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Architectures of Earth System Governance *Setting the Stage*

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Since the emergence of the modern state system, governments have sought to regulate their affairs through international treaties and other types of intergovernmental agreement. For example, when it became known that emissions of certain chemicals destroyed the stratospheric ozone layer, governments agreed on a global treaty to ban such emissions. When *Titanic* sank in 1912, governments negotiated the International Convention for the Safety of Life at Sea. More than 1,300 international treaties have been concluded just to address environmental concerns, from the Agreement on the Conservation of Populations of European Bats to the United Nations Framework Convention on Climate Change. There is even an international Agreement Governing the Activities of States on the Moon and Other Celestial Bodies and an Agreement on the Rescue of Astronauts.

In political science, the last 40 years have seen a tremendous number of studies on the emergence, maintenance and effectiveness of such international institutions, including fully fledged international organizations, specialized bodies and programmes, as well as intergovernmental treaty secretariats. And yet, it has become increasingly evident that such international institutions do not operate in a void. All institutions operate instead within complex webs of larger governance settings. Many regulations and policies under the United Nations Framework Convention on Climate Change, for instance, also affect the protection of biological diversity, along with policies on energy, trade, patent rights, civil aviation, shipping and migration. Climate change is addressed not only in meetings of the parties to the climate convention but also by the International Maritime Organization, the United Nations Security Council, the United Nations Development Programme, the International Bank for Reconstruction and Development and many other institutions. In short, international institutions in all their forms are important building blocks of global governance. And yet, they are only one part of the story. They are all part of a larger whole that shapes, enables and at times hinders the functioning of single institutions. We thus must look at this larger picture. Without a better understanding

of the entire system of global governance, we cannot grasp the functioning of its constituent parts.

In recent years, scholars began to refer to such complex institutional settings as governance architectures, using the powerful metaphor of buildings with copious rooms, lavish apartments, winding staircases and meandering corridors, all part of one interrelated system while keeping independent roles and spaces.¹ The concept of global governance architectures has filled a major conceptual void in the scholarship on international relations, which earlier, in the heydays of regime analysis from the 1970s onwards, rather focused on single institutions and their dyadic interactions. The concept of governance architecture now shifts the debate to situations in which a governance area is regulated by multiple institutions broadly understood as international organizations, regimes and norms in complex settings.

A key advantage of the architecture concept is its ability to allow for comparisons between and across issue areas, regions and time periods, with the possibility to study the variant effects of governance architectures. The policy relevance of such studies is clear: if a certain type of governance architecture is shown to be more effective, important policy conclusions can be drawn. The focus shifts then from the more limited examination of treaties and other agreements and their political impacts to the broader debate on the structures that shape the overall interplay, dynamics and effectiveness of global governance. We thus move, as it were, upwards from looking at single parts to assessing the larger whole. It is not about having better cake: it is about reinventing and restructuring the entire bakery.

Politically, such an analytical move allows for a new vision on the fundamental restructuring of world politics and global governance. While earlier research focused on the effectiveness of singular treaties or distinct international organizations, an ‘architecture lens’ invites a much deeper debate about the overall structure of global governance – and its overhaul. Research on the architectures of global governance, therefore, might assist in charting ways for a transformation of contemporary global policymaking.

In describing, comparing and assessing governance architectures in world politics, various classifications are possible. The analytical focus can lie on material structures, such as legal provisions, institutional designs, bureaucracies or financial resources. Characteristics of architectures might then include the degrees of institutional fragmentation, integration, polycentricity, multinodality, multilevelness, complexity, dynamics, density, modularity or hierarchy. Beyond these classical study areas, the analytical focus can also lie on ideational and discursive structures as part of broader governance architectures. Ideational structures, for instance, can

¹ See, for instance, Biermann et al. (2009a, 2009b); Kanie et al. (2010); Zelli (2011); Hackmann (2012); Zelli and van Asselt (2013); Biermann (2014); Abbott and Bernstein (2015); Holzscheiter, Bahr and Pantzerhielm (2016); Scobie (2019).

refer to ‘an overarching structure of values’ (Conca 2006: 26) that ‘exert a powerful influence on social and political action’ (Reus-Smit 2013: 224). Examples are overarching norms, values and belief systems that go beyond single issues, as they are articulated in general principles of international law.

Multiple causal relations can link such broader structural features and governance outcomes. Many analysts have tried to explain the problem-solving effectiveness of governance architectures, for example, whether certain types of governance architectures are better able to steer societies towards the prevention of global warming or the protection of biological diversity. Scholars have also begun to investigate broader questions of equity and of who gets what through the functioning of governance architectures. As structural constraints, governance architectures determine who has access to resources or justice and how burdens and responsibilities are distributed (Kanie et al. 2010). For instance, the principle of ‘common but differentiated responsibilities and respective capabilities’, a central part of numerous environmental agreements, has had a remarkable impact on the eventual distributional outcomes of these agreements.

Research on the emergence, functioning and impacts of governance architectures has been a central part of the science programme of the Earth System Governance Project, the leading global research network in the field of governance and sustainable development. This network, which has prioritized research on architectures as one of its five main analytical themes (Biermann et al. 2009a),² has mobilized a sizeable amount of research in this field, which in turn contributed numerous publications.

This book brings this and other research together. It is designed to harvest the work on governance architectures in the first ten years of operation of the Earth System Governance Project from 2009 to 2018 (including the work published in 2019); to highlight new debates and trends; and to chart new research directions. Importantly, the research covered in this book is not limited to studies by researchers formally affiliated with the Project. Instead, the book throws a wider net and seeks to draw together all the vibrant debates on governance architecture in all their complexity, diversity and dynamics.

Given the special research interest of our group of collaborators, our empirical focus is on architectures of *earth system governance*. Earth system governance is broader than traditional environmental policy and emphasizes the global complexity of integrated socio-ecological systems. Key concerns of earth system governance are, therefore, broad and often interdependent challenges such as ocean

² The other four main analytical themes are agency (e.g., Betsill, Benney and Gerlak 2019), adaptiveness (e.g., Boyd and Folke 2012), accountability (e.g., Biermann and Gupta 2011; Gupta and Mason 2014; Park and Kramarz 2019), and allocation and access (e.g., Gupta and Lebel 2010; Kanie et al. 2010). See Biermann (2014) for an integrated discussion of all five themes.

acidification, land use change, food system disruptions, climate change, environment-induced migration, species extinction, ocean governance and changing regional water cycles, as well as more traditional environmental concerns such as air pollution. While earth system governance is a broad area of scholarly inquiry, it also has its conceptual boundaries. Questions of international security, global communication, trade regulation, terrorism or human rights are less studied within the earth system governance research community, unless there are clear links to the functioning of socio-ecological systems, for example in the nexus of climate change impacts and local conflict.

This introductory chapter sets the scene for this book. We first define the concept of architectures of earth system governance and demarcate boundaries between the elements and processes of an architecture. We then provide a review of the past decade's research, addressing the five key questions on the analytical problem of architecture that were advanced in the 2009 Science and Implementation Plan of the Earth System Governance Project (Biermann et al. 2009a, 2010). In the concluding Chapter 14, we continue our review with a discussion of recent research trends and debates around complexity, dynamics and transformation, as well as key methodological approaches, challenges and advances in the field.

Conceptualization

Architecture

The term architecture has been used in many ways to refer to the fundamental structural characteristics of an institution (e.g., Aldy, Barrett and Stavins 2003), a regime (e.g., Hare et al. 2010) or a broader governance system (e.g., Young 2008). We define governance architectures in this book as the overarching system of public and private institutions, principles, norms, regulations, decision-making procedures and organizations that are valid or active in a given area of global governance (drawing on the definition by Biermann et al. 2010). Architecture can thus be described as the *macro-level* of governance, which can be regarded as a 'bird's-eye view' on the global governance landscape. This macro-level is not to be understood as a static entity, but rather as a fluid, dynamic architecture that continuously evolves according to external and internal pressures and governance processes.

Three elements are key in this conceptualization.

First, our conceptualization denotes an *overarching system*, which is broader than a single institution but narrower than an all-encompassing global order (Biermann 2014: 81–2). Therefore, architecture specifically refers to structures at the overarching governance level, which in turn consist of numerous building

blocks such as state and non-state actors, transnational networks, intergovernmental institutions and regime complexes.

Second, our conceptualization of architecture refers to institutional settings that *shape decisions of actors and institutions* which exist and interact in a given policy domain. Some degree of influence of architectures on agency is therefore assumed in terms of both the effectiveness of individual institutions and the overall governance system (see also Betsill, Benney and Gerlak 2019).

Third, the impact of an architecture extends to *all levels of governance*. While a key unit of analysis is the macrostructure at the global level, the level of analysis is not limited to the global. Examples include multilevel governance architectures in areas such as climate mitigation, ocean governance, biodiversity conservation and so on.

Importantly, the notion of governance architectures does not assume the existence of a single architect. Instead, in many cases, governance architectures emerge from incremental and tedious processes of institutionalization that are decentralized and hardly planned. In other words, instead of a single architect, many architects are involved in shaping an architecture, even though individually, most have little control over the overall design and performance. The resulting structural configuration then influences how institutions interact by limiting the choices and opportunities for actors or by creating and shaping opportunities (Betsill, Benney and Gerlak 2019). A governance architecture is, in other words, in constant flux, evolving through the interaction between individual institutions at the micro level and the dynamic structure at the macro level.

The notion of architectures of global governance has emerged over the last two decades. Twenty years ago, most institutional research focused on single institutions, such as the ozone regime or individual treaties on wildlife or fisheries. Comparative analyses of such institutions then led to a better understanding of the creation, maintenance and effectiveness of single international institutions and their relations with national policies (Brown Weiss and Jacobson 1998; Young 1999). As more and more institutions were established for new, interconnected issues, the global governance landscape became increasingly crowded (Brown Weiss 1993; Young 1996). Institutions started interacting and forming interlinkages, which has become a central analytical challenge (Young 2002; J. Kim 2004; Oberthür and Gehring 2006; UNEP 2007, 2012, 2019; Chambers 2008; Pattberg 2010; Oberthür and Stokke 2011; Pattberg et al. 2018). Eventually, such interlinkages gave rise to larger complexes of interlocking institutions or actor configurations (Kanie, Andresen and Haas 2013). While institutions in these complexes are only loosely coupled, they nonetheless often formed dense clusters that are sparsely connected to other clusters. As such, not every institution is connected to all others uniformly, just as some governance issues relate more closely to one than to others.

Naturally, distinguishable clusters appear, and each of these inherently emergent, macro-scale modular structures is what we refer to as an architecture of global governance.

Research on governance architectures is marked by a remarkable co-evolution of analytical and normative debates, theory and practice, scholarly discourse and calls for political reform. Theoretical debates – for instance on the orchestration effects of intergovernmental organizations – go hand in hand with elaborate calls for institutional reforms, for example for the creation of a world environment organization or the amendment of the Charter of the United Nations. Debates in theory and practice often run in parallel; at times, they are interrelated, for instance when the urge of policy dilemmas and inconsistent governmental actions stimulates further advancement and research in academia.

