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Institutional complexity and private authority in global climate governance: the cases of climate engineering, REDD+ and short-lived climate pollutants

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ABSTRACT

How and why do institutional architectures, and the roles of private institutions therein, differ across separate areas of climate governance? Here, institutional complexity is explained in terms of the problem-structural characteristics of an issue area and the associated demand for, and supply of, private authority. These characteristics can help explain the degree of centrality of intergovernmental institutions, as well as the distribution of governance functions between these and private governance institutions. This framework is applied to three emerging areas of climate governance: reducing emissions from deforestation and forest degradation (REDD+), short-lived climate pollutants (SLCPs) and climate engineering. Conflicts over means and values, as well as over relatively and absolutely assessed goods, lead to considerable variations in the emergence and roles of private institutions across these three cases.

KEYWORDS Regime complex; institutional complexity; institutional fragmentation; private authority; non-state actors; climate change; climate engineering; geoengineering; REDD+; short-lived climate pollutants

Introduction

In the run-up to the 2015 UN climate summit in Paris, non-state actors helped provide a new impetus to multilateral climate negotiations. After Paris, this functional differentiation and interplay between multilateral diplomacy and transnational climate action keeps evolving. Public, private and hybrid governance arrangements are experiencing further institutionalisation, but with considerable variation among subfields of international climate politics.

Here, we seek to both assess and explain the different shapes of institutional complexity or 'hybrid multilateralism' (Bäckstrand and Kuyper 2017) that characterise selected sub-areas of global climate governance. This objective implies two uncommon, but much needed perspectives for the study of institutional

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complexity. First, we bridge the divide between studies that mainly examine international regimes and studies focusing on transnational approaches (cf. Betsill *et al.* 2015). Second, we zoom in on global climate governance, addressing the institutional complexity of specific issues *within* this domain.

We understand institutional complexity as a diversity of international institutions that legally or functionally overlap in addressing a given issue area of global governance. They do so while potentially differing 'in their character (organisations, regimes, and implicit norms), their constituencies (public and private), their spatial scope (from bilateral to global), and their subject matter (from specific policy fields to universal concerns)' (Biermann *et al.* 2009, p. 16).

We analyse three distinct sub-areas of high policy relevance: reducing emissions from deforestation and forest degradation (REDD+), short-lived climate pollutants (SLCPs) and climate engineering (CE). We selected these cases, because all are dynamic areas of international climate policy that have recently experienced significant institutional development; they are relatively new and still represent major gaps in institutional analysis; they vary significantly in their degree of complexity, in the number of major public institutions involved in their regulation and in the distribution of functions across public, private and hybrid institutions.

For each of these issue areas, we address two questions. First, what is the shape of institutional complexity? Here, we are interested in identifying the functions that private or hybrid arrangements have come to carry out and how these relate to the roles of intergovernmental institutions.

Second, what are the underlying causes of this complexity? Here, we are interested in exploring why we observe a certain type of hybrid multilateralism or public–private mix, and why there are variations across areas. We specifically focus on the role of problem structure as an explanatory variable. We build it into a falsifiable research design, acknowledging that there would be other variables (e.g. constellations of power, norms, knowledge) that equally merit examination.

The following section sketches our analytical framework to address both research questions. The subsequent sections provide an explorative application of this framework to the three issue areas. The conclusion delivers crosscutting findings.

Analytical framework

Public and private authority

Following Bäckstrand and Kuyper (2017) in their understanding of 'non-state' as the broader class of actors, with 'private', we refer to a subgroup thereof: actors and institutions that are not exclusively public. This includes business, civil society, experts or media actors and also extends to hybrid

arrangements set up by both private and public actors.[1] It excludes intergovernmental bureaucracies and organisations, and public actors operating at sub-national levels such as municipalities. This distinction between intergovernmental and private is instrumental for the theoretical approach we develop here. Our framework consists of different, albeit connected, assumptions about the emergence of international public (i.e. intergovernmental) institutions and international private (i.e. transnational) institutions.

Second, we focus on 'authority', defined as the institutionalised forms of power exerted by public and private actors in an issue area of global governance (Hall and Biersteker 2002, Büthe 2004). The authority of a public entity refers to a recognised institutional competence to make decisions or interpretations in the name of the collective interest (Raz 2009). For private authority, institutionalisation and legitimacy are equally important (Cutler *et al.* 1999, Hall and Biersteker (2002). It is often much harder, however, to delineate a clear audience or set of principals for private institutions, and to assess the legitimacy-related aspect of private authority. For our explorative case studies, we therefore follow Green's (2014, p. 6) pragmatic definition that focuses on institutionalisation and 'restricts private authority to the creation of actual rules, standards, guidelines, or practices that other actors adopt'. We thus use the terms private authority, transnational institutions and private institutions interchangeably, referring to the institutions that private actors establish in a given area of global governance.

Institutional complexity, mixed governance architectures and the role of private institutions

If institutional complexity is a matter of degree (Biermann *et al.* 2009), what are useful criteria for characterising and comparing the respective mix between private and public institutions across issue areas? We distinguish centrality of one or several core public institutions, sources of private authority and the functional division of labour between public and private institutions.

With regard to the *centrality* of public institutions, we differentiate between architectures with one core institution, two or a few identifiable cores and multiple or no cores with no clear hierarchy or division of labour. We build our assessment on taxonomies by Biermann *et al.* (2009) and Keohane and Victor (2011). However, their taxonomies do not address the specific mix of private and public institutions and the respective functions that each 'camp' performs for a given architecture of global climate governance. For this, we draw on a second strand of literature.

