

Environmental Governance in the Anthropocene: Complexity, Fragmentation and the Role of Transnational Institutions

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It was in autumn 1995, when I began my studies in Political Science, Modern History and German Literature at the Rheinische-Friedrichs-Wilhelms Universität in Bonn, at that time still the capital of Germany, but otherwise a quiet and rather uneventful town. It would only later become a UN City and headquarter of the Secretariat to the United Nations Framework Convention on Climate Change (UNFCCC). The end of the first semester was drawing near and I had to decide on the topic of my first term paper for the introductory course in Political Science. While the course was very much focused on the German Political System, my interests were more inclined towards international questions, of which little found their way into the curriculum.

In any case, I suggested to my professor to write a paper on the climate change convention, which had entered into force in 1994 after having been agreed at the United Nations Conference for Environment and Development, the so called Earth Summit, in Rio de Janeiro in 1992. The first Conference of the Parties to the UNFCCC (the so-called COP) took place in Berlin in March and April 1995.

The advice of my professor was not to bother with a problem that was essentially solved. Some 20 years later, we are still discussing the challenge of climate change, although arguably, the recently concluded Paris Agreement brought us a step closer to solving the problem (but more about this later). What was different indeed in 1995 compared to today is that climate governance was exclusively international, that is, among governments only. Today, attempts to address the challenge of climate change and global warming include a wide range of actors beyond the state that have formed alternative and additional institutional structures to those existing among governments. In fact, it can be argued that successful climate governance post-Paris will be impossible without the contribution of transnational (as opposed to international) governance.

In this lecture, I will take stock of our knowledge of what we refer to as “transnational environmental governance”, i.e. problem-solving approaches that include actors other than governments (such as sub-national regions and cities, corporations, non-governmental organizations, international bureaucracies, scientific organizations, among others). After a brief reflection on the Paris Agreement and some clarifications about the notion of the Anthropocene, I will offer a rather cursory summary of our state of knowledge about transnational environmental governance (the title of my chair) with a focus on the current climate change regime complex (i.e. overarching governance architecture)¹. I will argue in particular that learning from complexity science will enable us to advance this research line beyond what we know today. I will conclude with some key research challenges that lie ahead.

¹ The terms “regime complex” and “governance architecture” are used as synonyms throughout this lecture.

Climate change and the Paris Agreement

COP 21 in Paris (i.e. the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change) is widely regarded as a success, reaffirming that multi-lateralism works and that governments can overcome their short-term political differences to address global challenges. Having been present in Paris during the second week of negotiations myself, I can confirm from my position as an observer on the sidelines that Paris indeed re-established confidence in the problem-solving ability of international negotiations when many had already written-off governments as agents of change.

However positive the general assessment might be, while governments have concluded the first universal international agreement to limit global warming to no more than 2 degrees above the preindustrial levels (possibly aiming at 1.5 degrees), current intended nationally determined contributions (the concrete promises that governments make to reduce their domestic emissions) fall short of delivering the envisaged 2 degree world. Instead, non-state actors – including cities, international organizations, non-governmental organizations and a wide range of business actors – are urgently needed to close the currently existing ambition gap.

In other words, climate change governance in 2016 is much more than the UNFCCC, its Kyoto Protocol (still in operation until the new Paris Agreement will enter into force in 2020), and the related international negotiations. Climate change governance in 2016 can more adequately be described as complex, messy and fragmented (Keohane and Victor 2010; Biermann et al. 2009; Abbott, Green and Keohane 2015). However, while scientist have started to describe and partially map the emerging regime complex of climate change and discuss its theoretical implications, adequate theories to make sense of these developments are scarce (with some notable exceptions to be discussed later). In addition, our knowledge on the scope conditions for effective engagement of a plethora of transnational governance arrangements is, however, limited. How do 80 separate public and private institutions in the field of climate change mitigation interact? Are there overlaps in terms of goals, instruments and targeted actors? Do we observe synergies or does the so-called bottom-up approach constitute an inefficient way of governing? Which actors and political interests are reflected in the emerging regime complex? And, what evidence for increased effectiveness do we have?