The analytical research focuses here on studying the structures of global governance architectures and explaining their institutional variation and varying degrees of performance. One example are studies on the fragmentation of global governance architectures (see Chapter 8). These studies investigate the causes and consequences of governance fragmentation that results, for instance, from international agreements being negotiated by specialized government ministries in forums that are detached from negotiations of other agreements. Some scholars have argued that the current architecture of earth system governance is not conducive to the development of coordinated and synergistic approaches to collective problem-solving in the face of increasing global interdependencies (Young 2008 and 2019). Such research findings have had significant policy implications and impact, as evident in the emphasis on policy and institutional coherence in the United Nations agreement in 2015 on seventeen ‘Sustainable Development Goals’ (see Chapter 12; see also Nilsson, Griggs and Visbeck 2016).

The normative debate focuses on how architectures should be redesigned or reconstructed in a way that improves the performance of institutions in achieving their primary objectives. A key guiding consideration has been the ‘problem of fit’ of architectures and institutions to underlying problems (Young 2002; Folke et al. 2007; Galaz et al. 2008; Ekstrom and Young 2009; Ekstrom and Crona 2017). The logic behind this approach is that ‘[m]ore effective architectures of earth system governance may come about by better linking the study of nature with the study of governance’ (Biermann et al. 2009a: 82). Politically, the challenge here is how to shape governance architectures in a way that they better fit the structure and dynamics of the regulatory target, including at the level of the earth system (Kim and Mackey 2014). This needs interdisciplinary research that draws, for instance, on the insights of earth system scientists who study the structure of the earth system (Schellnhuber et al. 2004; Steffen et al. 2004; Reid et al. 2010) and how different ecosystems and natural processes are interacting (Rockström et al. 2009; Steffen

et al. 2015, 2018). Such research needs to inform the work of governance scholars who explore the institutional implications for the broader architectures of global governance.³ However, the analytical and normative dimensions of research on architecture are not mutually exclusive. Instead, they cut across the interface between earth system analysis and governance theories (Biermann 2007).

Building Blocks, Structural Features and Policy Responses

Any global governance architecture consists of building blocks that share structural features and that are subject to a variety of policy interventions by governments and other international actors (see Figure 1.1). This book has been organized around these building blocks (Part I), structural features (Part II) and policy responses (Part III).

Despite the rise of non-state actors and transnational institutions, the central actors in global governance are still the governments of sovereign states. The literature on the state as actor in global governance is endless; hence we did not include a separate chapter on state actors but refer instead to the comprehensive review by Compagnon and colleagues (2012) in an earlier synthesis project. The first major building blocks that we are discussing in this book are *international institutions* that governments create to jointly tackle common problems. In world politics, such institutions with shared norms, principles and rules and decision-making procedures are often referred to as regimes (see Chapter 2). International institutions function through *international bureaucracies* that governments set up to administer and support such institutions. Such bureaucracies can be, for instance, treaty secretariats, such as the relatively large secretariat in support of the United Nations Framework Convention on Climate Change. Also the administrative apparatus of the World Bank or the International Maritime Organization fall into this broad category. While international bureaucracies formally function only to serve the interests of national governments, recent research has compellingly shown that international bureaucracies often enjoy large degrees of political freedom and play independent roles in global governance (Hickmann et al. 2019). They are hence important building blocks of global governance architectures with some degree of autonomy (see Chapter 3).

Furthermore, non-state actors have gained much influence in global governance, along with traditional state actors. In some areas of global governance, such as forest governance, non-state actors even seem to play central governing roles.

³ See, for instance, Vidas (2011); Biermann et al. (2012); Kim and Bosselmann (2013); Scott (2013); Bridgewater, Kim and Bosselmann (2014); Biermann (2014); Dryzek (2014); Robinson (2014); Vordermayer (2014); Vidas et al. (2015); Biermann et al. (2016); Kim and van Asselt (2016); Kotzé (2016); Pattberg and Zelli (2016); Young et al. (2017); Craik et al. (2018); Pickering (2018).

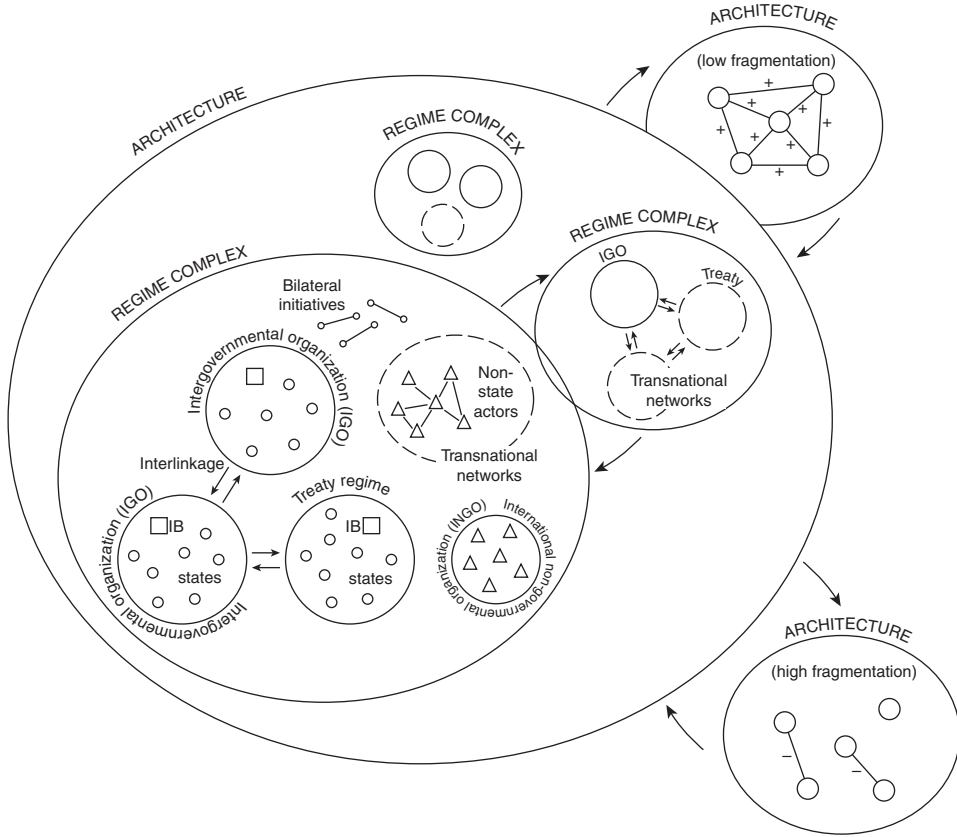


Figure 1.1: Architectures of global governance

Importantly, non-state actors often create their own *transnational institutions*, which we define as institutions set up by private actors with only a marginal role for governments or without any involvement of governments. These transnational institutions and networks are another major building block in any global governance architecture that will be discussed in this book in a separate chapter (see Chapter 4). Finally, vast areas of our planet are *beyond the jurisdiction and effective control* of governments, including the high seas and Antarctica, along with outer space. Other areas are diffuse, virtual and difficult to control by governments, such as the Internet. Thus, this book includes a chapter on institutions operating beyond the jurisdiction or control of national governments, as a final major building block of architectures of earth system governance (see Chapter 5).

These building blocks interact within broader global governance architectures in multiple ways. This has led in the last decade to a prolific research strand that we report on in Part II of this book. The first chapter in that part focuses on the

interlinkages between two or only a few institutions (see Chapter 6). The following chapter reviews research on the emergence of larger sets of interrelated and interdependent institutions, often described as *regime complexes* (see Chapter 7). In studying an entire governance architecture in which institutions interact, the third chapter of Part II investigates variant degrees of *fragmentation* in global governance architectures (see Chapter 8).

Finally, these institutional interlinkages and the fragmentation of global governance architectures have forced governments, non-state actors, the decision-making bodies of international conventions and treaties as well as leaders of international bureaucracies to develop a variety of policy responses (see Part III of this book). These responses in turn have led to substantial research programmes, which again have often informed policy decisions and pushed forward reforms. Typical responses by state representatives, international bureaucrats and treaty bodies have been, for example, the push for the mutual integration of policies through the advancement of systematic *policy integration* or *mainstreaming* (see Chapter 9).

In situations of institutional interlinkages – especially when norm conflicts and weak governance performance were identified – governments and treaty bodies reacted by purposeful attempts at *interplay management* (see Chapter 10). This research is inevitably linked to the study of institutional interlinkages, which is discussed by Hickmann and colleagues earlier in this book (see Chapter 6). While research on institutional interlinkages analyzes the effects of such interactions – often with a focus on identifying and explaining synergistic or conflicting interactions – the research on interplay management investigates the effectiveness of policy interventions to minimize disruptive effects of conflictive interlinkages.

A new strand of research explores the role of international bureaucracies, but also other actors, as *orchestrators* in global governance. If a governance architecture can be likened to the ensemble of musicians in an orchestra, international bureaucracies – such as the United Nations Environment Programme – might then be the conductors, or the orchestrators, through non-hierarchical, non-compulsory soft ways of global institutional steering (see Chapter 11). A special case, much related to orchestration, is the policy of negotiating *global goals* as joint, widely accepted standards of conduct, with the expectation that public and private actors align their behaviour with such goals. The 17 Sustainable Development Goals, agreed by the United Nations General Assembly in 2015, are the most prominent example of such ‘governing through goals’ (see Chapter 12). In some cases, however, governments might choose to reform the broader institutional architectures beyond simple interplay management and orchestration by more structural change that establishes *hierarchical orders* among institutions and actors in global

governance. We call this policy strategy *hierarchization*, acknowledging that such a strategy might evolve in numerous ways (see Chapter 13).

Figure 1.1 presents a schematic diagram of the architectures of global governance as we conceptualize them in this book. As mentioned above, the concept of governance architecture resembles the macro level structure and offers a bird's-eye view on the global governance landscape. While the overarching global governance architecture comprises the entirety of actors and institutions, individual governance architectures within a given domain may consist of one or more regime complexes, which are meso-level structures. When only one regime complex operates within a global governance domain, it would equate with an architecture. Key elements of a regime complex in turn include, at the micro level, intergovernmental institutions such as international treaties and organizations, as well as transnational networks and non-governmental organizations. These elementary building blocks along with emergent meso- and macrostructures form complicated interlinkages with one another and interact both horizontally and vertically. The increasing diversity and multiplicity of the building blocks and structural features has made global governance more and more complex over time. Such a conceptualization of global governance architectures underscores the fact that any attempt at structural transformation must be informed by a deep understanding of the intricate system of actors, norms, institutions and their networks.

Key Research Questions and Findings

Research on architectures of earth system governance has addressed questions relating to the emergence, design and effectiveness of governance systems as well as the overall integration of global, regional, national and local policymaking. It has essentially been about exploring and explaining causal relationships between architectural features and governance outcomes. We now present key findings to the five core research questions outlined a decade ago in the 2009 Science and Implementation Plan of the Earth System Governance Project (Biermann et al. 2009a).

Performance

The first question that the Earth System Governance Project sought to address over the last decade was, *how is the performance of individual environmental institutions – and of clusters of institutions – affected by the fact that institutions are embedded in larger architectures?*

The performance of architectures can be measured in multiple ways. A central focus in earth system governance research has been the problem-solving effectiveness of architectures (Breitmeier, Underdal and Young 2011; Young 2011a, 2018).