A first approach to analysing functions of private institutions in global climate governance is to ask *how* private institutions play a role, either duplicating or replacing public institutions for these functions or filling the governance gaps they leave. Building on some of the leading studies on private authority (Cutler *et al.* 1999, Abbott 2012), we distinguish the following *functions*: agenda-setting (with a particular focus on sharing information and networking), policy formulation (setting standards, rules and guidelines), financing, implementation and evaluation. These functions roughly correspond to the policy cycle model (cf. Howlett *et al.* 2009), with the difference that we collapse policy formulation and decision-making, and add financing, which represents a particular channel of influence for private authority.

A different question is *why* they have taken on a governing role. Green (2014, pp. 33–36) distinguishes two *sources* of private authority, delegated and entrepreneurial. Either a private institution has been instructed to create rules, set standards or perform other governance functions on behalf of the governed or a public institution; or a private institution has taken entrepreneurial initiative on its own to set rules or standards. By 'the governed', Green refers to 'those who obey' authority, meaning here those who adopt the rules of private institutions (Green 2014, p. 29).

This distinction is connected to the centrality of a public institution in the issue area. If there is a dominant intergovernmental institution, or but a few with a clear division of labour, we can expect this core to leave only limited functional space to private institutions and, potentially, to play a role in the assignment of respective functions through delegation. On the other hand, where there is no dominant institution or no clear division of labour, private institutions might have more space to fill governance gaps on their own initiative. Table 1 summarises the criteria through which we will assess the institutional complexity of the three selected governance architectures.

Table 1. Dimensions and values of institutional complexity in mixed architectures.

Dimensions	Values
Centrality of public authority	– One core institution – Two or a few identifiable cores (with hierarchy or division of labour) – Multiple cores (without hierarchy or division of labour) – No identifiable core
Sources of private authority	– Delegated – Entrepreneurial
Distribution of functions among public and private institutions	– Agenda-setting – Policy formulation – Financing – Implementation – Evaluation

The above dimensions cover aspects of institutional complexity that a problem-structural approach may help explain, including the emerging opportunities or functional spaces for private institutions. They do not specify which private institutions will fill these functional gaps. Moreover, our dimensions do not differentiate between the levels at which institutions operate. Finally, we avoided adding a relational dimension that would characterise interactions within and across the public and private institutional camps.

Explaining different degrees of complexity and architecture mixes

We distinguish two types of theory-guided assumptions: those derived from the problem-structural strand of institutionalism, to explain the degree of centrality of public institutions as well as potential sources of private authority; and those derived from private authority theory, to explain the functional mix between public and private institutions.

We chose the first set of theories because the considerable variation of institutional complexity across issue areas suggests that the definition and nature of issue areas may have a causal impact. Rittberger and Zürn (1990) distinguish different types of conflicts among actors according to the object of contention. Conflicts over means and values are both classified as dissensual conflicts, as actors disagree on the collective subject of the conflict. Whereas in conflicts over means, actors share a common goal but disagree on the means to pursue it, conflicts over values are based on 'incompatible principled beliefs regarding the legitimacy of a given action or practice' (Hasenclever *et al.* 1997, p. 63). Conflicts of interest, on the other hand, are consensual, as actors value the same scarce good, but compete for it. If the good in question is assessed absolutely, such as clean air or an intact ozone layer, actors tend to consider only their own shares and gains in these goods: 'how much do I get?' For relatively assessed goods, such as fisheries or plant genetic resources, relative shares and gains matter: 'how much more or less than the others do I get?' Rittberger and Zürn (1990) expect different degrees of regime-conduciveness for each of these four types. They assume that actors will more easily cooperate in conflicts over means and absolutely assessed goods, as these situations imply a less asymmetrical constellation of preferences.

Underdal adds situation-structural elements to this approach. He distinguishes between benign and malign problems, understanding the political malignancy of a problem as 'a function of the configuration of actor interests and preferences that it generates' (Underdal 2002, p. 15), with constellations of preferences corresponding to certain types of contested objects. *Malign problems* are characterised by competition among actors and incompatibility of values. They likely entail manipulation or coercion in the course of negotiations and are marked by persisting incentives for unilateral defection after an agreement is struck. In light of these features,

the notion of malign problems incorporates conflicts over values and conflicts over relatively assessed goods (problem-structural approach) as well as collaboration and suasion situations (situation-structural approach).

Benign problems are characterised mainly by imperfect information, with no incentives for unilateral defection from an agreed solution. By stressing symmetrical interests and values, the benign problem-type covers Rittberger and Zürn's conflicts over means and conflicts over absolutely assessed goods. Furthermore, with their relatively high potential for efficient cooperation, benign problems comprise major elements of the situation-structural types of assurance and coordination situations (Underdal 2002). Figure 1 summarises Underdal's integrated approach.

Based on the theory explained above, we derive a first set of hypotheses on the relation between problem structure and emergence of intergovernmental institutions:

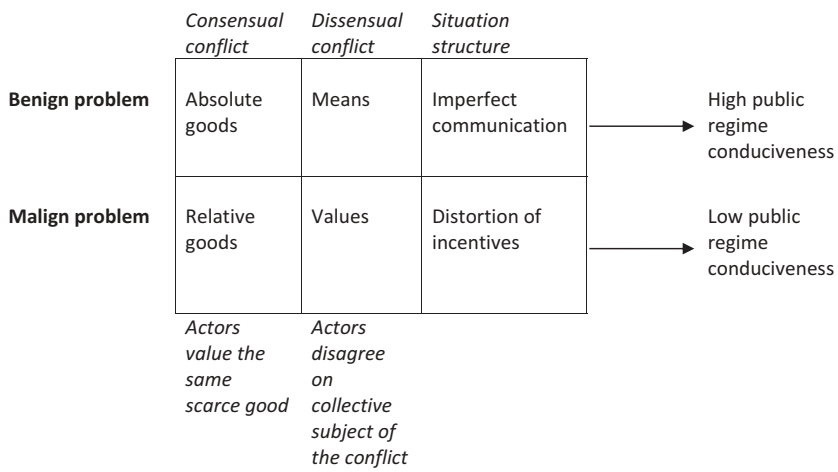

Figure 1. Integration of problem-structural and situation-structural explanations for regime-conduciveness.