The dominant theoretical approach to analyzing the performance and effectiveness of the UNFCCC is regime theory or neoliberal institutionalism. Assuming the primacy of the state as the organizational form of international politics, regime theory, in its original variant, has little to say about transnational governance. The focus of much empirical work is either on one international institution (e.g. the ozone regime, the climate regime, or the regime to combat desertification) or dyadic relations between two international institutions (under the heading of institutional interaction, interlinkages and interplay research; see for example Oberthür and Gehring 2006; Oberthür and Stokke 2011). As Raustiala and Victor (2004, 278) have noted: “Most empirical studies focus on the development of a single regime, usually centered on a core international agreement and administered by a discrete organization.”

While general insight of regime theory can surely be applied to the realm of transnational governance (see Pattberg 2012), I am doubtful about its usefulness for scrutinizing the aggregate level of institutional interactions.² How can we then make sense of the various interactions (both formal and informal, both material and immaterial) among hundreds of institutions with similar goals and instruments, involving possibly 10 thousands of organizations and many more individuals? New approaches and methods are needed to scrutinize the regime complex of climate change. My key message here is: the climate regime complex and regime complexes in other issue areas are complex

² For a criticism of regime theory from a complexity perspective, see Hoffmann (2006).

systems (in which the whole is more than the sum of its parts). By analyzing them through the lens of complexity sciences, we can advance our knowledge considerably. This advancement in knowledge is not just of theoretical value. In order to avoid abrupt large-scale environmental change and the related possible social disruptions, innovative governance approaches are urgently needed to embark on a co-evolutionary trajectory of the complex coupled earth-society system. The broader societal relevance of this line of inquiry presented here today therefore lies in an improved understanding of the possibilities and limitations of governance as a purposeful strategy to address complex problems in the Anthropocene epoch.

A note on the Anthropocene

Before discussing the state of our knowledge on transnational environmental governance, allow me to briefly comment on the term 'Anthropocene' (see for a longer treatment Pattberg and Zelli 2016).

While inherently a contested concept, the term Anthropocene denotes a new epoch in planetary history, one that is characterized by the unprecedented impact of human activities on the Earth's geological and ecological systems. As Lewis and Maslin (2015, p. 171) observe:

Human activity is now global and is the dominant cause of most contemporary environmental change. The impacts of human activity will probably be observable in the geological stratigraphic record for millions of years into the future, which suggests that a new epoch has begun.

Geologists of the future might well remember 16 July 1945 as the beginning of the Anthropocene. This day witnessed the explosion of the first nuclear bomb at the White Sands Proving Ground, New Mexico, under the code name 'Trinity'. The debris from more than 500 above-ground nuclear tests conducted between 1945 and 1963³ has created a detectable layer of radioactive elements in sediments all around the planet. However, other potential start dates have been suggested. In their original proposal of the Anthropocene, Crutzen and Stoermer (2000, p. 17) argue for the beginning of the Industrial Revolution in 1750 as an appropriate start date, while Ruddiman (2013) has suggested an earlier start date around 3000 BC, when agriculture and livestock cultivation intensified and the first centralized political authorities emerged.⁴

Irrespective of ongoing debates among geologists and stratigraphers, the Anthropocene hypothesis has gained political momentum as a symbolic representation of complex transformations within the earth system. The Anthropocene hypothesis has become a rallying call for action in the light of scientific evidence that warns against dangerous global environmental change (Rockström et al. 2009). The Anthropocene hypothesis also highlights specific challenges for governance (for more details see Pattberg and Zelli 2016): urgency, responsibility and complexity.

How will the discipline of International Relations and global governance studies react to the Anthropocene hypothesis? I argue that global environmental governance research is fruitfully challenged by the Anthropocene hypothesis, potentially leading to a reorientation of theory and practice. I see three reasons for this. First, the Anthropocene hypothesis calls into question long-held assumptions about the human-nature dualism and has therefore been associated with the end-of-

³ The Test Ban Treaty took effect in 1963, prohibiting nuclear weapons tests in the atmosphere, in outer space, and under water.

⁴ An intermediate position between the early anthropogenic hypothesis and the nuclear hypothesis is taken by Lewis and Maslin (2015) who propose the noticeable decline in atmospheric CO₂ concentrations between 1570 and 1620 as a good marker for the start of the Anthropocene.

nature discourse (see Wapner 2015). At the heart of most environmental activism over the last five decades lies the conviction that nature exists independent of human agency and that (supposedly) 'natural' states of our planet, such as a stable climate system, should be protected. However, if the nature-human dualism is questioned by the advent of the Anthropocene, what does this mean for popular conceptions of conservation, wilderness and sustainability and for environmental politics more generally? In the words of Paul Wapner (2015, p. 39): "Nature, then, is not a separate realm, as many environmentalists assume but, because it is always interpreted through cultural lenses, is part and parcel of human affairs." The challenge for global environmental governance scholarship is to scrutinize human agency as part of a broader 'earth-system' perspective (see Biermann 2014).