Other studies have also investigated other variables of governance performance, such as legitimacy, accountability and equity (Gupta and Lebel 2010; Biermann and Gupta 2011; Karlsson-Vinkhuyzen and McGee 2013). Research on performance in terms of problem-solving (output legitimacy) and on performance in terms of democratic and transparent procedures (input legitimacy) are deeply related, however (Scharpf 1999). As argued by Oran Young (2011a: 19855), the '[m]aintenance of feelings of fairness and legitimacy is important to effectiveness, especially in cases where success requires active participation on the part of the members of the group over time'.

The performance of a global governance architecture is generally expected to be shaped by certain institutional qualities. One defining characteristic of global governance architectures has been described as fragmentation (see Chapter 8), and many studies have sought to address key questions around the causes and consequences of, and responses to, the fragmentation of governance architectures (e.g., Zelli 2011; Van de Graaf 2013; Zelli and van Asselt 2013). Similar situations have been described from a different perspective as regime complexes (see Chapter 7), or as situations of institutional complexity or polycentricity (Jordan et al. 2018b). As for these characteristics of an architecture, the debate about the consequences of different degrees of fragmentation or the complexity of broader governance architectures has been most controversial. The key question has been whether high degrees of fragmentation or complexity of an architecture affect its performance as well as key institutions operating therein. However, the research community is far from conclusive in the current state of debate. Essentially, there are four broad clusters of assessments.

(1) First, in situations of fragmented architectures or convoluted regime complexes, there is agreement that institutions or actors are not uniformly affected by this broader architecture. For example, effects on the performance of an international institution depend on where the institution is located in an institutional architecture. One may ask, is the institution in the centre or periphery or does it assume a bottleneck position or not? Recent research has shown, for instance, that the texts and decisions of multilateral agreements with central positions attract far more citations in later agreements, hence spreading their rules or expanding legal effects (Kim 2013). Furthermore, the centrality of an international organization's position in a network is positively associated with the output of that organization (Murdie 2013). These institutional networks serve like a public good, and central positions are associated with a higher level of social capital (Young 2017). This also implies that an institution's performance depends not only on its position within an architecture, but also on the characteristics of that architecture. Social network analysis is one useful tool to study such complex arrangements (Kim 2019; see also Chapters 6 and 14).

(2) Second, a cluster of studies expects a strongly fragmented governance architecture to be less effective than a more integrated architecture (M. Young 2012; Biermann 2014; van Asselt 2014). Here, the argument is that disconnects between international institutions operating in silos result in limited cooperation or coordination among them. Most institutional interlinkages are believed to be disruptive or conflictive in character rather than synergistic or cooperative (Biermann et al. 2009b). More specifically, institutional fragmentation is seen as hindering progress in negotiating stringent targets and actions; this limits incentives of subnational actors to take urgently needed action and reduces the overall credibility, stability and coherence of the entire architecture of global governance (Biermann 2014: 83–97). Some researchers observe that fragmented governance architectures are intentionally created by states that benefit from them and maintained by power asymmetry, and in turn unevenly privilege more powerful countries (Benvenisti and Downs 2007; Alter and Meunier 2009). International ‘forum-shopping’ by astute national governments for pursuing their parochial interests is a case in point (Murphy and Kellow 2013).

The fragmentation of governance architectures is also seen as causing, or as being unable to prevent, negative spillovers and externalities (Ostrom 2010a; Truelove et al. 2014). For example, because global climate governance is fragmented, carbon leakages may occur if businesses transfer production to countries with lower emission restrictions (Carlarne 2008; Eichner and Pethig 2011). An emerging concept here is environmental problem-shifting, referring to instances where policies to solve one environmental problem transfer damage elsewhere or transform one type of pollution into another (Yang et al. 2012; van den Bergh et al. 2015). Problem-shifting is increasingly observed between international environmental regimes, presenting a risk to the overall performance of earth system governance (Kim and Bosselmann 2013; Kim and van Asselt 2016).

(3) Third, an opposing line of studies offers a more positive assessment of the performance of governance architectures that are highly fragmented or complex. For instance, scholars have claimed that fragmentation is ubiquitous and inherent to any governance architecture (Zelli 2011; Kim 2013; Pauwelyn 2014) and that in most systems everything is *not* connected (directly) to everything else, while most actors and institutions can be reached in a small number of steps. There is some evidence that the density of most systems is low, which can make a governance architecture appear as if it is excessively fragmented yet without significantly affecting its functioning.

Furthermore, contrary to the assumption that institutional proliferation leads to further fragmentation, some authors suggest the presence of defragmentation as a self-organized counteracting process that allows for keeping some cohesiveness in governance architectures despite the increasing number of institutions (Kim

2013). This process is also responsible for creating modular structures that are internally densely connected but externally sparsely connected through ‘weak ties’ (Granovetter 1973). A seemingly sparse and fragmented architecture could hence also be a well-functioning system (Stevens 2018). In this view, institutional fragmentation does not mean anarchy (Galaz et al. 2012) and there could be also ‘healthy’ fragmentation (Kanie 2007). For example, regime complexes consisting of loosely coupled, partially overlapping institutions are found in some studies as being more adaptable over time and flexible across issues when compared to other more integrated international regimes (Keohane and Victor 2011).

(4) Fourth, a more recent position emerged in the middle ground between these opposing poles of the debate. According to these scholars, the problem is ‘not fragmentation per se, but rather the coordination (or lack of it) of fragmented or differentiated institutions’ (Zürn and Faude 2013: 120). What matters then is the character or nature of the *institutional interplay* and *interplay management*, which is ‘just as likely to produce positive or even synergistic results as it is to lead to interference between or among regimes’ (Young 2011a: 19856; see also Oberthür and Pożarowska 2013). The key question is to what extent conflicts between regimes can be resolved through a better division of labour, or through negotiations that lead to mutual accommodation (see Chapter 10). Often, this line of research draws on an overtly optimistic view of governments that carry a general interest in complementarity within global governance architectures (Gehring and Faude 2014), especially when international cooperation in one regime impedes international cooperation in another (Johnson and Urpelainen 2012).

The debate on the implications of institutional fragmentation for global governance is far from resolved. Attempts are being made to test various theories, for example through a comparison across architectures or over time, and explain their performance in relation to the degree of fragmentation or other structural features (see Chapter 8). But we do not expect a broad agreement on how best to improve the performance of governance architectures soon.

Multilevel Governance

The second question emphasized by the Earth System Governance Project in 2009 was, *what is the relative performance of different types of multilevel governance architectures?* This question entails the comparative analysis of governance systems as multilevel structures where many interacting authorities are at work, including local, national, regional and global (Zürn 2012; also Peel, Golden and Keenan 2012). The analytical focus has been on vertical institutional interaction and variability in the performance of institutions within such multilevel governance systems (Biermann 2014: 83–97). Regime complexes of various international

institutions could, for example, be conceptualized and analyzed as multilevel governance architectures to the extent that there is a vertical dimension between institutions (Abbott 2014; Hickmann 2017). The same holds of course for the interaction when regional integration organizations – like the European Union – provide a further level of governance between states and international institutions.

Systematic comparisons of multilevel governance architectures require typologies of such architectures. Often the vertical dimension is unpacked along two axes: *levels* of political jurisdiction, from global institutions to local administrations, and *spatial scale* (Van Doren et al. 2018) (with scale generally seen as the spatial, temporal, quantitative or analytical dimensions to measure and study any phenomenon, and levels as units of analysis located at different positions on a scale, see Gibson et al. 2000; Cash et al. 2006: 2). Scale and level determine the frame within which architectures are designed, contested and evaluated. A core question in the study of multilevel governance architectures is, therefore, how problems are framed in terms of scale and level and what implications the framing has for the performance of institutions.

For example, research has sought to identify the appropriate scale at which to address a problem such as climate change or ocean acidification (Kim 2012; Billé et al. 2013). As for climate change, for instance, it has been concluded that ‘local thinking must be coupled with global and national scales of action to achieve the levels of carbon dioxide reductions needed to avoid dangerous climate impacts’ (Sovacool and Brown 2009). Some analysts have employed the neologism of ‘glocal’ to refer to characteristics of both local and global considerations, for example in multilevel water governance (Gupta, Pahl-Wostl and Zondervan 2013). Furthermore, scholars focusing on polycentric governance argue that climate change should not be framed and approached exclusively as a global issue. They argue that actors and authorities at all levels should take initiatives for, among others, policy experimentation (Hoffmann 2011; see also Ostrom 2010b; Galaz et al. 2012; Betsill et al. 2015; Dorsch and Flachsland 2017). In fact, such a polycentric arrangement, where top-down and bottom-up processes are simultaneously at play, is becoming widespread. In global climate governance, for instance, we can observe both governance through legally binding, multilateral agreements (Hare et al. 2010) and governance through voluntary commitments and non-state action (Chan et al. 2015).

Successful policy measures can be translated to other levels or contexts through scaling (Hoffmann 2011). But under what circumstances can policies be scaled up and down? Context-specific barriers exist that hamper scaling of successful initiatives, and it is important that these are identified and addressed (Van Doren et al. 2016; Fuhr, Hickmann and Kern 2018). Furthermore, scaling processes change

how policy measures and instruments operate and may also render them less effective. Likewise, it is important to understand whether there can be consistent architectures if policies cannot be easily scaled up and down administrative levels (Biermann et al. 2009a). Key conditions identified in the literature include the presence of boundary organizations, such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, which act as brokers connecting institutions across scales or levels (Gupta, Pistorius and Vijge 2016; Holzscheiter 2017; Morin et al. 2017).

In this regard, the role of subnational or transnational *regions* has received new attention in multilevel governance (Balsiger and VanDeveer 2012). Regional agreements such as the Convention for the Protection of the Marine Environment of the North-East Atlantic make up two-thirds of all international environmental agreements. Some of these institutions form regional governance architectures that have been mapped and analyzed (Fidelman and Ekstrom 2012). While the significance of regional governance has often been overshadowed by global counterparts such as the United Nations Convention on the Law of the Sea, researchers have rediscovered the important role that regional agreements play in vertically and horizontally linking governance levels, especially as intermediary institutions bridging the national and the global (Balsiger and Prys 2016).

Fundamental Norms

The third architecture question that the Earth System Governance Project formulated in 2009 was, *what are overarching and crosscutting norms of earth system governance?*

Not all norms are equal in their status, scope or strength. A relatively small number of norms run through most, if not all, institutions and architectures of global governance. One prominent example is the widely accepted norm of the precautionary approach, which requires states to take measures to prevent serious or irreversible environmental harm despite scientific uncertainty. Such overarching or crosscutting norms have formed the normative basis on which many multilateral institutions are negotiated, agreed and implemented. Research in this field has sought: (1) to show such overarching or crosscutting norms that are common to many institutions in the field of earth system governance; (2) to analyze and understand key functions they perform; and (3) to explore ways in which we can bring about progressive development of these norms. These three research foci are discussed below in turn.