H1a. Benign problems tend to feature a centrality of one (near-universal) or a few public institutions, with a legal or functional hierarchy or division of labour among them. This identifiable core takes over the key functions for regulating the issue area. It will leave less functional space for private institutions and rely on delegated authority.

H1b. Malign problems tend to feature no public institutional cores, or multiple ones that likely conflict on major subjects or lack a clear hierarchy or division of labour. The resulting functional governance gaps are (partly) filled

by other types of institutions (smaller public ones, private and hybrid ones) through entrepreneurial authority.

These hypotheses help predict the first dimension of public centrality and also tendencies towards sources of private authority (delegated or entrepreneurial), but they do not give concrete indications about the particular functions that are taken over by private institutions. For this, we refer to the literature on private authority. Green (2014) names both the demand for private authority and the supply of private authority as main explanatory factors for its emergence. Adapting Green's distinctions, we introduce two further sets of hypotheses to explain the functional mix in complex governance architectures.

H2a. Private institutions tend to perform specific functions *when there is a demand of the governed for*

- lowering transaction costs: through agenda-setting (here particularly information-sharing), policy formulation (soft rule/standard-setting) and financing;
- enhancing credibility of commitments: through implementation and evaluation;
- providing first-mover advantage to early adopters on a policy problem: through agenda-setting and policy formulation;
- enhancing reputation: through implementation and evaluation.

H2b. Private institutions tend to perform specific functions *when they supply*:

- expert opinions, practical experience or legal/moral authority: for agenda-setting, policy formulation, implementation and evaluation;
- financial capacities and economic experience: for implementation and financing.

Unlike the first set of assumptions, these hypotheses cover relatively short causal chains, with the dependent variable (distribution of functions among private and public institutions) explained by functional gaps (demand side) and functional qualities (supply side).[2] What is more, demand and supply can be (partly) seen as functions of the nature of the problem to be regulated. Green (2014, p. 47) makes clear that private institutions will only be chosen 'when [international organisations] cannot supply the equivalent benefits' – in other words, when significant public governance gaps exist. Green and Auld (2016) further argue that different game-theoretic situations may call for different types of private rule-setting. Thus, the factors of demand and

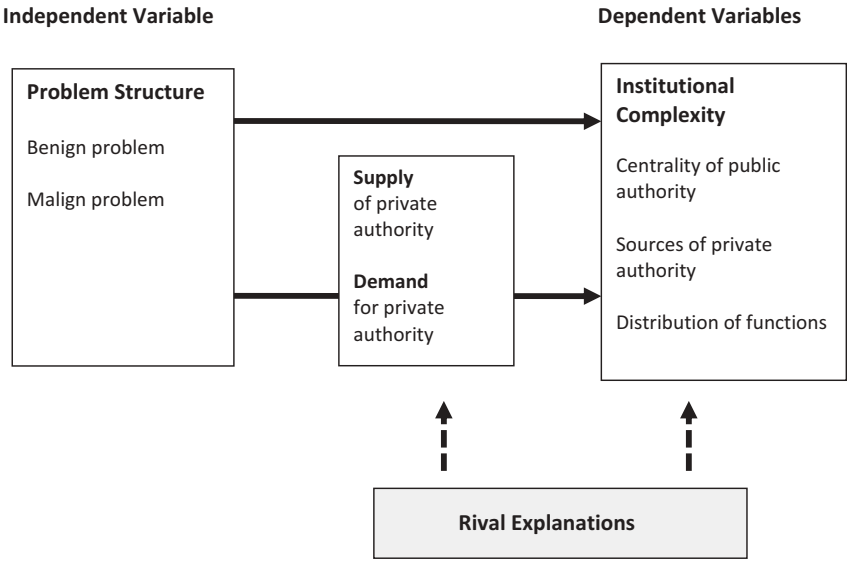

Figure 2. Overview of the analytical framework.

supply rather play the role of intervening variables in our framework (Figure 2).

Finally, there are rival factors that may influence the shape of an institutional architecture and the roles of private authority therein. Jordan *et al.* (2015, p. 979) summarise some of these factors: 'moral concerns, fear of new regulation (or the opportunity to secure first-mover advantages by shaping it), the pursuit of direct financial rewards, indirect or "non-climate" benefits (for example, reputational enhancement), and the satisfaction of consumer expectations'. Beyond these, the constellations of norms, knowledge or different forms of power may enable specific types of private actors more than others to build and entertain effective institutions. Our falsifiable, parsimonious approach hence comes at a price, since it cannot explain the dominance of specific actors, nor particular relations between public and private institutions.

To probe this framework, the following sections present an explorative qualitative analysis for each of three cases.

REDD+ governance

An incentive mechanism to avoid emissions from deforestation

REDD+ seeks to create financial value for carbon stored in forests. Proponents of REDD+ intend to provide economic incentives for the sustainable use and conservation of forests while also reducing the drivers of

deforestation and forest degradation. However, opponents have expressed scepticism about putting a price on nature through economic incentives (Corbera and Schroeder 2011) and cautioned against negative impacts on indigenous and local communities as well as biodiversity (Peskett and Todd 2013).

