that these would not necessarily be considered as geoengineering).

iii) The limitation of geoengineering to “direct intervention in the energy balance” is ambiguous. Are carbon dioxide removal (CDR) techniques considered to be direct or indirect?

iv) The footnote to paragraph 4 (d) of recommendation XVI/9 makes the latter interpretation, stating that this definition of geoengineering limits it to solar radiation management (SRM). The origin of the footnote is, however, not given. Elsewhere within IPCC AR4, the term geoengineering is used for both SRM and CDR techniques, and recognises that there might be other approaches; e.g. in Section 11.2.2 of WG III’s report, headed “Ocean fertilization and other geoengineering options”.

22. As already noted above, the IPCC 32<sup>nd</sup> session established an expert meeting to assist in resolving some of the above issues. The report of that expert meeting has now been published.<sup>8</sup> It includes the following “definition” of geoengineering for further consideration within the IPCC AR5 process:

<sup>6</sup> [www.ipcc.ch/meetings/session32/final\\_report\\_32.pdf](http://www.ipcc.ch/meetings/session32/final_report_32.pdf).

<sup>7</sup> [www.ipcc.ch/publications\\_and\\_data/ar4/wg3/en/annex1-ensglossary-e-1.html](http://www.ipcc.ch/publications_and_data/ar4/wg3/en/annex1-ensglossary-e-1.html).

<sup>8</sup> IPCC (2012). *Meeting Report of the Intergovernmental Panel on Climate Change Expert Meeting on Geoengineering*; Lima, Peru 20-22 June 2011 [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, C. Field, V. Barros, T.F. Stocker, Q. Dahe, J. Minx, K. Mach, G.-K. Plattner, S. Schlömer, G. Hansen, M. Mastrandrea (eds.)]. IPCC Working Group III Technical Support Unit, Potsdam, Germany. 99 pp., online at [www.ipcc-wg1.unibe.ch/publications/supportingmaterial/EM\\_GeoE\\_Meeting\\_Report\\_final.pdf](http://www.ipcc-wg1.unibe.ch/publications/supportingmaterial/EM_GeoE_Meeting_Report_final.pdf).

- **Geoengineering** refers to a broad set of methods and technologies that aim to deliberately alter the climate system in order to alleviate the impacts of climate change. Most, but not all, methods seek to either (a) reduce the amount of absorbed solar energy in the climate system (Solar Radiation Management) or (b) increase net carbon sinks from the atmosphere at a scale sufficiently large to alter climate (Carbon Dioxide Removal). Scale and intent are of central importance. Two key characteristics of geoengineering methods of particular concern are that they use or affect the climate system (e.g., atmosphere, land or ocean) globally or regionally and/or could have substantive unintended effects that cross national boundaries. Geoengineering is different from weather modification and ecological engineering, but the boundary can be fuzzy.

23. The above text is a description, rather than definition. Nevertheless, the features it describes are more consistent with the Expert Group's definition of geoengineering than the COP-10 provisional definition. The former congruence benefitted from participation in the IPCC's expert meeting in Lima by a member of the Expert Group. There were also other discussions between Lima participants and members of the Expert Group.

## VI. CONCLUSION

24. There are important differences in clarity and scope of the four definitions for climate-related geoengineering noted by SBTTA-16. COP-11 is expected to decide which of these definitions, or potentially an additional one, applies to its discussions on this topic before any other substantive decisions are made relating to SBSTTA recommendation XVI/9.

25. For consistency with wider usage, a relatively broad, science-based, definition would seem necessary, recognising that additional information on what is or is not covered by the term may be needed when the definition is applied for more specific technical, operational or legal purposes.

26. The Expert Group recommends the definition noted as paragraph 4(b) of recommendation XVI/9 as prepared by the group, and considers the other options unsuitable for the purpose of the consideration of this issue under the Convention.

27. This information is provided to the Secretariat on the basis that it would seem desirable to bring it to the attention of Parties prior to COP-11, and also discuss it with other United Nations bodies with interests, particularly the IPCC.

## ANNEX

### **Extract from Section 2.1 (Definition of climate-related geoengineering) from expert group report “Impacts of Climate-related Geoengineering on Biological Diversity” (UNEP/CBD/SBSTTA/16/INF/28)**

Based on the above [introductory discussion], and consistent with most of the definitions listed in Annex I, this report defines climate-related geoengineering as:

A deliberate intervention in the planetary environment of a nature and scale intended to counteract anthropogenic climate change and its impacts.

This definition is broad in scope, yet includes important criteria to clarify its intended meaning in an objective and consistent way. Key features of this definition are that the interventions are deliberate, that their purpose is to address human-driven climate change<sup>32</sup>, and that the implementation of the proposed technique is on a scale large enough to have a significant counter-acting effect; i.e. reducing or potentially reversing human-induced temperature increases and associated changes. The definition includes, but is not necessarily limited to, sunlight reflection methods, (SRM, also known as solar radiation management), and carbon dioxide removal (CDR) techniques, also known as negative emission methods or negative emission techniques<sup>33</sup>.

