



Arguments and architectures: *Discursive and institutional structures shaping global climate engineering governance*

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ABSTRACT

The Anthropocene is giving rise to novel challenges for global environmental governance. The barriers and opportunities shaping the ways in which some of these complex environmental challenges become governable on the global level are of increasing academic and practical relevance. In this article, we bring neo-institutionalist and post-structuralist perspectives together in an innovative framework to analyse how both institutional and discursive structures together bound and shape the global governance opportunities which become thinkable and practicable in the face of new global environmental challenges. We apply this framework to explore how governance of climate engineering – large scale, deliberate invention into the global climate system – is being shaped by discursive and institutional structures in three international forums: The London Convention and its Protocol, the Convention on Biological Diversity, and the United Nations Environment Assembly. We illustrate that the ‘degree of fit’ between discursive and institutional structures made climate engineering (un)governable in each of these forums. Furthermore, we find that the ‘type of fit’ set the discursive and institutional conditions of possibility for what type of governance emerged in each of these cases. Based on our findings, we critically discuss the implications for the future governance of climate engineering at the global level.

1. Introduction

The Anthropocene is giving rise to a range of novel environmental challenges. The barriers and opportunities shaping whether and how these challenges become governable on the global level are of increasing academic and practical relevance. Questions that merit deeper exploration include; how a new environmental issue becomes an object of global governance, in which forum, and what bounds and shapes the governance opportunities which emerge. These questions are increasingly relevant as environmental challenges become all the more global, and the international institutional space is crowded by forums with potentially overlapping mandates (Newig et al., 2020).

Two broad approaches have recently been taken to investigating these questions. First, the institutional approach focuses on *material* structures as key determinants of governance (Miles, 2002; Young, 2002; Young et al., 2008). These include the ways in which the scope, mandate, principles and institutional arrangement of existing international forums shape how a new environmental problem is addressed (Biermann and Kim, 2020). The institutional approach explains how existing institutions limit the governance choices and opportunities

available to address new problems. Second, the discursive approach is based on a constructivist understanding of how *discursive* structures shape the emergence of governance (Hajer, 2005; Schmidt, 2008; Leipold et al., 2019). The discursive approach highlights how an issue is discursively constituted as an object of governance, and how specific rationales, modes and instruments of governance come to appear natural and given (Stripple and Bulkeley, 2014).

Both these approaches have merit in identifying underpinning ‘conditions of possibility’ that shape whether and how environmental governance emerges. However, a perceived conceptual difference has kept these two approaches largely separate. While institutional analysis is understood as inherently structural by global governance scholars – focusing on the role of institutions in shaping governance outcomes – often ‘discourse’ is not similarly conceptualised as a structure in and of itself, but rather as a mere communication tool employed by strategic actors (Leipold et al., 2019). This seeming conceptual inconsistency has impeded fuller understanding of how discursive and institutional structures interact in international forums in the face of new environmental challenges to jointly bound and shape global governance decisions.

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In this article, we bring together neo-institutionalist and post-structuralist discourse perspectives to address this gap. We draw on the Foucauldian reconceptualization of discourse as a (ideational) structure which has the power to shape the emergence of global governance arrangements in a similar way to institutional (material) structures, putting both these approaches on compatible conceptual footings and making their complementary nature clear. We create an innovative framework for analysing how both *discursive* and *institutional* structures bound and shape the global governance opportunities which become thinkable and practicable in the face of new global environmental challenges.

Our empirical analysis deals with climate engineering (CE),¹ or the large-scale deliberate invention into the global climate system with the intent to mitigate the effects of climate change (Shepherd, 2009); a novel challenge which may be paradigmatic of global environmental governance in the Anthropocene (Pasztor et al., 2021; Sovacool, 2021). The heterogeneous range of proposed techniques for deliberately altering the climate would have global effects and has thus led to calls for governance through international forums (Morrow, 2017).

We focus on three international forums which have so far engaged with CE governance, with differing results: (1) The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and its 1996 Protocol, known as the London Convention/London Protocol (LC/LP), which put a framework in place for *permitting and regulating* marine CE activities that can be classified as legitimate scientific research; (2) the Convention on Biological Diversity (CBD), which passed a decision focusing on the *prevention of harm*, and *precautionary restriction* of CE activities with the potential to endanger biodiversity; and (3) the United Nations Environment Assembly (UNEA), which deliberated upon and subsequently *rejected* a draft resolution calling for an assessment of CE proposals with an eye to establishing global governance frameworks.

Our aim is to explore the variation in CE governance outcomes of the LC/LP, CBD, and UNEA. Building on the problem of fit literature (Young, 2002; Folke, 2007; Galaz, 2008; Cox, 2012) that highlights the importance of ‘fit’ between problem features and institutional structures, and post-structural governmentality literature (Bäckstrand and Lövbrand, 2006, 2016; Lövbrand and Stripple, 2014; Stripple and Bulkeley, 2014) that highlights the co-constitutive interaction between discursive ‘rationalities’ and material ‘techniques’ of governance, we ask: How did discursive and institutional structures co-shape the differing decisions on CE governance in these three international forums?

Building on the premise that the extent and nature of (dis)similarities between discursive and institutional structures are key to making sense of a governance outcome, we analysed how (1) the ‘*degree of fit*’ between given discursive structures (or ‘software’) and material institutions (or ‘hardware’) contributed to making CE an (un)governable issue in each of these forums; and (2) the ‘*type of fit*’ across four different analytical levels – objects (what), rationales (why), modes (how), and speakers (who) – set the discursive and institutional conditions of possibility for the governance decisions which emerged in each of these cases. By analysing the ‘fit’ between discursive and institutional structures across these four levels, our aim is to reconstruct the constitutive ‘conditions of possibility’ that made certain governance outcomes more thinkable and practicable.