These concerns entailed debates on social and environmental safeguards that should be provided by public and private actors. In addition, several other key aspects of REDD+ need further specification, for instance, conditions for the allocation of funds and approaches to measurement, reporting and verification (MRV).

Institutional complexity in REDD+: which role for private authority?

The global REDD+ architecture is fragmented, with a diverse mix of global public institutions, bilateral arrangements and non-governmental approaches (Gupta *et al.* 2016). This patchwork notwithstanding, a relatively high degree of public institutional centrality can be identified, with the United Nations Framework Convention on Climate Change (UNFCCC) at the core.

Negotiations under the UNFCCC represent the decision-making hub. At the 2005 Conference of the Parties (COP), REDD+ was proposed by an alliance of rainforest nations. In 2008, the definition of REDD+ was expanded to account for non-carbon benefits of forests and sustainable forest management. At COP 16 in Cancún in 2010, parties adopted a list of social and environmental safeguards to be respected when implementing REDD+ activities. COP 19 (2013) agreed on the Warsaw Framework for REDD+. To be eligible for performance-based financing, governments must in every 2 years provide a summary of how they are complying with REDD+ safeguards. The Paris Agreement did not add substantially to this framework and confirmed the non-binding character of REDD+.

In addition to, but closely related to, UNFCCC negotiations, three multilateral financing institutions are central in the REDD+ governance architecture: the Forest Carbon Partnership Facility, a World Bank programme launched in 2007; the Forest Investment Programme, a multi-trust fund under the World Bank's Strategic Climate Fund created by several regional developing banks and several bilateral donors; and UN-REDD (UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation), launched in 2008 by the Food and Agricultural Organization, the UN Environment Programme and the UN Development Programme.

All three institutions assist developing countries in their preparation and implementation of REDD+ projects, support respective capacity-building and, ultimately, provide payments for verified emissions reductions. With nearly US$ 2 billion as of October 2016,[3] the three funds provide the bulk of currently pledged REDD+ financing. Moreover, they exert key policy

formulation and implementation functions. The UNFCCC might be nominally tasked with providing overarching guidance, but, in practice, funds have fewer problems defining enforceable safeguards since they can make financing contingent on them (McDermott *et al.* 2012).

Next to these four central bodies, several other public initiatives contribute to REDD+ financing, including multilateral mechanisms (Global Environment Facility) and regional banks that administer their own funding mechanisms (the Amazon Fund and the Congo Basin Forest Fund). Norway, Germany and Japan are major donors of bilateral funding. Nearly all these institutions provide suggestions or even regulations on particular sub-issues, such as allocation criteria for funds, social and environmental safeguards, and MRV.

Against the backdrop of this strong public institutional involvement on REDD+ policy formulation and financing, private institutions perform largely agenda-setting functions (mostly information-sharing), implementation and evaluation services. Key actors are domestic or foreign companies and conservationist NGOs that serve as project developers and lobby or advise public forest authorities. The impact of vulnerable groups such as indigenous communities or smallholder associations, by contrast, is generally much lower.

One outcome of the engagement of NGOs and companies is the growing number of private REDD+ environmental and social safeguard certification schemes (Gupta *et al.* 2016). The specific mix of actors and the relevance of their schemes vary from country to country, as do the sources of their authority. While private institutions often proactively occupy and shape the functional spaces they find for project development, many collaborate with funding institutions, thus representing delegated rather than entrepreneurial forms of private authority.

This is not to say that policy formulation, especially the setting of soft standards on safeguards, and financing through private authority, do not play a role at all. Voluntary carbon markets, for instance, may provide funding for REDD+ pilot projects (Hamilton *et al.* 2010). Here, a whole array of private actors is involved, starting with project developers (NGOs or companies), that hire private auditors to verify their emission reductions, which are then registered as carbon offsets and traded by private brokers or re-sellers. While only a fraction of the sums raised by such markets is associated with REDD+ projects and the future weight of REDD+ financing is hard to predict, other market-based approaches, and linking of domestic and subnational markets, may increase these figures in future.

Explaining institutional complexity

Why does the governance architecture on REDD+ exhibit the observed degree of complexity – with not just the UNFCCC as a single core, but several public financing institutions with considerable functional leeway, while private

authority engagement largely happens in implementation and evaluation? This institutional setting covers some middle ground between the expectations for benign and malign problem structures. One answer is that REDD+ has eventually changed from a conflict over values to one over means. Early REDD+ debates concerned the compatibility of climate goals and market mechanisms. This debate reflected an overarching value conflict in global forest governance: there is no consensus about the core forest values and services that should be promoted, with key fault lines between social and cultural dimensions (livelihoods, spiritual values, recreation), economic dimensions (wood, non-wood products) and ecological dimensions (biodiversity conservation). REDD+ added the dimension of forests as carbon sinks. This constellation of multiple values may explain why, notwithstanding several high-profile deliberations, no agreement could be reached on establishing a central global forest institution (Dimitrov *et al.* 2007).

In REDD+ governance, the value conflict between carbon and non-carbon dimensions eventually turned into a conflict over means when the importance of social and environmental co-benefits became widely recognised. The debate on safeguards today is one about the scope and intensity of this recognition. Many stakeholder groups moved away from outright rejection towards active participation in implementation; indigenous associations such as the Coordinator of Indigenous Organizations of the Amazon Basin now seek to implement an indigenous version of REDD+ (Zelli *et al.* 2014).

This said, REDD+ is not a clear-cut benign problem. It also implies conflict over relative goods: the generation and distribution of considerable financial volumes. In this competitive setting, donor countries tend to avoid the one-country-one-vote structure under the UNFCCC and rather choose arenas that grant them more leeway over the allocation of their donations. The emergence of major bilateral or World Bank-related funds can be seen as a consequence of this relative goods conflict.