Second, the notion of the Anthropocene, and the related idea of a unified human force that exerts unprecedented influence on the earth system, challenges governance scholarship in two ways. First, it urges scholars to take a more system-theoretical perspective in order to identify the system-wide drivers of anthropogenic global change and the systemic reactions produced by various social sub-systems. And second, global governance scholarship is urgently needed as a corrective to accounts of the Anthropocene that neglect the fact that human agency is not uniform across the planet, and that contributions to the problem and the distribution of risks and opportunities arising from global environmental change are highly uneven.

Third, the Anthropocene hypothesis propels governance research to the center of attention, as the question becomes: how can we steer towards socio-natural co-evolution and a resulting safe operating space for human development (Biermann et al. 2012)? As a result, this position opens up opportunities for genuine inter-disciplinarity, in which the social sciences are not just a 'junior partner' of the sciences, but contribute fundamental insights into drivers, solutions and complex feedbacks between agency, unintended consequences and reactions to these (see also Pattberg and Widerberg 2015).

The institutionalization of transnational environmental governance

Governing global environmental problems in the Anthropocene increasingly takes place beyond the confines of international (i.e. intergovernmental) politics. While the issue area of environmental politics is firmly governed by more than 800 international agreements (in the form of international treaties and conventions such as the United Nations Framework Convention on Climate Change), their rate of increase has been slowing down in the last decade.

In fact, alternative transnational governance arrangements – including actors representing civil society, business interests as well as scientists and experts – are growing faster than their state-based counterparts. This observation has given rise to a broad debate about the overall organizational structure of world politics. Within the academic disciplines of Political Science and International Relations, there is an emerging consensus that contemporary approaches to solving societal challenges, from climate change to food security, are no longer to be seen as constraint to the realm of public policy, but indeed include a multitude of actors and levels beyond the state.

In the words of John Ruggie (2004, 2), we witness

the beginnings of a fundamental reconstitution of the global public domain: away from one that equated the 'public' in international politics with states and the interstate realm, to one in which the very system of states is becoming embedded in a broader, albeit still thin and partial, institutionalized arena concerned with the production of global public goods.

This emerging policy arena constitutes the field of *transnational* governance. 'Transnational' is defined in this context as "regular interactions across national boundaries when at least one actor is a non-state

agent” (Risse-Kappen 1995, 3). Figure shows the overall increase in institutional density for the climate change governance field (international and transnational institutions focusing on climate change mitigation), while figure 2 displays the percentages of public, hybrid and private institutions in the overall institutional mix for each half-decade in the period 2000-2015. Both figures together illustrate the institutionalization of climate governance.

Figure 1. Increase in international and transnational climate governance institutions 1973-2016

Figure 2. Public, hybrid and private institutions over time 1973-2016

While this transformation has been duly noted, research so far has failed to fully appreciate, scrutinize and visualize the emerging complexity of transnational environmental governance. In this inaugural lecture, I will tentatively outline a theory of *complex governance* to better reflect the complex nature of the emerging global sustainability governance landscape in the Anthropocene.

Research findings

Research on transnational environmental governance (i.e. the observation that attempts to address boundary-crossing societal problems no longer exclusively rest with governments) has focused on three distinct analytical levels. First, research has addressed individual transnational governance arrangements and instruments (for example, non-state market based certification systems) with a view towards understanding their emergence, their performance and impacts as well as their broader implication and consequences (Cashore 2002; Pattberg 2005, 2007; Dingwerth 2007; Gulbrandsen 2010; Kalfagianni and Pattberg 2013a, b). Second, research has focused on the meso-level of transnational institutionalization, i.e. organizational fields and the interactions among similar governance arrangements (examples include Dingwerth and Pattberg 2009a; Brunsson, Rasche and Seidl 2012; Fransen 2015). Finally third, research has recently and increasingly begun to scrutinize the system-level of transnational institutionalization. Here, the focus is on the aggregate governance system, referred to as the regime complex, governance architecture, geography, landscape or ecosystem (Raustiala and Victor 2004; Abbott and Snidal 2009; Biermann et al. 2009; Keohane and Victor 2010; Abbott, Green and Keohane 2015). Research on the system-level has successfully mapped aggregate governance systems in the area of climate change (examples include Zelli 2011; Abbott 2012; Bulkeley et al. 2012; Pattberg et al. 2014; Widerberg 2016). I will now briefly summarize important research findings for each analytical level.