¹ Climate engineering - sometimes also called geoengineering - is an umbrella term used to refer to a wide range of proposed methods for the deliberate large scale manipulation of the Earth system to counteract climate change by either removing carbon dioxide from the atmosphere and storing it – called carbon dioxide removal (CDR), or by changing the reflective properties of the Earth (i. e. by injecting aerosols into the stratosphere) to reduce warming, called solar radiation management (SRM). Whether CE is ‘lumped’ together, or ‘split’ into sub-categories or even individual proposals for governance purposes is a matter of ongoing debate (see e.g. Gupta and Möller, 2018).

In the following sections, we outline our analytical framework for exploring the degree and type of fit between discursive and institutional structures in emerging governance (Section 2); describe data and methods (Section 3); explore our research question in three case studies (Section 4); before discussing the implications of our results for the future governance of CE techniques at the global level (Section 5) and concluding (Section 6).

2. Analytical Framework

In following with neo-intuitionism, we conceptualize institutional structures as ‘hardware’ with the power to bound and shape the governance opportunities available within each international forum (Young, 2002; Biermann and Kim, 2020). In this regard, our study builds on the literature on the origin and consequences of the design of international institutions (Mitchell, 1994, 2006; Koremenos et al., 2001; Guzman, 2005; Dür et al., 2014). However, while institutional analysis posits that material structure is a key variable for explaining effectiveness, we suppose that it may also shape whether and how a new governance challenge becomes governable by certain institutions. Key elements of institutional structure include: A given forum’s mandate which specify *what* it has the purview to govern; the institutionalized principles that provide the normative basis for *why* governance is necessary; the decision-making modes and instruments which prescribe *how* a given institution governs; and the membership and informational input structures which stipulate *who* is involved in governance within a specific forum.

But institutional ‘hardware’ is only half of the environmental governance development story. The other half is told by the shaping effects of discursive structure, which we understand as the ‘software’ or ‘source code’ underpinning a given governance debate (Boettcher, 2019). In following with Foucauldian-inspired post-structural analysis, we conceptualize a discourse as an often-unrecognized power/knowledge structure that shapes what it is possible to (legitimately, truthfully, authoritatively) know and say within a given environmental governance debate (Hajer, 1995; Lövbrand and Stripple, 2014; Keller et al., 2018; Boettcher, 2020). This approach assumes the shaping power of discursive structures, as “objects, subjects and relations ... are contingent and co-constituted through discursive practices that render some ... knowable and governable and others not” (Leipold et al., 2019: 446). Discursive structures thus make certain types of governance ‘thinkable and practicable’ by bounding understandings of *what* is to be governed, *why* governance is necessary, *how* governance should be implemented, and by *whom* (Gordon, 1991; Boettcher, 2020).

Our approach focuses on the co-constitutive interplay of discursive ‘software’ and institutional ‘hardware’ which determines whether and how an issue becomes governable within a given forum. We theorize that the *degree* and *type* of fit between these two kinds of structures bound and shape the governance opportunities deemed possible and appropriate in a given institutional context. We consider Möller (2020) as our point of analytical departure, who highlights that ‘fit’ (or lack of it) between the definition of objects to be governed and the scope of a given institution’s mandate is central to determining whether and how the new CE issue is deemed governable within that forum (see also Jinnah et al., 2021). Yet, in our analysis, we go beyond this ‘problem definition’ plus ‘institutional mandate’ analysis of fit, with a view to overcoming the limitations of the conventional approach that leaves little room to consider the power of contextual values and principles in determining which governance discussions can be initiated in the first place (Möller, 2020).

We therefore assess more broadly the fit between discursive and institutional structures on *four analytical levels*, as outlined in Table 1: *Governance objects* (what is to be governed), *governance rationales* (why is it to be governed), *governance modes* (how is to be governed), and *governance speakers* (who is authorized to be involved in governance). For example, on the ‘*what*’ level, fit between a discursive definition of CE

Table 1

Analytical framework for comparing fit between discursive and institutional structures shaping decisions on CE governance.

	Discursive structure	Institutional structure
Objects (what)	What is discursively shaped as the object of governance? (E.g. Lumping all CE measures, or splitting based on i.e. efficacy, scale, impact)	Scope of mandate: Broad vs. narrow (geographically, sectorally, temporally)
Rationales (why)	What rationales are structuring calls for CE governance? (E.g., Utilitarian, precautionary)	Guiding norms/principles (especially those relating to risk/precaution and burden-sharing/allocation)
Modes (how)	How should CE be governed? (E.g., Centralized, decentralized, coercive, participatory)	Regulatory instruments, decision-making procedures (consensus/majority, binding/non-binding etc.)
Speakers/ roles (who)	Who is discursively authorized to be involved in shaping CE governance? (E.g., Experts vs. non-experts)	Input structures (expert scientific groups, NGO/stakeholder submissions, etc.)

as all ‘deliberate, large-scale interventions into the global climate to mitigate the effects of climate change’ and an international forum with a similarly geographically, sectorally and temporally encompassing mandate would create discursive and institutional opportunities for CE writ large to become governable within that forum. On the ‘why’ level, fit between discursive ‘risk-benefit’ rationales for governance of CE and a utilitarian risk-management principle institutionalized as a guiding norm within a given forum would make risk-benefit assessment-based governance ‘thinkable and practicable’ within that forum. On the ‘how’ level, discursive rationales for centralized modes of CE governance would ‘fit’ within institutional architectures which facilitate binding, top-down governance. On the ‘who’ level, a fit between the discursive privileging of scientists as legitimate knowledge producers/speakers, and institutional input structures that afford scientists a key role in informing decision-making would present the discursive and institutional ‘conditions of possibility’ for scientific assessment-based governance. A lack of ‘fit’ on one or more of these levels can conversely contribute to CE being deemed ungovernable within a given forum.