Regarding demand for, and supply of, private authority, the considerable volume of public funding has so far dampened requirements for financing from other sources. Instead, there is clear demand for private support in implementation and evaluation activities. At the early stages of REDD+, domestic and local authorities in developing countries had no or limited knowledge and capacities for establishing and administering payment schemes and projects. At the same time, the UNFCCC and most of the major funding institutions lacked on-the-ground capacities. This gap and the associated need for lowering transaction costs have been quickly addressed by experienced conservation NGOs and private investors. Providing a first-mover advantage, they collaborated with local stakeholders to develop REDD+ pilot projects. Similarly, the Climate, Community and Biodiversity Alliance and other NGO alliances use their expertise to design and assess standards to fill implementation and evaluation gaps on social and environmental safeguards (Zelli *et al.* 2014).

SLCP governance

SLCPs as a complementary mitigation strategy

SLCPs, which include black carbon, methane, tropospheric ozone and hydrofluorocarbons (HFCs), have relatively short lifespans but high global warming potential. Measures to address SLCPs can help slow climate change, if combined with aggressive CO_2 emission reductions (Ramanathan and Xu 2010).

SLCPs vary. Black carbon (soot) only stays in the atmosphere a few days but is an important driver of global warming: it absorbs sunlight and generates heat, reduces the ability of snow and ice to reflect sunlight and affects cloud formation. Reducing black carbon emissions is expected to bring near-term climate benefits (Shindell *et al.* 2012), deliver significant health benefits (by reducing exposure to local air pollutants) and improve food security (by reducing crop yield losses) (UNEP & WMO 2011).

Methane is a greenhouse gas 34 times more potent than CO_2, with an atmospheric lifetime of 9.1 years (Myhre *et al.* 2013). Methane emissions are also responsible for another SLCP, tropospheric ozone. Measures to reduce methane emissions are estimated to avoid warming of 0.28°C by 2050 (Shindell *et al.* 2012). Longer term methane mitigation is considered essential for staying below 2°C (Rogelj *et al.* 2014).

HFCs are chemicals whose global warming potential outstrips that of CO_2 significantly, sometimes by a factor of thousands. While used in only a limited set of products, their use is increasing, mainly as a result of phasing out ozone-depleting substances. HFCs could contribute to annual greenhouse gas emissions of between 3.5 and 8.8 Gt CO_2 equivalent (UNEP 2011).

Institutional complexity in SLCPs: which role for private authority?

Several global public institutions are concerned with the governance of SLCPs, albeit without a clearly identifiable core institution. Depending on the specific SLCP, different institutions come into play.

Black carbon is addressed in the context of the Convention on Long-Range Transboundary Air Pollution (LRTAP) and the International Maritime Organization (IMO). In 2012, the Gothenburg Protocol to the LRTAP Convention, whose parties include the European Union and the United States, was amended to encourage voluntary black carbon emission reductions. To facilitate this, the LRTAP regime issued guidance to assist parties to identify control techniques for, and report on, black carbon emissions. As several parties have submitted voluntary emissions inventories, the regime helps to improve transparency. Since international shipping is a source of black carbon, it also falls within the IMO's remit. In 2010, Norway, Sweden and the United States proposed to discuss black carbon emission reductions from shipping in the Arctic, focusing on the

definition of black carbon, measurement methods and possible control measures, but discussions have not yet moved beyond agreement on a definition.

Methane is a greenhouse gas covered by the UNFCCC, and parties can achieve their climate targets by reducing methane emissions. In addition, methane emissions are regularly reported by UNFCCC parties through greenhouse gas inventories. Methane and other SLCPs are increasingly discussed in the context of the UNFCCC, including through the incorporation of SLCPs in some parties' intended nationally determined contributions submitted ahead of the Paris Agreement.[4]

HFCs, whose use was initially promoted under the Montreal Protocol on ozone-depleting substances, will be phased down under the same treaty following the adoption of the Kigali amendment in October 2016. For developing countries, the Protocol's Multilateral Fund can help finance the transition towards climate-friendly alternatives to HFCs.

SLCPs are also addressed by several hybrid governance institutions involving governmental and non-governmental actors. The Climate and Clean Air Coalition (CCAC) was created in 2012 to raise awareness, enhance and develop actions at various levels, promote best practice, improve scientific understanding on SLCPs and mobilise resources. Although the CCAC is government driven, private actors, including business, civil society and research organisations, play an important part by implementing projects, financing activities and providing scientific advice (CCAC 2014). Supported by a Scientific Advisory Panel, the coalition has launched several projects involving the private sector as an implementing partner, such as the Oil & Gas Methane Partnership[5] and the Global Green Freight Project.[6]

Another hybrid institution, the Global Methane Initiative, is, like the CCAC, country driven, although it also involves the private sector and NGOs in implementation. The Arctic Council, a high-level forum bringing together eight Arctic states and six indigenous peoples' organisations, is another hybrid institution addressing SLCPs. Drawing on scientific assessments by its Arctic Monitoring and Assessment Programme and efforts by its Task Force for Action on Black Carbon and Methane, the Council agreed a voluntary framework for action on SLCPs in 2015 (Arctic Council 2015).

In addition to these government-driven institutions, there are examples of private sector-driven initiatives, such as 'Refrigerants, Naturally!', a collaboration between companies in the food and drinks sectors (including Coca Cola and Unilever), UNEP and Greenpeace, through which companies commit to reduce HFC consumption,[7] creating a market for climate-friendly substitutes for HFCs.