(1) First, regarding norm identification, two different approaches have been employed. For identifying *overarching* norms, researchers have assessed the legal status of candidate norms. Here, one would ask whether a norm has reached

a certain status in international law, for example, as customary international law or a general principle of international law. This approach is typically taken up by legal scholars who assume a hierarchy among norms, with some norms being superior or more widely applicable than others (Shelton 2006). For identifying *crosscutting* norms, researchers have looked for norms that appear as central across a range of global governance architectures. Here, the analytical concern is less on the actual legal status of a norm, but rather on the extent to which it appears as a constitutional principle or a basic norm. An example of such a crosscutting norm is the duty to maintain or restore the integrity of the earth's ecosystem (Kim and Bosselmann 2013; Bridgewater, Kim and Bosselmann 2014). Here the argument is that, although there is no explicit recognition among governments that global ecological integrity is a higher order norm than others, it is nonetheless an emergent 'common denominator' that all international soft law instruments such as the 1992 United Nations Declaration on Environment and Development have in their core (Kim and Bosselmann 2013).

It should be noted that this norm identification, sometimes referred to as codification, is done not only by academics but also by policymakers and other practitioners. Probably the most important organization with a codification mandate is the International Law Commission of the United Nations. In earth system governance, the International Union for Conservation of Nature has played an unofficial but significant role through the drafting and updating of an International Covenant on Environment and Development since 1995. Most recently, the United Nations General Assembly has initiated an intergovernmental process for developing a framework agreement for international environmental law, the Global Pact for the Environment. This pact is intended to entrench key fundamental principles that could serve to integrate the fragmented field of earth system governance (see Chapter 13; see also Kotzé and French 2018).

(2) Second, researchers have been interested in determining key functions that these overarching or crosscutting norms perform. One key function is the steering or adjudication of international institutions (Hickmann 2017). There is an emerging consensus in the literature that basic norms are key ingredients for maintaining some degree of polycentric order in global governance architectures (Jordan et al. 2018b). Here, overarching or crosscutting norms may 'provide a means to settle disputes and reduce the level of discord between units to a manageable level' (Jordan et al. 2018a: 19). Therefore, these overarching or crosscutting norms may also contribute to orchestration efforts of international organizations and coordinate the plethora of international institutions (see Chapter 11). In this light, some scholars argue that the absence of a clearly defined goal of international environmental law, for example, is conducive to conflicts and competition between international environmental regimes. In other words, the apparent ineffectiveness of

earth system governance could be attributed in significant part to the weak constitutional character of international environmental law (Kim and Bosselmann 2013).

Although the absence of an overarching norm is likely to be a key barrier for international institutions to function in a mutually beneficial manner, this theoretical proposition has yet to be empirically tested and supported. One area in which empirical evidence can be gathered are the Sustainable Development Goals (see Chapter 12). These goals are an outcome of political processes that codified overarching and crosscutting norms of earth system governance (see Chapter 13; see also Biermann, Kanie and Kim 2017). Will these global goals have any measurable effects on integrating and harmonizing policies that point in different directions into a more coherent whole? If so, what are the key mechanisms of governance through goals? Some see the Sustainable Development Goals as a well-integrated network of targets that will help coordinate competing policy objectives (Le Blanc 2015). Others are more cautious and argue that the goals merely reflect the fragmented set of existing commitments (Kim 2016; see also Kim and Bosselmann 2015; Underdal and Kim 2017; Young et al. 2017). They argue that it is imperative to agree on one overarching goal for the Sustainable Development Goals (Costanza et al. 2015).

(3) Third, earth system governance research has considered the more normative question of how the current set of overarching or crosscutting norms should be reconfigured or reinterpreted in light of rapid global change. For example, researchers have begun to engage cautiously in prescribing which norms should be recognized as most fundamental, especially in the face of challenges of the Anthropocene (Robinson 2014). Here, governance scholars often draw on scientific understandings of the earth system. The concept of planetary boundaries (Rockström et al. 2009; Steffen et al. 2015) has been particularly useful for legal and political theorizing regarding limitations of the sovereignty of nations (Biermann 2012; Kim and Bosselmann 2013; Ebbesson 2014; Kotzé and Kim 2019). For example, certain standards that are fundamental to protecting planetary boundaries could be accepted by the international community as *jus cogens* norms, from which no derogation is permitted. The restrictions on emissions of ozone-depleting substances, in accordance to the provisions of the Montreal Protocol, is a good example of what could be recognized as such a peremptory norm in the Anthropocene (Biermann 2014: 112–8).

There has been a considerable amount of political and academic effort to facilitate and formalize the recognition of, and respect for, planetary boundaries as a fundamental norm of earth system governance. Examples include the lobbying by scientists in the run-up to the 2012 United Nations Conference on Sustainable Development ('Rio+20') to insert planetary boundaries into the 2030 Agenda for

Sustainable Development as well as a proposal for a framework convention on planetary boundaries (Fernández and Malwé 2018). However, the recognition of planetary boundaries has been perceived as conflicting with some other fundamental norms including global social equity (Steffen and Stafford-Smith 2013). Consequently, the effort did not succeed, and the 2030 Agenda does not include any reference to planetary boundaries. Nonetheless, the Sustainable Development Goals reflect a novel normative development of global governance, and some scholars have put forward the argument that some of the existing but outdated norms and principles of international law should be reinterpreted in light of the new political consensus reached by the international community (Kim 2017).

Interaction between Policy Domains

The fourth question emphasized by the Earth System Governance Project was, *what are the environmental consequences of non-environmental governance systems?* Earth system governance is not just about protecting the environment but more broadly about achieving sustainable development. Therefore, institutional interactions between environmental institutions and those in other policy domains such as trade, energy, transport and agriculture become critical. Mapping of the interaction between the Sustainable Development Goals and a corresponding call for institutional ‘championing of one or a subset of the goals is a recent example (Nilsson, Griggs and Visbeck 2016). Research has been organized around analytical and normative dimensions: first, to understand the nature of interaction between institutions in different policy domains (Gehring and Oberthür 2009) and second, to strike a balance between environmental and non-environmental policy objectives and to address trade-offs (Boyle 2007; Pauwelyn 2007).

One of the most researched cross-domain interactions is between trade and environment. Traditionally, trade liberalization was viewed as undermining global environmental governance (Conca 2000). These scholars condemn free trade agreements that favour intensive production and long-distance transportation for causing additional pollution. They also fear that trade agreements can limit the regulatory capacity of political leaders to enact environmental regulations that frustrate the interest of exporters and investors (Morin and Bialais 2018). In particular, researchers have found potential conflicts between climate measures and the law of the World Trade Organization and examined to what extent the principle of integration might address trade-offs (Voigt 2009; Kim 2016).

More recently, however, the nexus between trade and environment has changed through a new generation of preferential trade agreements from the 2000s, such as the 2009 United States–Peru Trade Promotion Agreement (Morin, Pauwelyn and

Hollway 2017). These agreements have created strategic linkages between trade and environment (Jinnah and Morgera 2013) through including environmental provisions (Morin, Dür and Lechner 2018). Contrary to traditional wisdom, research on the new trade–environment nexus suggests the possibility of trade agreements having positive implications for consolidating the effectiveness of environmental agreements (Morin and Bialais 2018). The dynamism of the trade regime, in particular, has been identified as a leverage point for strengthening environmental governance (Morin and Jinnah 2018).

Other non-environmental governance systems studied for their impact on the environment include food and energy (Boas, Biermann and Kanie 2016). As for food, the research community has investigated, for example, how threats to food security and associated norms of the right to food influence negotiations on the architectures of earth system governance (Ziervogel and Ericksen 2010). The governance of the nitrogen and phosphorus cycles has also emerged as an important topic for addressing the food and environment nexus (Ahlström and Cornell 2018; Morseletto 2019). Furthermore, policies around controversial energy sources such as biofuel and hydropower have come under scrutiny for their negative consequences for environmental concerns (Pittock 2010; Scott et al. 2014).

Although research has so far pointed to some positive trends, the general finding still is that more policy integration or coordination is needed across policy domains. Then, the question arises how to respond to negative consequences of non-environmental governance systems on the environment. One key political response is environmental policy integration (see Chapter 9), which refers to the incorporation of environmental goals into non-environmental policy sectors with the aim of targeting the underlying driving forces rather than merely symptoms of environmental degradation (Persson et al. 2018; see also Jordan and Lenschow 2010). More recently, the concept of mainstreaming has become popular in research as well, for example regarding the mainstreaming of climate and biodiversity policies (e.g., Nunan, Campell and Foster 2012; Runhaar, Driessen and Uitenbroek 2014; Karlsson-Vinkhuyzen et al. 2017; Runhaar et al. 2018).

Ultimately, any response to interactions between policy domains entails a normative decision. Sustainable development is widely seen as the overarching objective of the international society; how to reconcile the three pillars of sustainable development – society, economy and environment – remains far from clear. Some argue that environmental concerns must be prioritized because the earth and its natural resources are finite; others argue that socio-economic concerns are as important. The latest version of this long-standing debate is the tension between the ‘ecological ceiling’ and the ‘social foundation’ (Raworth 2017). A group of scholars sought to ease the stalemate by proposing the protection of the earth’s life-support systems and poverty reduction as the twin priorities (Griggs et al. 2013). Yet, critics

argue that the twin priorities simply reflect the dichotomy between (environmental) sustainability and development, which has always been the core of the problem with the concept of sustainable development (Kim and Bosselmann 2015).

Architectural Voids

Finally, in 2009 the Earth System Governance Project called for more research on *how to explain instances of non-governance*, or the occurrence of ‘voids’ in the governance architecture.

This line of research started from the observation that in earth system governance we often do not have specialized institutions in areas or on issues that are widely identified as being problematic. For example, deforestation proceeds with tremendous speed, yet no global treaty exists to tackle this issue. While governments agreed in 1992 on a global convention on halting climate change and on protecting biological diversity, no treaty on deforestation was negotiated, even though this issue was also on the agenda at that time. How can we explain such instances of ‘non-governance’ or ‘architectural voids’? While the puzzle of the lacking agreement on global deforestation has attracted some attention by researchers and found compelling explanations (Dimitrov 2005), numerous other issues of non-governance are still insufficiently understood. Therefore, the study of governance architecture must also explore the gaps and empty spaces in or between them (Dimitrov, Sprinz and DiGiusto 2007). In comparative research designs, studies on non-governance will also help better explain the emergence and performance of those institutions that have been agreed. Moreover, research on why there are no global institutions in some areas will further our understanding of the consequences of governance architectures. For example, the absence of a global biofuel regime has created a risky North-South allocation pattern (Lima and Gupta 2013).

Some studies in this direction have improved understanding on why we do not have a world environment organization despite 40 years of political struggles (Vijge 2013), why there is no comprehensive law of the atmosphere (Sand 2017) and why we have no comprehensive treaty that covers the Arctic region (Young 2011b). However, there are still areas where our understanding is lacking. For instance, natural scientists have identified nine areas where they believe that our global system is facing planetary boundaries with fundamental value for human survival. While some of these boundaries are heavily institutionalized – for example by the climate convention of 1992 – others are hardly subject to global policy, notably the planetary boundaries on nitrogen and phosphorus (Ahlström and Cornell 2018; Morseletto 2019) and ocean acidification (Kim 2012). In addition, issues such as the global spread of plastics, especially into the marine environment, have been addressed in earth system governance only recently (Dauvergne 2018;

Nielsen, Holmberg and Stripple 2019). In short, the research programme on global non-governance is by far not concluded.