3. Methods & Materials

Our research design is based on *qualitative case studies* analysing the institutional and discursive structures that played a role in shaping decisions on CE governance in three international forums. We selected as our cases the three international forums that have so far engaged directly with the issue of CE governance: The LC/LP, the CBD, and UNEA.² Each of these forums produced a different *type* of CE governance outcome: One more permissive, one more precautionary, one a complete rejection of the issue as ‘ungovernable’. Each forum has differing institutional structures and initial analysis and commentary on the CE decisions made have suggested that varying discursive structures also played a role in shaping governance outcomes (Fuentes-George, 2017; Gupta and Möller, 2018; Biermann and Möller, 2019; Jinnah and Nicholson, 2019; Möller, 2020; Jinnah et al., 2021; McLaren and Corry, 2021).

To explore the co-constitutive effects of both discursive and institutional structures on governance decisions in these forums, we used a mixed methodological approach, combining *neo-institutional analysis* with *post-structural discourse analysis* techniques.

Neo-institutional analysis aims to identify key elements of institutional structures shaping the *why, what, how and who* of CE governance

² The IPCC has included CE in assessment reports etc., but the UNFCCC itself has so far made no concrete decisions pertaining to CE governance, and thus we decided not to include it as a case.

in each forum. These attributes are “significant features of institution that give individual forums their distinct character” such as “goals, principles, norms, rules and decision-making procedures” (Young and Zürn, 2006: 132). Although institutional structures are relatively resilient, institutional ‘hardware’ – like discursive ‘software’ – is subject to change. For the purposes of our analysis, we therefore focused on a snapshot of what the institutional structure of each forum looked like at the time decision was made. The data pool for the institutional analysis included a combination of following materials for each case: Treaty texts (for the identification of mandate, key principles, modes of governance, and the basic input structure); decisions of the parties (the details of governance mode); publications by the secretariat and other treaty bodies (the content of input); and secondary literature (for validation or as background). These materials were sourced from both the forums’ websites and aggregated databases (Mitchell et al., 2020).

Post-structural discourse analysis aims to reverse-engineer underlying structures from a data pool of individual utterances (Hajer, 2005; Keller et al., 2018; Boettcher, 2019, 2020). Guided by the analytical categories outlined in Table 1 above, our discourse analysis aimed to identify recurring discursive structures shaping the *what, why, how and who* of CE governance in discussions leading up to the decisions in the three international forums. The data pool of materials for the discourse analysis included a combination of following types of materials for each case: Materials published by the international forums in the lead up to decisions (meeting reports, decision documents, and member statements); independent reports from observers, (sourced from the Earth Negotiation Bulletin); and background interviews with people who were involved in and/or observers to discussions leading up to decisions in each forum.

Our analysis proceeded in two steps. We first independently identified institutional and discursive structures at play in each forum, with one co-author responsible for the institutional analysis, and the other for the discourse analysis. For both types of analysis, we used the qualitative text analysis programme MAXQDA to conduct iterative coding of the text materials – guided by the analytical categories outlined in Table 1 above, with analytical categories being revisited and consolidated as the analysis progressed. We then qualitatively compared the results of both types of analysis, assessing the fit between the categories coded in both the discursive and institutional analyses in each case. The assessment of ‘fit’ was carried out independently by both authors before the results for each case were consolidated.

4. Results

In each of the three case studies presented below, we first describe the type of governance decision reached in each forum, and then illustrate how a range of institutional and discursive structures jointly provided the ‘conditions of opportunity’ for this outcome.

4.1. LC/LP

Three resolutions on marine CE were passed by the parties to the LC/LP: “Ocean fertilization activities, other than legitimate scientific research should not be allowed” (LC/LP, 2008) “scientific research proposals should be assessed on a case-by-case basis using the Assessment Framework” (LC/LP, 2010); and the parties “should continue to develop guidance for listing additional marine geoengineering activities”, thereby subjecting them to assessment and regulation/permission according to the new Assessment Framework for Matter that may be Considered for Placement (LP, 2013). Thus, the LC/LP, in addition to *restricting* marine CE activities in general, also put in place a framework for *permitting* certain CE activities which classify as legitimate scientific research.

4.1.1. Institutional structures

The institutionalized mandate (what) of the LC/LP is narrowly

defined, namely “to prevent the pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea” (Article 1). To fulfil this mandate, the parties assess whether the dumping or “deliberate disposal” of specific substances at sea is likely to cause marine pollution.

The precautionary principle has been a key guiding norm (why) since 1996 (LC, 1996) and is prominently reflected in the ‘reverse list’ approach of the LP (Article 3(1)). Instead of prohibiting the dumping of listed substances, the LP prohibits the dumping of any substance (including iron) that is not listed in Annex 1, unless authorized under a permit. In accordance with the principle, if the parties are unable to determine the likely effects of a proposed disposal option due to the lack of information, they are not allowed to consider the disposal option further (Annex 2, paragraph 14).