Several public institutions thus play an increasingly important role in governing SLCPs, including policy formulation, aimed at enhancing transparency about SLCPs, but also leading to commitments (e.g. the Kigali amendment). These institutions are also instrumental in financing SLCP reductions (e.g. through the Montreal Protocol's Multilateral Fund or the UNFCCC's Green Climate Fund). As with REDD+, the role of private institutions is mainly confined to agenda-setting, by providing scientific advice and implementation. Multi-stakeholder partnerships such as the CCAC and the Global Methane Initiative play a key role in the implementation of various activities – from sharing practical experiences to development of climate-friendly products.

Explaining institutional complexity

SLCPs exhibit a consensual problem structure dealing with absolutely assessed goods (notably clean air). If there is a conflict, it is mainly over means: what kind of measures should be implemented, when should they be implemented, and who will pay? The measures themselves are rather clear. For instance: to mitigate black carbon, traditional cookstoves could be replaced by modern ones; for HFCs, substitutes with limited or no global warming potential are available; for methane, measures could minimise leakage from pipelines (UNEP & WMO 2011). This availability of options to abate SLCPs, combined with co-benefits, has arguably made SLCPs 'the climate threat we can beat' (Victor *et al.* 2012). The problem can thus be characterised as benign.

But why do we see *multiple* institutions? One possible explanation is that while SLCPs are often discussed as a group of substances that are short lived but nonetheless have a climate impact, they are also very different. For instance, the problem structure of HFCs is different from that of black carbon. Abatement of the latter is often in a country's own interest, as it will also help reduce local air pollution and promote public health. Phasing out HFCs, by contrast, does not yield such co-benefits. Moreover, as HFC emissions are primarily expected to increase in the global South, the problem of HFCs becomes more dissensual. This was clear in Kigali amendment negotiations, with India and Saudi Arabia insisting on financial and technological support from the North.

Concerning the role of private authority in SLCP governance, it is notable that the main hybrid governance institutions – the CCAC and the Global Methane Initiative – still have governments in the driver's seat. Nonetheless, the role of private actors in these institutions, in agenda-setting and implementation, is important. Arguably, these activities are carried out because they help lower transaction costs, complementing the

efforts by public governance institutions, which are still in the process of gathering information and formulating policies. Activities under the CCAC and the Global Methane Initiative, as well as private initiatives such as 'Refrigerants, Naturally!', can be considered as important first-mover actions on SLCPs, important if the near-term climate benefits of SLCP mitigation are to be achieved. At the same time, the role of private authority can be explained by the fact that they have something unique to offer: whether scientific advice (CCAC's Scientific Advisory Panel), economic power (companies involved in 'Refrigerants, Naturally!') or practical experience (NGOs involved in the CCAC).

Climate Engineering Governance

Technologies to engineer the climate

CE entails intentionally altering the Earth's atmosphere with the aim of reducing climate impacts. CE is often subdivided into solar radiation management (SRM) and carbon dioxide removal (CDR) (National Academy of Sciences 2015). However, technologies within each group are very different. For example, land-based CDR techniques such as afforestation and bioenergy with carbon capture and storage (BECCS) face other governance challenges than marine-based techniques such as ocean fertilisation.

For our purpose, we scrutinise the problem as identified by key communities, which leads to a duality. On the one hand, CE is an amalgam of large-impact technologies that are difficult to compare with one another. On the other hand, the dominant discourse continues to group these technologies into the subcategories of CDR and SRM. Analysing this discourse, we address the problem-structural connotation associated with each subcategory and the implications for the respective formation of governance institutions for both CDR and SRM.

CE has experienced dramatic changes within only a few years. Initially a marginal idea in climate science, the term 'geoengineering' arose in the 1990s. It described a diverse set of ideas to intentionally combat impacts of rising greenhouse gas concentrations and was considered 'unmentionable' and deeply disturbing (Schelling 1996). The breakthrough for geoengineering is often associated with a publication by Nobel Prize winner Paul Crutzen (2006), who advocated research on stratospheric aerosol injection. Subsequently, several popular science books brought the idea to a broader audience, whence national governments started showing interest and commissioned scientific inquiries. From that period onwards, scientific publications on geoengineering increased exponentially, in the wake of which

geoengineering was renamed 'climate engineering' and was further divided into subcategories (Oldham *et al.* 2014).

The widely cited differentiation between CDR and SRM suggested by the UK Royal Society (Shepherd *et al.* 2009) created a split in the pathways of the two technology groups. Consequently, CDR is now often called negative emissions technologies (NET) and widely described as a necessary strategy for addressing climate change. In recent years, the connotation shifted from controversial marine-based techniques to large-scale afforestation and BECCS, which are now included in the Intergovernmental Panel on Climate Change (IPCC) scenarios of the Intergovernmental Panel on Climate Change (IPCC) and considered a central component of climate policy (Fuss *et al.* 2014). Meanwhile, SRM, including equally different types of techniques, continues to be seen as less desirable and more problematic, although acceptance here is also rising gradually (Burns and Nicholson 2016). Some argue that the Paris Agreement has contributed to justifying CE techniques to achieve the treaty's 1.5°C goal (Horton *et al.* 2016).

Institutional complexity in CE: which role for private authority?

Unlike for REDD+ and SLCPs, international public governance of CE is considered more absent than present. There are currently three international institutions with direct relevance to CDR: the Convention on Biological Diversity (CBD), the London Convention and London Protocol on the Prevention of Marine Pollution (LC/LP) and the UNFCCC (Schäfer *et al.* 2015).