Two reasons, however, might explain why non-governance is less prominent and possibly also less problematic. First, institutions are becoming more adaptive. New and emerging problems do keep surfacing, potentially creating governance gaps. But in most cases, these gaps do not last for very long, with existing institutions quickly adapting to fill them. For example, ocean acidification has emerged as a new global issue. While there is no specialized treaty on this issue, the problem has nonetheless been taken up by the climate regime (Campbell et al. 2016). Similarly, the issue of deforestation has been taken up by the international climate convention since the introduction of Reducing Emissions from Deforestation and forest Degradation (REDD+) in 2005 (Gupta, Pistorius and Vijge 2016). Another example is the debate on geoengineering, that is, artificially cooling the planet by for instance spraying aerosols into the atmosphere to reflect parts of the sunlight or various other technologies. One such technology – the ‘fertilization’ of oceans to increase the uptake of carbon dioxide from the atmosphere – quickly came under scrutiny because of the unknown environmental risks and side effects. In 2008, parties to the Convention on Biological Diversity agreed on a moratorium on ocean fertilization, and the issue has remained a priority topic as well for the London Convention on dumping of wastes at sea (Pasztor, Scharf and Schmidt 2017), both halting global non-governance at least in the area of ocean fertilization.

Second, in areas of seeming non-governance by states, we often see informal and unconventional forms of steering. The Sustainable Development Goals, as a novel and broad governing mechanism, are one example that leaves little space unaffected by the goals (see Chapter 12; see also Kanie and Biermann 2017). Some also argue that, contrary to the popular claim that geoengineering is still a largely ungoverned space (Nicholson, Jinnah and Gillespie 2017; Jinnah 2018), certain types of geoengineering are governed through ‘unacknowledged sources of steering’ such as high-level authoritative assessments (Gupta and Möller 2018: 1). This point also reflects the emergence of new non-governmental actors, mechanisms and institutions, which go beyond traditional forms of state-led treaty-based regimes and that fill in areas marked by governmental non-action (Biermann and Pattberg 2008; Biermann 2010).

Methodological Approaches

The 2009 Science and Implementation Plan of the Earth System Governance Project lists several research methods as useful for the study of earth system governance. They include a wide range of approaches such as case studies, statistical techniques, discourse and content analysis, legal analysis, social network

analysis, agent-based modelling, systems analysis and qualitative comparative analysis (Biermann et al. 2009a: 77–85). These methods have been employed by researchers to varying degrees. Yet despite this methodological pluralism in earth system governance research, methodological challenges persist. While some of these challenges are common across the field (O'Neill et al. 2013), others are unique to research on governance architectures. We now discuss key methodological approaches used in research on global governance architectures and point to some challenges for future research directions.

The most widely used methodological approaches are qualitative small-*n* case studies. Data are usually gathered through semi-structured expert interviews, surveys and document analysis. For example, in a study of the fragmentation of global climate governance, van Asselt (2014) conducted three case studies of regime interplay between the United Nations climate regime on the one hand, and on the other hand multilateral clean technology agreements, the Convention on Biological Diversity and the World Trade Organization on the other. Similarly, Jinnah (2014) conducted four case studies to better understand how treaty secretariats help to manage the dense interplay of issues, rules and norms between international regimes. Most studies on governance architectures still tend to draw on comparable methodological approaches.

Some studies employed medium-*n* analysis, including a growing number of studies on international regime complexes. The framework presented by Keohane and Victor (2011), for example, has been used widely. Many studies that map transnational regime complexes have also used the 'governance triangle' framework by Abbott (2012). These analyses include in their scope not only intergovernmental institutions but also those with constituent actors that range from state and civil society organizations to firms (Guerra 2018). Such mapping exercises allow for a systematic comparison; one can see the different compositions of governance architectures and compare across them.

There is a growing number of quantitative studies using large-*n* datasets. Here, researchers often describe, analyze and explain an entire global governance architecture by mapping actor or institutional configurations or connectivity patterns (for a review, see Kim 2019). For example, studies were conducted with 681 international non-governmental organizations working on human rights (Murdie 2013), 747 multilateral environmental agreements (Kim 2013) and 680 trade agreements (Morin et al. 2017). In a similar vein, Green (2010) has examined the question to what extent states decide to delegate authoritative functions to private actors, such as rule-making, adjudication, implementation, monitoring and enforcement activities. Other studies include those that looked at the entire set of intergovernmental organizations (Greenhill and Lupu 2017) as well as international fisheries agreements (Hollway and Koskinen 2016). Furthermore, another innovative large-*n* study used over

1.5 million tweets to assess the influence of the climate treaty secretariat (Kolleck et al. 2017). In many of these large-*n* analyses, the network approach has been particularly popular and useful.⁴ Network analyses have uncovered the structural and dynamic patterns as well as power asymmetries in a range of global governance architectures (Lazer 2011).

Against this backdrop, we identify at least four key methodological and empirical challenges for the future study of global governance architectures.

First, given the complexity of global governance architectures, proving causality between constituent processes remains methodologically challenging. Some advances have been made through techniques such as exponential random graph models that allow for determining which generative processes have resulted in observed structural configurations (Chapter 14). Furthermore, statistical regression techniques have been useful to find correlations between network variables such as centrality and non-network variables such as outputs of individual institutions, and to find causality between the so-called network effects (Murdie 2013; also Hafner-Burton, Kahler and Montgomery 2009). More recently, qualitative comparative analysis has been used by earth system governance researchers to carve out combinations of necessary conditions for explaining the effectiveness of governance. Yet despite all progress, establishing causality remains a key challenge in research on global governance architectures (Young 2013).

Second, we lack methodological tools to capture and analyze an entire governance architecture. It is reasonable to expect that an architecture is complex, and therefore is not a simple sum of its parts. However, most of our methodological tools are designed for a reductionist approach, that is, trying to understand the structure and function of a whole by studying individual institutions and then inferring how the whole would function by aggregating them. We need a method that will link two distinct scales, the micro scale at which individual institutions work and the macro scale at which architectures evolve. The network approach introduced above does capture the whole, but it also has weaknesses. For example, it is limited because it only investigates structures, leaving processes in the network often insufficiently considered. A better combination of network analysis and agent-based modelling might be a promising future research path.

Third, research on how two architectures interact and co-evolve has only started to emerge. Existing research on the interaction between policy domains has focussed on how key institutions interact across architectural boundaries, for example regarding cooperation between the Convention on International Trade in Endangered Species of Wild Fauna and Flora and the World Trade Organization.

⁴ See, for instance, Fiedelman and Ekstrom 2012; Kim 2013; Green 2013; Murdie 2013; Böhmelt and Spilker 2016; Hollway and Koskinen 2016; Widerberg 2016; Greenhill and Lupu 2017; Kolleck et al. 2017; Morin et al. 2017; Ahlström and Cornell 2018.

However, research that maps the interface between two entire architectures and explains their interaction is still at a nascent stage. A recent example is the study on how two populations interact from an organizational ecology perspective (Morin 2018). While promising advances are being made, methodological challenges increase as we zoom out to a higher level of abstraction while not losing detail in resolution of individual institutions.

Fourth, while more data are not always the answer to challenges of social science research (Watts 2017; see also Lazer et al. 2009), it is still a challenge to access quality longitudinal, relational data for advancing our understanding of the global institutional complexity. Datasets on international institutions have been developed and maintained such as the International Environmental Agreements Database (Mitchell 2003), the Transnational Climate Initiatives Database (Bulkeley et al. 2012), the Design of Trade Agreements Database (Dür, Baccini and Elsig 2014), and the Trade and Environment Database (Morin, Dür and Lechner 2018). Other relevant databases include those maintained by international organizations such as ECOLEX (by International Union for Conservation of Nature, United Nations Environment Programme, and Food and Agriculture Organization), InforMEA (United Nations Environment Programme) and the Yearbook of International Organizations (Union of International Associations). However, some of these datasets are not open access, and more importantly, relational data are not always collected or complete. ECOLEX, for example, has information on references to others that are law-related, and the Yearbook of International Organizations offers self-reported longitudinal data on inter-organizational relationships, but these data can be expensive for individual researchers (Murdie 2013; Wilson, Davis and Murdie 2016).

Organization of the Book

We structured this book in four parts.

Part I presents the *building blocks* of architectures of global governance, namely intergovernmental institutions (including treaties and regimes) (Chapter 2), international bureaucracies (secretariats and intergovernmental organizations) (Chapter 3) and non-state, transnational institutions and networks (Chapter 4), along with a chapter on the special challenges of governance in areas beyond national jurisdiction (Chapter 5).

Part II discusses the core structural features of global governance architectures at micro, meso and macro levels. At the micro level, we look at dyadic interlinkages between institutions (Chapter 6). We then move on to study the meso level of regime complexes of loosely coupled institutions (Chapter 7), and governance fragmentation at the macro level of whole architectures (Chapter 8).

Part III lays out research on policy responses to fragmentation and complexity in global governance architectures. Our author teams look into policy integration, which seeks to incorporate environmental concerns and objectives into non-environmental policy areas (Chapter 9); interplay management, which tries to limit conflicts caused by institutional interlinkages (Chapter 10); orchestration through intermediaries (Chapter 11); governance through goals, such as the Sustainable Development Goals (Chapter 12); and finally, the hierarchization of governance architectures (Chapter 13).

Part IV concludes our book and presents, in Chapter 14, new directions in policy and research.

References

- Abbott, K. W. (2012). The transnational regime complex for climate change. *Environment and Planning C: Government and Policy*, 30, 571–90.
- Abbott, K. W. (2014). Strengthening the transnational regime complex for climate change. *Transnational Environmental Law*, 3, 57–88.
- Abbott, K. W., & Bernstein, S. (2015). The High-level Political Forum on Sustainable Development: Orchestration by default and design. *Global Policy*, 6, 222–33.
- Ahlström, H., & Cornell, S. E. (2018). Governance, polycentricity and the global nitrogen and phosphorus cycles. *Environmental Science and Policy*, 79, 54–65.
- Aldy, J. E., Barrett, S., & Stavins, R. N. (2003). Thirteen plus one: A comparison of global climate policy architectures. *Climate Policy*, 3, 373–97.
- Alter, K. J., & Meunier, S. (2009). The politics of international regime complexity. *Perspectives on Politics*, 7, 13–24.
- Balsiger, J., & Prys, M. (2016). Regional agreements in international environmental politics. *International Environmental Agreements*, 16, 239–60.
- Balsiger, J., & VanDeveer, S. D. (2012). Navigating regional environmental governance. *Global Environmental Politics*, 12, 1–17.
- Betsill, M. M., Benney, T. M., & Gerlak, A. K. (eds.) (2019). *Agency in earth system governance*. Cambridge, UK: Cambridge University Press.
- Betsill, M. M., Dubash, N., Paterson, M., van Asselt, H., Vihma, A., & Winkler, H. (2015). Building productive links between the UNFCCC and the broader global climate governance landscape. *Global Environmental Politics*, 15 (2), 1–10.
- Benvenisti, E., & Downs, G. W. (2007). The Empire's new clothes: Political economy and the fragmentation of international law. *Stanford Law Review*, 60, 595–631.
- Biermann, F. (2007). 'Earth system governance' as a crosscutting theme of global change research. *Global Environmental Change*, 17, 326–37.
- Biermann, F. (2010). Beyond the intergovernmental regime: Recent trends in global carbon governance. *Current Opinion in Environmental Sustainability*, 2, 284–8.
- Biermann, F. (2012). Planetary boundaries and earth system governance: Exploring the links. *Ecological Economics*, 81, 4–9.
- Biermann, F. (2014). *Earth system governance: World politics in the Anthropocene*. Cambridge, MA: The MIT Press.
- Biermann, F., Abbott, K. W., Andresen, S. et al. (2012). Navigating the Anthropocene: Improving earth system governance. *Science*, 335, 1306–7.
- Biermann, F., Bai, X., Bondre, N. et al. (2016). Down to earth: Contextualizing the Anthropocene. *Global Environmental Change*, 39, 341–50.