The LC/LP mode of governance (how) has long been technocratic regulation based on scientific (risk) assessment. As the dumping of waste necessarily involves some degree of problem shifting to the marine environment (Kim and van Asselt, 2016), the parties to the LC/LP put in place assessment guidelines. Using these guidelines, the parties make a comparative (risk) assessment of dumping and alternative options, and balance any benefits of the disposal option against the cost in terms of human health and environmental risks. When benefits clearly outweigh the cost, a permit may be issued by the parties.

Institutional input for decision-making within the LC/LP comes largely from the Scientific Groups of the LC/LP (who), which evaluate and review the existing list of permitted or prohibited substances in light of new scientific information (Stokke, 1998; see also Verlaan, 2013). These Scientific Groups comprise experts nominated by the parties, and their expertise is largely concentrated on the marine environment. Non-governmental organizations may only participate in meetings of the LC/LP upon invitation by the Chair and with approval of the parties (LC, 1988), which is common for multilateral environmental agreements.

4.1.2. Discursive structures

A narrow governance object (what) was shaped within the structure of the LC/LP debate on CE. Ocean fertilization (OF) was discursively constituted as one specific type of ‘placement of matter for a purpose other than the mere disposal thereof’ into the marine environment and this concept was expanded to potentially include other ‘marine geo-engineering’ activities in the lead up to the 2013 amendment (see Supplementary Table 1). The defining criterion for constituting OF activity as a governance object under the LC/LP was the potential for marine environmental harm through placement of matter in the ocean:

The London Convention and the London Protocol should continue to work towards providing a global, transparent and effective control and regulatory mechanism for ocean fertilization and other activities that fall within the scope of the London Convention and the London Protocol and have the potential to cause harm to the marine environment. (LP, 2013).

This specific governance object was then internally split into placement of matter for the purposes of ‘legitimate scientific research’ - to be permitted pending expert (risk) assessment - and other ‘dumping’ activities which fall outside this category, and are to be prevented:

To date, this debate has revolved around whether ocean fertilization research should be permitted, which is only possible under the current dumping controls, or subjected to “voluntary” controls under the existing placement regime. By creating a permitting authority for ocean fertilization research as a placement activity, a binding permit requirement is created without having to interpret ocean fertilization research as dumping. (LC, 2010a).

The rationales for governance (why) underpinning the LC/LP debate were largely utilitarian, balancing between the potential benefits and risks of OF and other marine geoengineering activities. Governance was correspondingly constituted as needed to quantify and mitigate risks and benefits of activities:

Any specific framework developed for placement activities requires consideration of the following aspects: The details of the specific proposal, including its purpose and characteristics; A clear justification that the proposal is a placement activity with a description of the anticipated benefits and risks; Means to maximize any anticipated benefits and minimize disbenefits. (LC, 2011b).

Correspondingly, the governance mode (how) discursively constituted as practicable within the discursive structure of the LC/LP debate on CE was based on case-by-case expert assessment according to a prescribed framework to determine which activities to permit/restrict:

Scientific research proposals should be assessed on a case-by-case basis using an assessment framework to be developed by the Scientific Groups under the Convention and the Protocol. (LC, 2009).

The discursive structure of OF governance debate privileged scientific and legal experts (who), affording them authoritative speaker positions as legitimate producers of the knowledge on which governance decisions could (and should) be based (see Supplementary Table 3):

Where respondents considered the act to be dumping, it was generally not seen to be captured by Annex 1 (which allows the dumping of certain wastes or other matters with a permit) unless the iron could be classified as an “inert, inorganic geological material”. Guidance on this was requested from the Scientific Groups, who responded, and specifically noted, that it should not be considered as ‘inert, inorganic geological material.’ (LC, 2008d).

4.1.3. Fit

As Table 2 illustrates, there was fit between discursive and institutional structures within the LC/LP on several levels. Those calling for governance discursively shaped a narrow governance object (one specific type of marine-based CE as adding matter to the marine environment for a purpose other than the mere disposal thereof) and the LC/LP’s scope is correspondingly narrow (prevent dumping of environmentally harmful materials in the ocean). The rationales and modes for OF governance were largely utilitarian, balancing between the potential benefits and risks of OF, and this overlapped with the institutionalized

Table 2
Comparing discursive and institutional structures shaping LC/LP decisions on CE.

	Discursive structure	Institutional structure
Objects (what)	A narrow, bounded governance object was discursively constituted (OF as one specific type of ‘placement’).	Scope of LC/LP mandate – focused, narrow (to prevent pollution of the sea by dumping of wastes and other matter)
Rationales (why)	Rationales for governance were largely utilitarian, balancing between the potential benefits and risks of OF activities.	Utilitarian risk-management principle as a guiding norm of LC/LP
Modes (how)	Regulatory governance mode based on scientific assessment of risks/benefits discursively constituted as practicable	LC/LP mode of governance – technocratic regulation/management based on case-by-case scientific (risk) assessment
Speakers (who)	Discursive structure of OF governance debate privileged scientific and legal experts as legitimate knowledge producers	Input for LC/LP decision making from expert working groups

risk-management principles and modes of the LC/LP. The discursive structure of the debate on OF governance within the LC/LP the privileged expert knowledge producers, and this was reinforced by the input ‘hardware’ of the LC/LP which are centred around scientific and legal expert working groups to inform governance decisions. As shown in Table 2, there was a considerable degree of fit across multiple ‘hardware’ and ‘software’ levels, and the type of fit provided the ‘conditions of possibility’ for governance in the form of expert-led risk-benefit assessment to permit certain activities on a case-by-case basis.