Unlike some definitions of geoengineering, the above definition includes the potential removal of greenhouse gases other than CO<sub>2</sub>, such as methane<sup>34</sup>; it also includes the possibility that cooling might be achieved by enhancing the loss of long-wave radiation from the Earth, through cirrus-cloud manipulations<sup>35</sup>. However both those approaches are currently speculative, with little or no peer-reviewed discussion of their methods and potential impacts: they are therefore not further examined in this report, nor are others of a similar, very preliminary, status.

The above definition excludes “conventional” carbon capture and storage (CCS) from fossil fuels, since that involves the capture of CO<sub>2</sub> before it is released into the atmosphere. Thus that form of CCS reduces the problem of greenhouse-gas emissions, rather than counter-acting either their presence in the atmosphere or their climatic effects. Nevertheless, all CDR techniques necessarily involve carbon capture, by either biological or chemical means, and some may involve the same or similar processes of managed carbon storage as used for at-source CCS<sup>36</sup>.

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<sup>32</sup> Geoengineering could also be defined with non-climatic objectives; for example, to counter-act ozone depletion or specifically to address ocean acidification.

<sup>33</sup> McLaren D. (2011). *First stop digging. An assessment of the potential for negative emission techniques to contribute safely and fairly to meeting carbon budgets in the 21<sup>st</sup> century*. McLaren Environmental Research & Consultancy Working Paper 1/11; <https://sites.google.com/site/mclarenerc>.

<sup>34</sup> Boucher O. & Folberth G.A. (2010). New directions: atmospheric methane removal as a way to mitigate climate change? *Atmospheric Environment* 44, 3343-3345.; doi: 10.1016/j.atmosenv.2010.04.032.

<sup>35</sup> Mitchell D.L, Mishra S. & Lawson R.P. (2011). Cirrus clouds and climate engineering: new findings on ice nucleation and theoretical basis. In: *Planet Earth 2011- Global Warming Challenges and Opportunities for Policy and Practice*, ed E Carayannis; InTech, p 257- 288; online at [www.intechopen.com/articles/show/title/cirrus-clouds-and-climate-engineering-new-findings-on-ice-nucleation-and-theoretical-basis](http://www.intechopen.com/articles/show/title/cirrus-clouds-and-climate-engineering-new-findings-on-ice-nucleation-and-theoretical-basis).

As noted in Chapter 1, there is currently a range of views concerning whether geoengineering should include or exclude a number of activities involving bio-energy, afforestation and reforestation, and changing land management practices. If such techniques are deployed at sufficient scale to significantly counteract climate change, and are implemented with that intention, then their inclusion within the definition of geoengineering seems logically justified, notwithstanding that such measures are already being used for climate change mitigation and other purposes, and that they may involve minimal use of new technologies<sup>37</sup>.

There is also a range of views concerning the inclusion or exclusion of weather modification technologies, such as cloud seeding, within the definition of geoengineering. Proponents of inclusion argue that the history, intention, institutions, technologies themselves, and impacts are closely related to geoengineering. Nevertheless, unless they can be scaled-up sufficiently to achieve (beneficial) climatic effects at the global level, they are considered out of scope for the current study<sup>38</sup>.

The above definition is broad in scope, suitable for broad-based analysis such as this study. More specific definitions that are narrower in scope and allow for more precise legal interpretations may be required for some purposes, such as providing policy advice and regulation. Such definitions might be confined to specific techniques, classes of techniques, or environments, and the distinction between regional and global-scale effects may be less important. For example, definitions relating to SRM techniques or CDR techniques that have the potential for significant negative transboundary implications, or the potential to directly affect all or part of the global commons in a negative way, may warrant separate treatment.

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<sup>36</sup> Most CCS techniques involve the storage of CO<sub>2</sub> in depleted hydrocarbon reservoirs and saline aquifers. However, it has also been proposed that liquid CO<sub>2</sub> could be injected into basaltic rocks, to form calcium and magnesium carbonates – as discussed in Chapter 5.

<sup>37</sup> The expert group considered defining geoengineering on the basis that (novel) technologies were necessarily involved. However, that did not provide a workable definition, since most human activities (including agriculture and forestry) are, to some degree, technological, and ‘novel’ did not unambiguously define what was in scope.

<sup>38</sup> A similar conclusion (to exclude weather modification) was made by the UK House of Commons Science and Technology Committee (2010). *The regulation of geoengineering*. 5<sup>th</sup> Report of Session 2009-10, HoC STC; [www.publications.parliament.uk/pa/cm200910/cmselect/cmsctech/221/221.pdf](http://www.publications.parliament.uk/pa/cm200910/cmselect/cmsctech/221/221.pdf).