As the CBD encourages its own members to adhere to the LC/LP's strict regulations on ocean iron fertilisation and suboceanic CO_2 storage (CBD 2012), these two institutions can be regarded as cooperative and coupled on the issue. By contrast, although mentioned by the CBD as potentially relevant for regulation, the UNFCCC only implicitly addresses CE. Nonetheless, as the IPCC relies on NET for its emissions pathways, and the Paris Agreement now includes carbon removal as a form of mitigation, it seems that the UNFCCC plays a key role in justifying development and use of land-based CDR. Together, the three public institutions provide some degree of agenda-setting and policy formulation for CDR technologies.

Private authority, apart from agenda-setting for the recognition of CDR by the epistemic community, is increasingly visible in technology development, financing and implementation. Examples are public–private venture companies such as Carbon Engineering (connected to the University of Calgary) or Skytree (a spinoff company of the European Space Agency) that develop direct air capture technologies, and several philanthropic foundations supporting them. Private for-profit companies are becoming

increasingly involved with BECCS and biochar, with the first industrial-scale BECCS plant having been set up in Decatur, Illinois in a public–private partnership between the US Department of Energy and the agri-business Archer Daniels Midland (Yeo and Pearce 2016).

The Paris Agreement, with its acknowledgement of carbon removal, has provided a formalised legitimacy that could characterise these activities as examples of delegated authority. However, the fact that many such initiatives started before Paris shows that the lines between public and private authority, as well as between entrepreneurial and delegated, may not be as clear-cut as our framework suggests. Entrepreneurial authority may change into delegated authority if a public institution starts regulating a given policy issue.

While the institutional landscape for CDR can be tentatively described as an emerging regime with two cores (land-based and ocean-based CDR techniques, respectively) and an increasing number of private actors involved in implementation, the landscape for SRM displays no identifiable public regulation or pronounced engagement of private actors beyond the epistemic community. Although knowledge about the opportunities and dangers of SRM is relatively established, no international public institution has started regulating it. Explicit public interest in, and reference to, these technologies exist only at national and subnational levels in the United States, United Kingdom, Germany, Russia and China, but without legal regulation (Huttunen *et al.* 2015).

In the absence of public governance, some private actors within academia have spurred institutionalisation, making suggestions on how to govern research, in the hope that their efforts will be adopted by public actors. NGOs linked to academia, such as the Solar Radiation Management Governance Initiative and the Forum for Climate Engineering Assessment, seek to increase transparency, inclusiveness and public participation in discussion on SRM. Simultaneously, several research institutes working on CE have proposed frameworks for self-regulation, including the Oxford principles (Rayner *et al.* 2013) and a 'Draft Code of Conduct' on responsible CE research (Hubert and Reichwein 2015). While NGOs focus explicitly on networking and information-sharing, and thereby agenda-setting, the self-regulation frameworks suggest policy formulation. Private authority here exists mainly in the form of scientific authority, with some more prominent members of the epistemic community informing government positions on SRM. As they lack political experience or legal/moral authority, resulting initiatives focus mainly on knowledge-brokering or suggestions for self-regulation that are not (yet) endorsed by a wider community.

Explaining institutional complexity

Why is the governance structure for CE in general so underdeveloped? One explanation lies in the problem structures around CE. Until recently, CE

was characterised by an ideological battle between belief in social change and belief in technological power. Core debates circled around: the hubristic nature of CE versus the urgency for climate action, a 'slippery slope' towards deployment versus the control of an already opened Pandora's box and concern for moral hazard (threatening efforts to decarbonise society) versus embracing of climate change as a pollution control issue (Anshelm and Hansson 2014).

In recent years, the exclusive conflict over values shifted increasingly towards a conflict over means. Catalysed by slow progress on emissions reductions, continuous investment in fossil fuels and the normalisation of CE research, the core question is no longer *whether* research should be done but rather *how* research should be regulated and *which kind* of research should be funded. This development has facilitated some governance activity by public actors, including the elementary regulations on CDR described above. But while CDR is now at least recognised and addressed by public institutional cores that regulate and/or encourage research and development of carbon removal technologies, SRM still remains conspicuously absent from international governance realms.

Meanwhile, the composition and functional distribution of private actors and their institutionalisation attempts differ in each area. Many private actors in CDR exist at the nexus of research and business and are mainly involved in technology financing and implementation. Private actors in SRM are only visible within the epistemic community, advocating research, suggesting governance options, creating space for public deliberation and providing advice to governments. It seems that in the absence of public regulation, not even university-based research (beyond modelling) is possible, and the general lack of public authority is requiring private actors to engage with questions of governance before any further advances can be made.

Why are the institutional landscapes for CDR and SRM so different? With the increasing emphasis on separating CDR from SRM, the two groups of technologies have experienced changes in perceived problem structures independently from one another. Whereas SRM still exhibits a significant conflict over values, CDR has evolved towards a conflict mainly over means. The general perception of CDR[8] is shifting from a malign to an increasingly benign problem structure, while SRM remains characterised as largely malign. The assessment of the US National Academy of Sciences is illustrative:

> Carbon dioxide removal (CDR) approaches generally share some characteristics with respect to how they are perceived by society. Some methods, such as direct air capture and sequestration (DACS) and reforestation, result in far less of a perturbation to the Earth system than that associated with albedo modification (…). Deployment of such methods is more likely to be viewed as an "undoing" of what has been done and, thus, may be perceived as more benign. (National Academy of Sciences 2015, p. 97)

Discussion and conclusions

We started from the assumption that the understanding and delineation of a given global governance issue is connected to the roles of intergovernmental and private institutions, leading us to approach the phenomenon of institutional complexity in two novel ways. Empirically, we focused on three subfields of climate governance. We showed that these subfields differ in their institutional complexity from global climate governance as a whole. The latter exhibits an identifiable institutional core in the UNFCCC, while this centrality is considerably qualified, albeit in different ways, for the global governance architectures for REDD+, SLCPs and CE. The three subfields also vary considerably concerning key sources of private authority and predominant functions taken over by public and private institutions.