4.2. CBD

Two decisions on CE were made by the parties to the CBD. The parties decided that, “[i]n the absence of science based, global, transparent and effective control and regulatory mechanisms for geo-engineering [...] no climate-related geo-engineering activities that may affect biodiversity take place, [...] with the exception of small-scale scientific research studies that would be conducted in a controlled setting” (CBD, 2010). Furthermore, the parties decided that “[m]ore transdisciplinary research and sharing of knowledge among appropriate institutions is needed in order to better understand the impacts of climate-related geoengineering on biodiversity” (CBD, 2016). The CBD’s governance decisions thus focus on *prevention of harm and precaution* in relation to CE activities.

4.2.1. Institutional structures

In comparison to the LC/LP, the CBD has a broad institutional mandate and jurisdictional scope (what): The conservation of biodiversity in areas within the limits of national jurisdiction as well as in the area beyond the limits of national jurisdiction (Articles 1 and 4). Furthermore, the CBD has adopted the (holistic) ecosystem approach as the primary framework for action (CBD, 2000), where ecosystem is defined under the convention as “a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit” (Article 2). Accordingly, the CBD aims for “the integrated management of land, water and living resources” by focusing, for example, on cross-cutting issues such as climate change and biodiversity, where the contribution of biodiversity to climate change mitigation and adaptation is recognized.

The CBD is guided by several principles (why), including the precautionary approach. The preamble notes 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”. The application of such an approach has been most prominent in relation to the conservation of marine and coastal biodiversity. Decision II/10, for example, states that the work of the Executive Secretary on marine and coastal biodiversity “should not be impeded by the lack of full scientific information and will incorporate explicitly the precautionary approach in addressing conservation and sustainable use issues” (CBD, 1995).

The mode of governance institutionalized in the CBD (how) is generally not top-down. The implementation of measures for conservation and sustainable use is at the discretion of each party “in accordance with its particular conditions and capabilities” (Article 6). Importantly, however, there is an exception for activities which are deemed to endanger biodiversity. This is made explicit in Article 22(1), which is dubbed a “reverse” conflict clause. It obliges the parties to the CBD to give their rights and obligations under the convention precedence over their rights and obligations from other international agreements, if the exercise of those rights and obligations would “cause a serious damage or threat to biodiversity”. Although the CBD has never elaborated on the content of Article 22 (Kim and van Asselt, 2016), the underlying premise is clear: Serious harm to biodiversity must be avoided.

In terms of input structures, decisions are informed by both science and non-scientific knowledge (who). The parties receive scientific

advice from the Subsidiary Body on Scientific, Technical and Technological Advice (Morgera and Tsioumani, 2011). Unlike the LC/LP, the parties to the CBD do not rely exclusively on scientific risk assessments of the impact of certain activities on biodiversity, but also on other forms of knowledge such as those of indigenous peoples and local communities. Decision-making is relatively open and inclusive at the CBD. The CBD Secretariat encourages the participation of a number of major stakeholders, including business, children and youth, local authorities, non-governmental organizations, parliamentarians, universities and the wider scientific community (CBD Secretariat, 2005). Notably, the preamble of the convention text stresses the importance of cooperation with the non-governmental sector, which is exceptional for a multilateral environmental agreement.

4.2.2. Discursive structures

A broad, unspecific governance object (what) was constituted with the discursive structure of the CBD debate on CE (see Supplementary Table 2). The defining criterion for constituting the idea of CE as a ‘lumped’, singular governance object was the various approaches’ potential to have effects on biodiversity and coupled socio-ecological human/nature systems:

An interim definition of geo-engineering includes any technologies that deliberately reduce solar insolation or increase carbon sequestration from the atmosphere on a large scale that may affect biodiversity. (CBD Secretariat, 2011a).

Rationales for governance (why) structuring the CBD debate on CE were precautionary, emphasizing the potential (environmental and social/cultural) detrimental effects of CE activities. Precautionary governance was constituted as needed to prevent activities with the potential to have detrimental effects on socio-ecological systems:

On geo-engineering, the COP invites parties and governments, according to national circumstances and priorities, to ensure, in line with decision IX/16 C on ocean fertilization, in the absence of a science-based, global, transparent and effective control and regulatory mechanism for geo-engineering, and in accordance with the precautionary approach and CBD Article 14, that no climate change-related geo-engineering activities that may affect biodiversity take place, until there is an adequate scientific basis on which to justify them and appropriate consideration of the associated risks for the environment and biodiversity and associated social, economic and cultural impacts. (ENB, 2010).

In addition, emphasis was placed on the need for governance to facilitate transdisciplinary research and knowledge integration to better understand the potential biodiversity impacts of CE. Governance was posited as being needed for capacity building – to ensure that information can be gathered, integrated and shared, especially on possible impacts on biodiversity and associated social, economic, cultural, ethical considerations:

The COP reiterated the importance of the precautionary approach in relation to climate-related geoengineering, [...] and the need for more research and knowledge-sharing in order to better understand the impacts of climate-related geoengineering. (CBD Secretariat, 2016).

A centralized, restrictive governance mode (how) was linked to this precautionary logic. Enforcement of a broad ‘ban’ on all CE activities was constituted as appropriate, rather than regulation based on a case-by-case assessment of risk. This translated into the discursive constitution of global, transparent and effective *control and regulatory* mechanisms to *prevent potentially harmful* CE activities from taking place:

Informal exchanges also continued on a possible moratorium on geo-engineering, with conjecture surrounding the possible fate of one of the conditions for lifting the moratorium, namely the setting up of a global regulatory framework. (ENB, 2010).