- Biermann, F., Betsill, M. M., Gupta, J. et al. (2009a). *Earth system governance: People, places and the planet. Science and implementation plan of the Earth System Governance Project*. Bonn: Earth System Governance Project.
- Biermann, F., Betsill, M. M., Gupta, J. et al. (2010). Earth system governance: A research framework. *International Environmental Agreements*, 10, 277–98.
- Biermann, F., & Gupta, A. (2011). Accountability and legitimacy in earth system governance: A research framework. *Ecological Economics*, 70, 1856–64.
- Biermann, F., Kanie, N., & Kim, R. E. (2017). Global governance by goal-setting: The novel approach of the UN Sustainable Development Goals. *Current Opinion in Environmental Sustainability*, 26–27, 26–31.
- Biermann, F., & Pattberg, P. (2008). Global environmental governance: Taking stock, moving forward. *Annual Review of Environment and Resources*, 33, 277–94.
- Biermann, F., Pattberg, P., van Asselt, H., & Zelli, F. (2009b). The fragmentation of global governance architectures: A framework for analysis. *Global Environmental Politics*, 9, 14–40.
- Billé, R., Kelly, R., Biastoch, A. et al. (2013). Taking action against ocean acidification: A review of management and policy options. *Environmental Management*, 52, 761–79.
- Boas, I., Biermann, F., & Kanie, N. (2016). Cross-sectoral strategies in global sustainability governance: Towards a nexus approach. *International Environmental Agreements*, 16, 449–64.
- Böhmelt, T., & Spilker, G. (2016). The interaction of international institutions from a social network perspective. *International Environmental Agreements*, 16, 67–89.
- Boyd, E., & Folke, C. (eds.) (2012). *Adapting institutions: Governance, complexity and social-ecological resilience*. Cambridge, UK: Cambridge University Press.
- Boyle, A. (2007). Relationship between international environmental law and other branches of international law. In D. Bodansky, J. Brunnée, & E. Hey (eds.), *The Oxford handbook of international environmental law*. Oxford: Oxford University Press.
- Breitmeier, H., Underdal, A., & Young, O. R. (2011). The effectiveness of international environmental regimes: Comparing and contrasting findings from quantitative research. *International Studies Review*, 13, 579–605.
- Bridgewater, P., Kim, R. E., & Bosselmann, K. (2014). Ecological integrity: A relevant concept for international environmental law in the Anthropocene? *Yearbook of International Environmental Law*, 25, 61–78.
- Brown Weiss, E. (1993). International environmental law: Contemporary issues and the emergence of a new world order. *Georgetown Law Journal*, 81, 675–710.
- Brown Weiss, E., & Jacobson, H. K. (eds.) (1998). *Engaging countries: Strengthening compliance with international environmental accords*. Cambridge, MA: The MIT Press.
- Bulkeley, H., Andonova, L., Bäckstrand, K. et al. (2012). Governing climate change transnationally: Assessing the evidence from a database of sixty initiatives. *Environment and Planning C: Government and Policy*, 30, 591–612.
- Campbell, L. M., Gray, N. J., Fairbanks, L. et al. (2016). Global oceans governance: New and emerging issues. *Annual Review of Environment and Resources*, 41, 517–43.
- Carlarne, C. (2008). Good climate governance: Only a fragmented system of international law away? *Law and Policy*, 30, 450–80.
- Cash, D. W., Adger, W. N., Berkes, F. et al. (2006). Scale and cross-scale dynamics: Governance and information in a multilevel world. *Ecology and Society*, 11.
- Chambers, W. B. (2008). *Interlinkages and the effectiveness of multilateral environmental agreements*. Tokyo: United Nations University Press.
- Chan, S., van Asselt, H., Hale, T. et al. (2015). Reinvigorating international climate policy: A comprehensive framework for effective nonstate action. *Global Policy*, 6, 466–73.

- Compagnon, D., Chan, S., & Mert, A. (2012). The changing role of the state. In F. Biermann, & P. Pattberg (eds.), *Global environmental governance reconsidered* (pp. 237–63). Cambridge, MA: The MIT Press.
- Conca, K. (2000). The WTO and the undermining of global environmental governance. *Review of International Political Economy*, 7, 484–94.
- Conca, K. (2006). *Governing water: Contentious transnational politics and global institution building*. Cambridge, MA: The MIT Press.
- Costanza, R., McGlade, J., Lovins, H., & Kubiszewski, I. (2015). An overarching goal for the UN Sustainable Development Goals. *Solutions*, 5, 13–16.
- Craik, N., Jefferies, C. S. G., Seck, S. L., & Stephens, T. (eds.) (2018). *Global environmental change and innovation in international law*. Cambridge, UK: Cambridge University Press.
- Dauvergne, P. (2018). Why is the global governance of plastic failing the oceans? *Global Environmental Change*, 51, 22–31.
- Dimitrov, R. S. (2005). Hostage to norms: States, institutions and global forest politics. *Global Environmental Politics*, 5 (4), 1–24.
- Dimitrov, R. S., Sprinz, D. F., & DiGiusto, G. M. (2007). International nonregimes: A research agenda. *International Studies Review*, 9, 230–58.
- Dorsch, M. J., & Flachsland, C. (2017). A polycentric approach to global climate governance. *Global Environmental Politics*, 17, 45–64.
- Dryzek, J. S. (2014). Institutions for the Anthropocene: Governance in a changing earth system. *British Journal of Political Science*, 46, 937–56.
- Dür, A., Baccini, L., & Elsig, M. (2014). The design of international trade agreements: Introducing a new dataset. *Review of International Organizations*, 9, 353–75.
- Ebbesson, J. (2014). Planetary boundaries and the matching of international treaty regimes. *Scandinavian Studies in Law*, 59, 259–84.
- Eichner, T., & Pethig, R. (2011). Carbon leakage, the green paradox, and perfect future markets. *International Economic Review*, 52, 767–805.
- Ekstrom, J. A., & Crona, B. I. (2017). Institutional misfit and environmental change: A systems approach to address ocean acidification. *Science of the Total Environment*, 576, 599–608.
- Ekstrom, J. A., & Young, O. R. (2009). Evaluating functional fit between a set of institutions and an ecosystem. *Ecology and Society*, 14.
- Fernández, E. F., Malwé, C. (2018). The emergence of the ‘planetary boundaries’ concept in international environmental law: A proposal for a framework convention. *Review of European, Comparative & International Environmental Law*, 28, 48–56
- Fidelman, P., & Ekstrom, J. A. (2012). Mapping seascapes of international environmental arrangements in the coral triangle. *Marine Policy*, 36, 993–1004.
- Folke, C., Pritchard, Jr., L., Berkes, F., Colding, J., & Svedin, U. (2007). The problem of fit between ecosystems and institutions: Ten years later. *Ecology and Society*, 12.
- Fuhr, H., Hickmann, T., & Kern, K. (2018). The role of cities in multi-level climate governance: Local climate policies and the 1.5 °C target. *Current Opinion in Environmental Sustainability*, 30, 1–6.
- Galaz, V. (2011). Double complexity: Information technology and reconfigurations in adaptive governance. In E. Boyd, & C. Folke (eds.), *Adapting institutions: Governance, complexity and social-ecological resilience* (pp. 193–215). Cambridge, UK: Cambridge University Press.
- Galaz, V., Crona, B., Österblom, H., Olsson, P., & Folke, C. (2012). Polycentric systems and interacting planetary boundaries: Emerging governance of climate change–ocean acidification–marine biodiversity. *Ecological Economics*, 81, 21–32.

- Galaz, V., Olsson, P., Hahn, T., Folke, C., & Svedin, U. (2008). The problem of fit between governance systems and environmental regimes. In O. R. Young, L. A. King, & H. Schroeder (eds.), *Institutions and environmental change: Principal findings, applications and research frontiers* (pp. 147–86). Cambridge, MA: The MIT Press.
- Gehring, T., & Faude, B. (2014). A theory of emerging order within institutional complexes: How competition among regulatory international institutions leads to institutional adaptation and division of labor. *Review of International Organizations*, 9, 471–98.
- Gehring, T., & Oberthür, S. (2006). Comparative empirical analysis and ideal types of institutional interaction. In S. Oberthür, & T. Gehring (eds.), *Institutional interaction in global environmental governance: Synergy and conflict among international and EU policies* (pp. 307–71). Cambridge, MA: The MIT Press.
- Gehring, T., & Oberthür, S. (2009). The causal mechanisms of interaction between international institutions. *European Journal of International Relations*, 15, 125–56.
- Gibson, C., Ostrom, E., & Ahn, T.-K. (2000). The concept of scale and the human dimensions of global change: A survey. *Ecological Economics*, 32, 217–39.
- Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology*, 78, 1–22.
- Green, J. F. (2010). Private authority on the rise: A century of delegation in multilateral environmental agreements. In J. Tallberg, & C. Jönsson (eds.), *Transnational actors in global governance* (pp. 155–76). Basingstoke: Palgrave.
- Green, J. F. (2013). Order out of chaos: Public and private rules for managing carbon. *Global Environmental Politics*, 13, 1–25.
- Greenhill, B., & Lupu, Y. (2017). Clubs of clubs: Fragmentation in the network of inter-governmental organizations. *International Studies Quarterly*, 61, 181–95.
- Griggs, D., Stafford-Smith, M., Gaffney, O. et al. (2013). Sustainable development goals for people and planet. *Nature*, 495, 305–7.
- Guerra, F. (2018). Mapping offshore renewable energy governance. *Marine Policy*, 89, 21–33.
- Gupta, A., & Möller, I. (2018). De facto governance: How authoritative assessments construct climate engineering as an object of governance. *Environmental Politics*, 28, 480–501.
- Gupta, A., Pistorius, T., & Vijge, M. J. (2016). Managing fragmentation in global environmental governance: The REDD+ partnership as bridge organization. *International Environmental Agreements*, 16, 355–74.
- Gupta, J., & Lebel, L. (2010). Access and allocation in earth system governance: Water and climate change compared. *International Environmental Agreements*, 10, 377–95.
- Gupta, A., & Mason, M. (eds.) (2014). *Transparency in global environmental governance: Critical perspectives*. Cambridge, MA: The MIT Press.
- Gupta, J., Pahl-Wostl, C., & Zondervan, R. (2013). ‘Glocal’ water governance: A multi-level challenge in the Anthropocene. *Current Opinion in Environmental Sustainability*, 5, 573–580.
- Hackmann, B. (2012). Analysis of the governance architecture to regulate GHG emissions from international shipping. *International Environmental Agreements*, 12, 85–103.
- Hafner-Burton, E. M., Kahler, M., & Montgomery, A. H. (2009). Network analysis for international relations. *International Organization*, 63, 559–92.
- Hare, W., Stockwell, C., Flachsland, C., & Oberthür, S. (2010). The architecture of the global climate regime: A top-down perspective. *Climate Policy*, 10, 600–14.
- Hickmann, T. (2017). The reconfiguration of authority in global climate governance. *International Studies Review*, 19, 430–51.