Theoretically, we sought to break new ground by bridging problem-structural approaches of institutionalism and private authority theory. Our main expectation was that 'benign' problems are more likely to be regulated through central public institutions, with one or few cores and relatively clear hierarchy among them, while private institutions will largely exert authority on behalf of public ones ('delegated authority'). 'Malign' problems are less likely to be addressed by public institutions. We expected them to exhibit either no intergovernmental core or multiple cores that likely conflict on major subjects and/or lack a clear legal or functional hierarchy. Most institutional activities of private actors in such settings will rely on 'entrepreneurial' authority.

While we only provided an explorative application of our framework, the overview of dependent, independent and intervening variables in Table 2 supports some of our assumptions. The benign (CDR) and malign cases (SRM) exhibit the expected shapes of public cores (i.e. two complementary ones and none, respectively), while the ambiguity of REDD+ and SLCPs is reflected in intergovernmental diversity at the centre. These different public constellations, in turn, open up different spaces for private authority.

The increasingly benign case of REDD+ features one core public institutional complex where the leadership of the UNFCCC is challenged by the functional impact of multilateral funding institutions. Private institutions are taking on functions qualified by delegated authority, mainly in implementation and evaluation.

In CE, private institutions take different roles for CDR and SRM. Private actor networks are engaging in financing and implementation of land-based CDR, relying on public authority for legitimacy. Meanwhile, the complete lack of public authority in SRM inhibits any private action beyond agenda-setting and policy formulation.

On the other hand, the 'benign' case of SLCPs exhibits multiple institutional cores, while still showing delegated authority amongst private

Table 2. Institutional complexity and problem structure across cases.

			CE	
	REDD+	SLCPs	CDR	SRM
Centrality of public authority	One core, flanked and partly challenged by further central institutions	Several cores with division of labour	Two cores with division of labour	No core
Predominant source of private authority	Delegated	Delegated	Entrepreneurial, moving towards delegated (?)	Entrepreneurial
Predominant functions of public and private institutions	*Public* – Policy formulation – Financing	*Public* – Policy formulation – Financing	*Public* – Agenda-setting – Policy formulation – Financing	*Public* – None
	Private – Implementation – Evaluation – Agenda-setting	*Private* – Implementation – Agenda-setting	*Private* – Implementation – Financing	*Private* – Policy formulation – Agenda-setting
Problem structure	*Benign* – Shifting from values to means	*Benign* – Absolutely assessed good; means (e.g. black carbon)	*Benign* – Shifting from values to means – Absolutely assessed good	
	Malign – Relatively assessed good	*Malign* – Relatively assessed good (e.g. HFCs)		*Malign* – Values – Relatively assessed good
Demand for/supply of/private authority	*Demand* – Providing first mover advantage – Lowering transaction costs	*Demand* – Providing first mover advantage – Lowering transaction costs	*Demand* – Enhancing credibility	*Demand* – Enhancing reputation
	Supply – Expert opinions – Political experience	*Supply* – Expert opinions – Finance	*Supply* – Expert opinions, practical experience – Finance	*Supply* – Expert opinions

institutions, perhaps because of the framing of the policy area. SLCPs represent a synthetic group of non-carbon climate pollutants that exhibit different qualities and problems. Similar issues arise with CE technologies. A breakdown according to single pollutants and technologies may yield additional corroboration for our framework. This is not a limitation but rather a confirmation for the need to zoom in on sub-issues to better understand underlying mechanisms of institutional complexity – as, following dominant perceptions, we have done for the CE case.

The case studies show that problem structure is not static, but subject to changes in framing and public perception. Problems initially perceived as malign have experienced changes in discourse, association and framing, making them more accessible to public authority and governance. This said, in our analyses we only addressed the changing nature of core conflicts but could not detail the associated situation structures or constellations of preferences. A more thorough application to a larger sample of cases is needed to probe the plausibility of this framework. Here, the interests of both public and private actors could provide additional explanations for the institutional and functional constellations we observed. Moreover, the analysis of problem structures should ideally rely on conflict perceptions of key stakeholders and not only on deductive assessments.

The preliminary nature of our analysis notwithstanding, it shows the importance of explaining institutional complexity and the roles of public and private authority in complex settings. Deeper causal insights can help us make more informed decisions about whether and how such complexities need to be addressed. While there is a rich theoretical basis that can be drawn upon to close this research gap, problem-structural approaches suggest that there may be no right or wrong degree of complexity, but rather different institutional fits – and respective roles of private authority – for different governance problems.

Notes

1. While we use 'private' as a generic term that also includes such arrangements, we will explicitly refer to the hybrid nature of specific institutions.
2. Demand may be directly voiced by certain groups of the governed or be identified indirectly, for example, via high transaction costs or lacking legitimacy. But this is different from ascertaining the very delegation of authority to private actors and their institutions. There may be potential for such delegation, but it does not need to be exploited (Tosun et al. 2016, p.5).
3. http://www.climatefundsupdate.org/data (Accessed 9 April 2017).
4. See http://www.ccacoalition.org/sites/default/files/resources/SAP-MAR2016-04_CurrentStatusofSLCPsintheINDCs.pdf (Accessed 9 April 2017).
5. http://www.ccacoalition.org/en/content/ccac-oil-gas-methane-partnership
6. http://www.globalgreenfreight.org/

7. http://www.refrigerantsnaturally.com/
8. A possible exception is the still very controversial case of marine-based CDR, although international regulation does allow scientifically informed outdoor experimentation (Dixon et al. 2014).

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