The discursive structure of the CBD CE debate privileged both scientific and non-scientific actors as legitimate ‘knowledge producers’ (who). As biodiversity/sustainability involves ‘people on the ground’, socio-cultural knowledge was constituted as legitimate alongside science to inform CE governance decision making:

[The COP] recognizes the importance of taking into account sciences for life and the knowledge, experience and perspectives of indigenous peoples and local communities when addressing climate-related geoengineering and protecting biodiversity. (SBSTTA, 2015b).

4.2.3. Fit

As Table 3 outlines, there was a ‘fit’ between discursive and institutional structures within the CBD on several levels. The governance object (what) was broad/unspecific – lumping all CE measures together based on their potential to harm biodiversity (and related socio-ecological systems). This fit with the broad scope of the CBD mandate to protect biodiversity from potential harms. There was a fit between discursively constituted rationales (why) for governance structuring the debate on CE, and the guiding precautionary norm of the CBD. The mode of governance (how) being discursively constituted as practicable involved control and regulation in line with the top-down regulatory mode that the CBD employs for activities which are deemed to endanger biodiversity. The discursive structure of the CE governance debate in the CBD assigned discursive authority to knowledges in the plural, with scientific and local, indigenous knowledge producers (who) constituted as legitimate speakers. This fit with institutionalized input structures providing a range of actors with access to decision-making in this forum. In sum, there was a high degree of fit across multiple discursive and institutional levels, and the type of fit provided conditions of possibility which made precautionary prevention of harm through a coercive ‘ban’ on CE deployment thinkable and practicable.

4.3. UNEA

UNEA discussed and rejected a draft resolution in 2019 calling for an assessment of CE proposals to provide “conclusions on potential global governance frameworks” (UNEA, 2019). As no active decision was taken to provide guidance on or regulate activities related to CE, UNEA’s decision represents an example in which CE was deemed ungovernable

Table 3
Comparing discursive and institutional structures shaping CBD decisions on CE.

	Discursive structure	Institutional structure
Objects (what)	A broad, unspecific governance object was discursively constituted (CE as a whole, effects on socio-ecological systems).	Scope of CBD mandate – broad (the conservation of biological diversity)
Rationales (why)	Rationales for governance were precautionary, emphasising the (biodiversity and social/cultural) risks of CE	Precautionary principle as a guiding norm of the CBD
Modes (how)	Coercive, centralized governance mode constituted as practicable	CBD mode of governing activities which threaten to cause serious damage or threat to biodiversity restrictive, coercive
Speakers (who)	Discourse privileged both scientific and non-scientific knowledge producers	Input for CBD decision making open to scientific and non-scientific groups.

within a specific international forum.³

4.3.1. Institutional structures

UNEA is the governing body of the UN Environment Programme. It meets biennially “to set priorities for global environmental policies and develop international environmental law” (what) (UNEA, 2021). Its core function is to keep the state of the global environment under periodic review and to identify novel challenges for global environmental governance (Perrez, 2020).

As an overarching institution, its aim is to enhance the ability of UNEP to fulfil its coordination mandate, and to empower UNEP to lead efforts to formulate UN system-wide strategies on the environment (UNGA, 2012: para.88(c)). While the entire corpus of international environmental law applies in UNEA decision-making, the principles (why) that aim to reconcile, integrate, or balance various conflicting global environmental goals and interests play a significant role in the operation of UNEA.

UNEA makes ministerial declarations and resolutions which are non-legally-binding but nonetheless authoritative (how). The authority is largely derived from the strengthened legitimacy of UNEA, which is an outcome of Agenda 2030 and a subsequent UN General Assembly resolution (UNGA, 2013) that reinforced and upgraded the UN Environment Programme by establishing universal membership in the then Governing Council (Kaniaru, 2014). This institutional reform has established UNEA as “the world’s highest-level decision-making body on the environment” (UNEA, 2021), thereby increasing some degree of hierarchy in global environmental governance (Kim et al., 2020).

UNEA makes decisions not solely on a scientific basis, but seeks input from various experts and stakeholders (who). UNEA, for example, refers to the Intergovernmental Panel on Climate Change for scientific expertise. If necessary, it may establish expert groups or working groups (such as the Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics) to generate input for decision-making (UNEA, 2016). Notably, UNEA also engages with stakeholder and private sectors: All Major Groups and Stakeholders’ organizations accredited with UNEA are authorized to vote (UNEA, 2016).

4.3.2. Discursive structures

The discursive constitution of the object to be governed by UNEA (what) was disputed. There was a split between a broad vs. a narrow governance object - constituting CE as a whole, or only certain types of CE activities as the object of governance (see Supplementary Table 3). This was based on conflicting defining criteria for constituting CE as a governance object: Overall usefulness as a climate policy strategy on the one hand and potential environmental/socio-ecological risk on the other:

There are different factions who are either emphasizing “we need to govern this as an emerging risk issue”, while others are saying “we need to govern this as an uncertain climate action avenue”. (Interviewee A1).

Likewise, discursive governance rationales (why) were split between governing (some types) of CE for the purpose of precautionary control and oversight and not governing others to avoid infringing on the political realm of climate change, potentially placing inappropriate restrictions on (national) climate policy:

Some delegates cautioned the negotiations were veering into the difficult political domain of climate change, while others said

³ We do not mean to imply that CE may not be governed within UNEA in the future, nor to negate the possibility that simply discussing a possible resolution at UNEA may have a *de facto* governance effect on CE activities going forward.

discussions on geoengineering and climate change are unavoidably intertwined. (ENB, 2019a).