- Hickmann, T., Widerberg, O., Lederer, M., & Pattberg, P. (2019). The United Nations Framework Convention on Climate Change Secretariat as an orchestrator in global climate policymaking. *International Review of Administrative Sciences*, in press.
- Hoffmann, M. J. (2011). *Climate governance at the crossroads: Experimenting with a global response after Kyoto*. Oxford: Oxford University Press.
- Hollway, J., & Koskinen, J. (2016). Multilevel embeddedness: The case of the global fisheries governance complex. *Social Networks*, 44, 281–94.
- Holzscheiter, A. (2017). Coping with institutional fragmentation? Competition and convergence between boundary organizations in the global response to polio. *Review of Policy Research*, 34, 767–89.
- Holzscheiter, A., Bahr, T., & Pantzerhielm, L. (2016). Emerging governance architectures in global health: Do metagovernance norms explain inter-organisational convergence? *Politics and Governance*, 4, 5–19.
- Jinnah, S. (2014). *Post-treaty politics: Secretariat influence in global environmental governance*. Cambridge, MA: The MIT Press.
- Jinnah, S. (2018). Why govern climate engineering? A preliminary framework for demand-based governance. *International Studies Review*, 20, 272–82.
- Jinnah, S., & Morgera, E. (2013). Environmental provisions in American and EU free trade agreements: A preliminary comparison and research agenda. *Review of European, Comparative & International Environmental Law*, 22, 324–39.
- Johnson, T., & Urpelainen, J. (2012). A strategic theory of regime integration and separation. *International Organization*, 66, 645–77.
- Jordan, A., Huitema, D., Schoenefeld, J., van Asselt, H., & Forster, J. (2018a). Governing climate change polycentrically: Setting the scene. In A. Jordan, D. Huitema, H. van Asselt, & J. Forster (eds.), *Governing climate change: Polycentricity in action?* (pp. 3–26). Cambridge, UK: Cambridge University Press.
- Jordan, A., Huitema, D., van Asselt, H., & Forster, J. (eds.) (2018b). *Governing climate change: Polycentricity in action?* Cambridge, UK: Cambridge University Press.
- Jordan, A., & Lenschow, A. (2010). Environmental policy integration: A state of the art review. *Environmental Policy and Governance*, 20, 147–58.
- Kanie, N. (2007). Governance with multilateral environmental agreements: A healthy or ill-equipped fragmentation? In L. Swart, & E. Perry (eds.), *Global environmental governance: Perspectives on the current debate* (pp. 67–86). New York: Center for UN Reform Education.
- Kanie, N., Andresen, S., & Haas, P. M. (eds.) (2013). *Improving global environmental governance: Best practices for architecture and agency*. Cambridge, MA: The MIT Press.
- Kanie, N., & Biermann, F. (eds.) (2017). *Governing through goals: Sustainable Development Goals as governance innovation*. Cambridge, MA: The MIT Press.
- Kanie, N., Nishimoto, H., Hijioka, Y., & Kameyama, Y. (2010). Allocation and architecture in climate governance beyond Kyoto: lessons from interdisciplinary research on target setting. *International Environmental Agreements*, 10, 299–315.
- Karlsson-Vinkhuyzen, S. I., & McGee, J. (2013). Legitimacy in an era of fragmentation: The case of global climate governance. *Global Environmental Politics*, 13, 56–78.
- Karlsson-Vinkhuyzen, S., Kok, M. T. J., Vissere-Hamakers, I. J., & Termeer, C. J. A. M. (2017). Mainstreaming biodiversity in economic sectors: An analytical framework. *Biological Conservation*, 210, 145–56.
- Keohane, R. O., & Victor, D. G. (2011). The regime complex for climate change. *Perspectives on Politics*, 9, 7–23.
- Kim, J. A. (2004). Regime interplay: The case of biodiversity and climate change. *Global Environmental Change*, 14, 315–24.

- Kim, R. E. (2012). Is a new multilateral environmental agreement on ocean acidification necessary? *Review of European, Comparative and International Environmental Law*, 21, 243–58.
- Kim, R. E. (2013). The emergent network structure of the unilateral environmental agreement system. *Global Environmental Change*, 23, 980–91.
- Kim, R. E. (2016). The nexus between international law and the Sustainable Development Goals. *Review of European, Comparative & International Environmental Law*, 25, 15–26.
- Kim, R. E. (2017). Should deep seabed mining be allowed? *Marine Policy*, 82, 134–7.
- Kim, R. E. (2019). Is global governance fragmented, polycentric, or complex: The state of the art of the network approach. *International Studies Review*.
- Kim, R. E., & Bosselmann, K. (2013). International environmental law in the Anthropocene: Towards a purposive system of multilateral environmental agreements. *Transnational Environmental Law*, 2, 285–309.
- Kim, R. E., & Bosselmann, K. (2015). Operationalizing sustainable development: Ecological integrity as a *Grundnorm* of international law. *Review of European, Comparative & International Environmental Law*, 24, 194–208.
- Kim, R. E., & Mackey, B. (2014). International environmental law as a complex adaptive system. *International Environmental Agreements*, 14, 5–24.
- Kim, R. E., & van Asselt, H. (2016). Global governance: Problem shifting in the Anthropocene and the limits of international law. In E. Morgera, & K. Kulovesi (eds.), *Research handbook on international law and natural resources* (pp. 473–95). Cheltenham: Edward Elgar.
- Kolleck, N., Well, M., Sperzel, S., & Jörgens, H. (2017). The power of social networks: How the UNFCCC Secretariat creates momentum for climate education. *Global Environmental Politics*, 17, 106–26.
- Kotzé, L. J. (2016). *Global environmental constitutionalism in the Anthropocene*. Portland: Bloomsbury Publishing.
- Kotzé, L. J., & French, D. (2018). A critique of the global pact for the environment: A stillborn initiative or the foundation for *Lex Anthropocenae*? *International Environmental Agreements*, 18, 811–38.
- Kotzé, L. J., & Kim, R. E. (2019). Earth system law: The juridical dimensions of earth system governance. *Earth System Governance*, 1.
- Lazer, D. (2011). Networks in political science: Back to the future. *Political Science and Politics*, 44, 61–8.
- Lazer, D., Pentland, A., Adamic, L. et al. (2009). Computational social science. *Science*, 323, 721–3.
- Le Blanc, D. (2015). Towards integration at last? The Sustainable Development Goals as a network of targets. *Sustainable Development*, 23, 176–87.
- Lima, M. G. B., & Gupta, J. (2013). The policy context of biofuels: A case of non-governance at the global level? *Global Environmental Politics*, 13, 46–64.
- Mitchell, R. B. (2003). International environmental agreements: A survey of their features, formation, and effects. *Annual Review of Environment and Resources*, 28, 429–61.
- Morin, J. F. (2018). Concentration despite competition: The organizational ecology of technical assistance providers. *Review of International Organizations*, 70, 1–33.
- Morin, J. F., & Bialais, C. (2018). *Strengthening multilateral environmental governance through bilateral trade deals*. Policy Brief No. 123. Waterloo, ON Canada: Centre for International Governance Innovation.
- Morin, J. F., Dür, A., & Lechner, L. (2018). Mapping the trade and environment nexus: Insights from a new data set. *Global Environmental Politics*, 18, 122–39.

- Morin, J. F., & Jinnah, S. (2018). The untapped potential of preferential trade agreements for climate governance. *Environmental Politics*, 27, 541–65.
- Morin, J. F., Louafi, S., Orsini, A., & Oubenal, M. (2017). Boundary organizations in regime complexes: A social network profile of IPBES. *Journal of International Relations and Development*, 20, 543–77.
- Morin, J. F., Pauwelyn, J., & Hollway, J. (2017). The trade regime as a complex adaptive system: Exploration and exploitation of environmental norms in trade agreements. *Journal of International Economic Law*, 20 (2), 365–90.
- Morseletto, P. (2019). Confronting the nitrogen challenge: Options for governance and target setting. *Global Environmental Change*, 54, 40–9.
- Murdie, A. (2013). The ties that bind: A network analysis of human rights international nongovernmental organizations. *British Journal of Political Science*, 44, 1–27.
- Murphy, H., & Kellow, A. (2013). Forum shopping in global governance: Understanding states, business and NGOs in multiple arenas. *Global Policy*, 4, 139–49.
- Nicholson, S., Jinnah, S., & Gillespie, A. (2017). Solar radiation management: A proposal for immediate polycentric governance. *Climate Policy*, 18, 322–34.
- Nielsen, T. D., Holmberg, K., & Stripple, J. (2019). Need a bag? A review of public policies on plastic carrier bags – Where, how and to what effect? *Waste Management*, 87, 428–40.
- Nilsson, M., Griggs, D., & Visbeck, M. (2016). Map the interactions between Sustainable Development Goals. *Nature*, 534, 320–2.
- Nunan, F., Campbell, A., & Foster, E. (2012). Environmental mainstreaming: The organisational challenges of policy integration. *Public Administration and Development*, 32, 262–77.
- Oberthür, S., & Gehring, T. (eds.) (2006). *Institutional interaction in global environmental governance: Synergy and conflict among international and EU policies*. Cambridge, MA: The MIT Press.
- Oberthür, S., & Pożarowska, J. (2013). Managing institutional complexity and fragmentation: The Nagoya Protocol and the global governance of genetic resources. *Global Environmental Politics*, 13, 100–18.
- Oberthür, S., & Stokke, O. S. (eds.) (2011). *Managing institutional complexity: Regime interplay and global environmental change*. Cambridge, MA: The MIT Press.
- O’Neill, K., Weinthal, E., Marion Suiseeya, K. R., Bernstein, S., Cohn, A., Stone, M. W., & Cashore, B. (2013). Methods and global environmental governance. *Annual Review of Environment and Resources*, 38, 441–71.
- Ostrom, E. (2010a). Nested externalities and polycentric institutions: Must we wait for global solutions to climate change before taking actions at other scales? *Economic Theory*, 49, 353–69.
- Ostrom, E. (2010b). Polycentric systems for coping with collective action and global environmental change. *Global Environmental Change*, 20, 550–7.
- Park, S., & Kramarz, T. (2019). *Global environmental governance and the accountability trap*. Cambridge, MA: The MIT Press.
- Pasztor, J., Scharf, C., & Schmidt, K. U. (2017). How to govern geoengineering? *Science*, 357, 231.
- Pattberg, P. (2010). Public–private partnerships in global climate governance. *Wiley Interdisciplinary Reviews: Climate Change*, 1, 279–87.
- Pattberg, P., Chan, S., Sanderink, L., & Widerberg, O. (2018). Linkages: Understanding their role in polycentric governance. In A. Jordan, D. Huitema, H. van Asselt, & J. Forster (eds.), *Governing climate change: Polycentricity in action?* (pp. 169–87). Cambridge, UK: Cambridge University Press.
- Pattberg, P., & Zelli, F. (eds.) (2016). *Environmental politics and governance in the Anthropocene: Institutions and legitimacy in a complex world*. London: Routledge.