The opponents called the resolution premature, and criticised it for threatening inappropriate restrictions, especially on carbon removal approaches. (McLaren, 2019).

Three conflicting modes of governance (how) were discursively constituted as practicable – a centralized, expert-led, mode, a bottom-up, participatory mode and a decentralized, laissez faire mode. While the first emphasised that CE governance should be shaped by experts and informed by existing international principles/laws, as the basis of policy recommendations for UNEP parties, the second posited that such decisions should be taken with full participation of civil society and relevant affected parties, and the third put forward that CE governance on the global level was inappropriate and should rather be decentralized through national policy (see Supplementary Table 3).⁴

The discursive structure of the CE governance debate at UNEA privileged several types of actors as potentially conflicting ‘knowledge producers’ (who). On the one hand, it was posited that governance decisions were to be made based on expert knowledge about risks and benefits of CE, while on the other privileged speaker positions were afforded to producers of indigenous and traditional knowledge:

Many representatives expressed regret that, due to the opposition of some Member States, no agreement had been reached at the current session on the draft resolution on geoengineering and its governance, which would have requested UNEP to collect information and prepare a factual report on the risks, potential and governance challenges of geoengineering technologies, in line with its mandate of keeping Member States apprised of emerging environmental issues. (UNEP-EA, 2019).

A representative of Asia Indigenous Peoples Pact made a statement on behalf of the major groups and stakeholders except business and industry. He noted with regret the abandonment of proposed resolutions on deforestation, agricultural supply chains and the strengthening of geoengineering governance and the dilution of other resolutions, which would mean, inter alia, a lack concerted action on and resources for implementation [...] intended to enhance their engagement in work programmes with the inclusion of indigenous traditional knowledge and practices. (UNEP-EA, 2019).

4.3.3. Fit

As Table 3 outlines, the failure of the UNEA resolution on CE may have been influenced by a lack of fit between conflicting discursive and institutional structures. The discursive structures were split between several competing logics: One top-down, expert-led; one bottom-up and participatory; and one decentralized and laissez faire, which resulted in the constitution of conflicting governance rationales (why), objects (what) and modes (how) and speakers (who). These logics were in turn at odds with some of the institutional structures of UNEA – in particular the forum’s mode of non-binding but nevertheless politically authoritative global governance, which did may have fit with the top-down, expert-led mode, but not with the other two conflicting modes being discursively constituted. The institutionalized input structures which provided a range of actors access to decision-making in this forum fit with the discursive privileging of differing social actors as legitimate

⁴ While in practice differing modes of governance may mutually reinforce one another, we posit that – especially during the emergence of governance - conflict between the underlying modes being constituted as most appropriate within a given forum can make consensual decisions on governance harder to reach.

knowledge producers. But given the low degree of fit within and between discursive and institutional structures on other levels, this may have played a role in making the decision not to govern CE within this forum the most ‘thinkable and practicable’ governance outcome (Table 4).

5. Discussion

Faced with same emerging environmental issue – how to govern deliberate, large-scale interventions into the climate system in response to climate change – the three forums produced differing governance outcomes: The fit between software and hardware in the LC/LP provided the conditions of possibility for governance in the form of expert-led risk-benefit assessment to permit certain CE activities on a case-by-case basis, the fit between discursive and institutional structures in the CBD made a precautionary ban on CE activities thinkable and practicable, and the lack of fit within and between discursive and material structures at UNEA contributed to CE being deemed (currently) un-governable within the forum.

What might this mean for future governance of CE on the global level? Answering this question fully is beyond the scope of this paper, but to begin to consider it, we need to take a step back and relate the findings presented here to wider investigations of the interconnected roles of discursive and material structures in political and institutional stability and change.

5.1. The structuring power of discourse

Our work feeds into an ongoing academic debate on the role of discourse in the emergence, persistence, and transformation of political institutions. Representatives of various branches of social constructivist institutionalist theory such as Schmidt and Hay contributed significantly to understanding the roles played by ideas and discourses in institutional dynamics. Hay’s constructivist institutionalism highlights the role of actors’ perceptions and ‘ideas of institutions’ in pursuing institutional change (Hay, 2006, 2011, 2016, 2017), and Schmidt’s discursive institutionalism focuses on the discursively mediated preferences, strategies, and normative orientations of actors in explaining the dynamics of institutional processes (Schmidt, 2008, 2010, 2011a, 2011b, 2017). However, as argued by proponents of post-structuralist institutionalism (PSI) such as Larsson (2018), these approaches privilege the subjective ideational agency of actors and fall short of putting the inherent shaping power of discursive and material structures at the centre of analysis. PSI posits discourses as having constitutive causality, meaning discourse itself has the power to structure and shape institutional dynamics. Our framework builds upon similar theoretical footings, and thus parallels

Table 4
Comparing discursive and institutional structures shaping UNEA decision on CE.

	Discursive structure	Institutional structure
Objects (what)	Governance object formation disputed, broad vs. narrow. CE as a whole, or only certain types of CE	Scope of UNEA mandate – broad: To set and coordinate priorities for global environmental governance.
Rationales (why)	Discursive rationales for governance were split. Enable some types to help achieve (political) climate goals vs. precautionary restriction of others to reduce (political/ environmental) risk	Guiding norm(s) of the UNEA: Principles of integration, reconciliation, coordination, to ensure the overall state of the global environment improves
Modes (how)	Centralized, top-down mode conflicted with bottom-up, participatory and laissez faire, neo-liberal modes	UNEA mode of governance: Non-binding, but politically authoritative guidance
Speakers (who)	Discourse privileged a range of knowledge producers/speakers	Input for UNEA decision-making from a range of actors

can be drawn between the potential for institutional change posited by PSI and future governance of CE within global institutions. While Hay and Schmidt may argue that new institutional outcomes can result from changing subjective and intersubjective ideas being brought forward by actors in a given institutional setting, PSI posits that existing discursive and material structures are more resistant to change. This hypothesis would seem to be in line with our findings, suggesting that whether CE is governable on the global level, and if so, how, will continue to depend on existing discursive and material structures in various international forums.

Post-structuralist theories, however, do not posit that structure is restrictive enough to preclude all change. Rather, they highlight the emancipatory function of elucidating reified discursive and material structures which make some types of governance more ‘thinkable and practicable’ than others (Boettcher, 2020). Mapping the discursive and material structures which form the ‘conditions of possibility’ making certain types of CE governance seem most appropriate within a given international forum may therefore enable those engaging in CE governance development to recognize and critically reflect upon their contingent nature – a necessary first step towards considering alternatives.

5.2. Navigating material and discursive structures in future CE governance

A look to the literature on climate governmentalities is also instructive for interpreting the wider implications of our results. Governmentality scholars such as Bäckstrand, Bulkeley, Lövbrand and Stripple have traced how persistent discursive and material ensembles have shaped international climate governance in recent decades (Bäckstrand and Lövbrand, 2006, 2016; Lövbrand and Stripple, 2014; Stripple and Bulkeley, 2014). Their detailed historical analyses have identified three competing ‘meta discourses’ underpinning climate governance – each of which shapes and is reinforced by a corresponding set of institutional structures: ‘Green governmentality’ which is based on a hierarchical, administrative logic, ‘ecological modernization’, which reflects an neoliberal logic, and ‘civic environmentalism’, which is built upon a logic of democratic participation.

Building on this work, some effort has been made to identify if and how emerging CE governance is being shaped by these persistent ‘meta discourses’ and their associated institutional structures (Boettcher, 2020; Low and Boettcher, 2020). In a similar vein, it is possible to compare if and how the discursive and material structures identified in this paper ‘fit’ the broader governmentalities at play in climate governance. The expert risk-benefit assessment-based governance mode constituted in the LC/LP debate on CE governance may reflect the utilitarian logic of ecological modernization. The CBD discursive and material structures which emphasise precautionary control may reflect elements of a hierarchical ‘green governmentality’. The UNEA debate seems to include competing elements of the neo-liberal ecological modernisation governmentality, top-down green governmentality, and elements of what Bäckstrand and Lövbrand (2016) dub the ‘reformist’ strand of civil environmentalism, which calls for including a wider range of stakeholders in governance development processes. Our results suggest that conflicting discursive and material ensembles which have historically shaped broader climate governance may therefore also be influencing the emerging governance of CE at the global level. Looking to lessons of the past may help to anticipate and navigate the effects of these persistent meta structures in current and future CE governance development processes.

These broader implications highlight the emancipatory potential of our approach: Mapping how existing institutional and discursive structures create barriers and opportunities for the governance of new environmental challenges can help actors involved in governance development in specific forums “navigate a social reality that is saturated with structures” (Larsson, 2018: 325). Here, “reverse engineering”

the relatively soft, discursive structures may be key for building a holistic and principled approach to governing CE. Reverse engineering facilitates rethinking the discursive construction of reified objects, speakers and subjects, rationales, modes and instruments of CE governance (Boettcher, 2019). Without such reflection, CE governance could become increasingly fragmented through the engagement of multiple institutions establishing their own rules. Governance fragmentation would in turn open the door for forum shopping or increase the risk of problem shifting. By identifying potential conflicts and synergies between different systems of thinking about the nature and practice of CE governance, mapping discursive structures may play a key role in steering away from the current piecemeal approach to governance development towards more principled, coordinated, and inclusive CE governance.

6. Conclusion

Our combined institutional and discursive analysis has highlighted that the fit between discursive ‘software’ and existing institutional ‘hardware’ shaped the governance choices and opportunities available in the three international forums that have thus far dealt with the same novel environmental challenge – whether and how to govern deliberate, large-scale anthropogenic inventions into the global climate system.

As we have shown in this paper, varying structural ‘conditions of possibility’ have the power to shape how the same environmental issue is governed differently in various forums. We have highlighted that neither an exclusive focus on institutional ‘hardware’ nor on ‘discursive’ software is sufficient to understand the emergence of governance. Existing institutional architectures at the global level influence whether and how a new environmental challenge becomes governable (Biermann and Kim, 2020). Discourse is the ‘source code’ with which contested futures are written, shaping what governance options can be imagined and materialized (Boettcher, 2019, 2020). Developing an innovative analytical framework that brings together neo-institutionalist and post-structuralist discourse approaches, we have shown that reverse-engineering the fit between both the institutional architectures and the discursive blueprints underpinning governance development processes can help to anticipate, critically reflect upon, and more successfully navigate the emergence of global climate (engineering) governance in the Anthropocene.

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CRedit authorship contribution statement

MB: Conceptualization, Data curation, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **RK:** Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.envsci.2021.11.015](https://doi.org/10.1016/j.envsci.2021.11.015).

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