- Pauwelyn, J. (2007). *Conflict of norms in public international law: How WTO law relates to other rules of international law*. Cambridge, UK: Cambridge University Press.
- Pauwelyn, J. (2014). At the edge of chaos? Foreign investment law as a complex adaptive system, how it emerged and how it can be reformed. *ICSID Review*, 29, 372–418.
- Peel, J., Godden, L., & Keenan, R. J. (2012). Climate change law in an era of multi-level governance. *Transnational Environmental Law*, 1, 245–80.
- Persson, Å., Runhaar, H., Karlsson-Vinkhuyzen, S., Mullally, G., Russel, D., & Widmer, A. (2018). Environmental policy integration: Taking stock of policy practice in different contexts. *Environmental Science and Policy*, 85, 113–15.
- Pickering, J. (2018). Ecological reflexivity: Characterising an elusive virtue for governance in the Anthropocene. *Environmental Politics*, in press.
- Pittock, J. (2010). Better management of hydropower in an era of climate change. *Water Alternatives*, 3, 444–52.
- Raworth, K. (2017). *Doughnut economics: Seven ways to think like a 21st-century economist*. White River Junction: Chelsea Green Publishing.
- Reid, W. V., Chen, D., Goldfarb, L. et al. (2010). Earth system science for global sustainability: Grand challenges. *Science*, 12, 916–17.
- Reus-Smit, C. (2013). Constructivism. In S. Burchill, & A. Linklater (eds.), *Theories of international relations* (pp. 217–40). New York: Palgrave.
- Robinson, N. A. (2014). Fundamental principles of law for the Anthropocene? *Environmental Policy and Law*, 44, 13–27.
- Rockström, J., Steffen, W., Noone, K. et al. (2009). A safe operating space for humanity. *Nature*, 461, 472–5.
- Runhaar, H., Driessen, P., & Uittenbroek, C. (2014). Towards a systematic framework for the analysis of environmental policy integration. *Environmental Policy and Governance*, 24, 233–46.
- Runhaar, H., Wilk, B., Persson, Å., Uittenbroek, C., & Wamsler, C. (2018). Mainstreaming climate adaptation: Taking stock about ‘What Works’ from empirical research worldwide. *Regional Environmental Change*, 18, 1–10.
- Sand, P. H. (2017). The discourse on ‘protection of the atmosphere’ in the International Law Commission. *Review of European, Comparative & International Environmental Law*, 26, 201–9.
- Scharpf, F. W. (1999). *Governing in Europe: Effective and democratic?* Oxford: Oxford University Press.
- Schellnhuber, H. J., Crutzen, P. J., Clark, W. C., Claussen, M., & Held, H. (2004). *Earth system analysis for sustainability*. Cambridge, MA: The MIT Press.
- Scobie, M. (2019). *Global environmental governance and small states: Architectures and agency in the Caribbean*. Cheltenham: Edward Elgar.
- Scott, D., Hitchner, S., Maclin, E. M., & Dammert B, J. L. (2014). Fuel for the fire: Biofuels and the problem of translation at the tenth conference of the parties to the convention on biological diversity. *Global Environmental Politics*, 14, 84–101.
- Scott, K. N. (2013). International law in the Anthropocene: Responding to the geoengineering challenge. *Michigan Journal of International Law*, 34, 309–58.
- Shelton, D. (2006). Normative hierarchy in international law. *American Journal of International Law*, 100, 291–323.
- Sovacool, B. K., & Brown, M. A. (2009). Scaling the policy response to climate change. *Policy and Society*, 27, 317–28.
- Steffen, W., Richardson, K., Rockström, J. et al. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, 347, 1259855.

- Steffen, W., Rockström, J., Richardson, K. et al. (2018). Trajectories of the earth system in the Anthropocene. *Proceedings of the National Academy of Sciences of the United States of America*, 2, 201810141–8.
- Steffen, W., Sanderson, A., Tyson, P. et al. (2004). *Global change and the earth system: A planet under pressure*. Berlin: Springer.
- Steffen, W., & Stafford-Smith, M. (2013). Planetary boundaries, equity and global sustainability: Why wealthy countries could benefit from more equity. *Current Opinion in Environmental Sustainability*, 5, 1–6.
- Stevens, C. (2018). Scales of integration for sustainable development governance. *International Journal of Sustainable Development and World Ecology*, 25, 1–8.
- Truelove, H. B., Carrico, A. R., Weber, E. U., Raimi, K. T., & Vandenbergh, M. P. (2014). Positive and negative spillover of pro-environmental behaviour: An integrative review and theoretical framework. *Global Environmental Change*, 29, 127–38.
- Underdal, A., & Kim, R. E. (2017). The Sustainable Development Goals and multilateral agreements. In N. Kanie, & F. Biermann (eds.), *Governing through goals: Sustainable Development Goals as governance innovation* (pp. 241–9). Cambridge, MA: The MIT Press.
- UNEP (2007). *Global environment outlook 4: Environment for development*. Nairobi: United Nations Environment Programme.
- UNEP (2012). *Global environment outlook 5: Environment for the future we want*. Nairobi: United Nations Environment Programme.
- UNEP (2019). *Global environment outlook 6: Healthy planet, healthy people*. Nairobi: United Nations Environment Programme.
- van Asselt, H. (2014). *The fragmentation of global climate governance: Consequences and management of regime interactions*. Cheltenham: Edward Elgar.
- Van de Graaf, T. (2013). Fragmentation in global energy governance: Explaining the creation of IRENA. *Global Environmental Politics*, 13, 14–33.
- Van den Bergh, J., Folke, C., Polasky, S., Scheffer, M., & Steffen, W. (2015). What if solar energy becomes really cheap? A thought experiment on environmental problem shifting. *Current Opinion in Environmental Sustainability*, 14, 170–9.
- Van Doren, D., Driessen, P. P., Runhaar, H., & Giezen, M. (2018). Scaling-up low-carbon urban initiatives: Towards a better understanding. *Urban Studies*, 55, 175–94.
- Van Doren, D., Giezen, M., Driessen, P. P. J., & Runhaar, H. (2016). Scaling-up energy conservation initiatives: Barriers and local strategies. *Sustainable Cities and Society*, 26, 227–39.
- Vidas, D. (2011). The Anthropocene and the international law of the sea. *Philosophical Transactions of the Royal Society A*, 369, 909–25.
- Vidas, D., Fauchald, O. K., Jensen, Ø., & Tvedt, M. W. (2015). International law for the Anthropocene? Shifting perspectives in regulation of the oceans, environment and genetic resources. *Anthropocene*, 9, 1–13.
- Vijge, M. J. (2013). The promise of new institutionalism: Explaining the absence of a world or united nations environment organisation. *International Environmental Agreements*, 13, 153–76.
- Voigt, C. (2009). *Sustainable development as a principle of international law: Resolving conflicts between climate measures and WTO law*. Leiden: Martinus Nijhoff Publishers.
- Vordermayer, M. (2014). ‘Gardening the great transformation’: The Anthropocene concept’s impact on international environmental law doctrine. *Yearbook of International Environmental Law*, 25 (1), 79–112.
- Watts, D. J. (2017). Should social science be more solution-oriented? *Nature Human Behaviour*, 1, 5–15.

- Widerberg, O. (2016). Mapping institutional complexity in the Anthropocene: A network approach. In P. Pattberg, & F. Zelli (eds.), *Environmental politics and governance in the Anthropocene: Institutions and legitimacy in a complex world* (pp. 81–102). London: Routledge.
- Wilson, M., Davis, D. R., & Murdie, A. (2016). The view from the bottom: Networks of conflict resolution organizations and international peace. *Journal of Peace Research*, 53, 442–58.
- Yang, Y., Bae, J., Kim, J., & Suh, S. (2012). Replacing gasoline with corn ethanol results in significant environmental problem-shifting. *Environmental Science and Technology*, 46, 3671–8.
- Young, M. A. (2012). *Regime interaction in international law: Facing fragmentation*. Cambridge, UK: Cambridge University Press.
- Young, O. R. (1996). Institutional linkages in international society: Polar perspectives. *Global Governance*, 2, 1–23.
- Young, O. R. (ed.) (1999). *The effectiveness of international environmental regimes: Causal connections and behavioural mechanisms*. Cambridge, MA: The MIT Press.
- Young, O. R. (2002). *The institutional dimensions of environmental change: Fit, interplay, and scale*. Cambridge, MA: The MIT Press.
- Young, O. R. (2008). The architecture of global environmental governance: Bringing science to bear on policy. *Global Environmental Politics*, 8, 14–32.
- Young, O. R. (2011a). Effectiveness of international environmental regimes: Existing knowledge, cutting-edge themes, and research strategies. *Proceedings of the National Academy of Sciences of the United States of America*, 108, 19853–60.
- Young, O. R. (2011b). If an arctic ocean treaty is not the solution, what is the alternative? *Polar Record*, 47, 327–34.
- Young, O. R. (2012). Arctic tipping points: Governance in turbulent times. *AMBIO*, 41, 75–84.
- Young, O. R. (2013). Sugaring off: Enduring insights from long-term research on environmental governance. *International Environmental Agreements*, 13, 87–105.
- Young, O. R. (2017). *Governing complex systems: Social capital for the Anthropocene*. Cambridge, MA: The MIT Press.
- Young, O. R. (2018). Research strategies to assess the effectiveness of international environmental regimes. *Nature Sustainability*, 1, 461–5.
- Young, O. R., Underdal, A., Kanie, N., & Kim, R. E. (2017). Goal setting in the Anthropocene: The ultimate challenge of Planetary Stewardship. In N. Kanie, & F. Biermann (eds.), *Governing through goals: Sustainable Development Goals as governance innovation* (pp. 53–74). Cambridge, MA: The MIT Press.
- Young, O. R. (2019). Constructing diagnostic trees: A stepwise approach to institutional design. *Earth System Governance*, 1.
- Zelli, F. (2011). The fragmentation of the global climate governance architecture. *Wiley Interdisciplinary Reviews: Climate Change*, 2, 255–70.
- Zelli, F., & van Asselt, H. (2013). The institutional fragmentation of global environmental governance: Causes, consequences, and responses. *Global Environmental Politics*, 13, 1–13.
- Ziervogel, G., & Ericksen, P. J. (2010). Adapting to climate change to sustain food security. *Wiley Interdisciplinary Reviews: Climate Change*, 1, 525–40.
- Zürn, M. (2012). Global governance as multi-level governance. In D. Levi-Faur (ed.), *The Oxford handbook of governance* (pp. 730–44). Oxford: Oxford University Press.
- Zürn, M., & Faude, B. (2013). On fragmentation, differentiation, and coordination. *Global Environmental Politics*, 13, 119–30.