Micro-level. At the level of individual institutions and organizations, scholarship on transnational environmental governance has, by and large, focused on two questions. First, the emergence of innovative governance arrangements, both from a broader contextual viewpoints as well as starting from actors’ preferences and resources (e.g. Pattberg 2007; Dingwerth and Pattberg 2009b; Gulbrandsen 2010). Second, the extent to which transnational forms of governance contribute to increased effectiveness and legitimacy of global governance. The focus is on discrete governance institutions, such as the Marine Stewardship Council (Ponte 2012) or the Renewable Energy and Energy Efficiency Partnership, REEEP (Szulecki, Pattberg and Biermann 2011), and their measurable effects. In this context, effectiveness is usually understood as the level of success of institutional performance towards some objective that motivated its establishment, such as its ability to solve economic, social or ecological problems. Some scholars perceive transnational environmental governance as an opportunity to address global governance deficits (Haas 2004). Others, by contrast, warn against negative consequences, such as failure to address the underlying causes of social and environmental problems and a tendency to privilege business-as-usual practices and powerful actors, while at the same time weakening the representation of the less privileged actors.

Empirical research arrives at rather mixed conclusions when it comes to the effectiveness of transnational environmental governance. For example, research on forest certification has shown that due to the lack of ownership and the cost of complying with its stringent standards, many producers opt for industry-dominated programs, especially when it comes to operations in developing countries (Gulbrandsen 2004). Moreover, in exploring conditions for effective transnational environmental governance in the fisheries and aquaculture domain, their ability to deliver effective governance solutions is found to be limited (Kalfagianni and Pattberg 2013). Finally, in the case of private transnational governance of climate change, empirical research highlights that the problem-solving potential of transnational governance arrangements is up till now far greater than their actual effects (Widerberg and Pattberg 2015a, b); in addition, the promises of such forms of governance to increase effectiveness might also be compromised by the profit-seeking behavior of private actors (Hickmann 2013).

In relation to the question of legitimacy, scholarship in global environmental governance has highlighted the legitimacy challenges resulting from hyper-globalization and neo-liberal environmental policies, including the intensifying integration of non-state actors (in particular multi-national corporations) in transnational rule-making. For example, Biermann and Gupta (2011) identify the process of globalization as a major driving force for the search for accountable and legitimate governance, strengthening the need for new rule-making institutions at all levels of the political system. Empirical research has in particular assessed the democratic quality of transnational environmental governance (for example Dingwerth 2007; Cadman 2011), its output legitimacy (Bäckstrand 2006; Kalfagianni and Pattberg 2014), and the relation between legitimacy and effectiveness (Beisheim and Dingwerth 2008).

Meso-level. At the meso-level, rather than analyzing discrete governance arrangements, research has been occupied with the process, degree and effects of institutionalization in a given issue area. Researchers have relied on the notion of organizational fields, defined as

an arena of social interaction where organized individuals or groups (...) routinely interact under a set of shared understandings about the nature of the goal of the field, the rules governing social interaction, who has the power and why and how actors make sense of another's action (Fligstein 2008, 8).

Following this conceptualization, research has for example attempted to explain why private transnational certification organizations (such as the Forest Stewardship Council and the Marine Stewardship Council) become more similar over time (Dingwerth and Pattberg 2009). Dingwerth and Green (2015) have recently proposed a useful typology of interactions at the field-level. Researchers have also proposed to further investigate the process of transnational institutionalization along four distinct stages (Pattberg forthcoming), which I will now briefly discuss. The stages are conceptually separate, but in reality they will occur simultaneously to some degree. It is also important to note that while the different stages represent distinct stages of institutionalization in the transnational realm, they do not represent a strict sequence. An organizational field (such as carbon disclosure within the broader climate change area) moves towards transnational organization through a number of distinct stages. If all four stages can be observed, this can be interpreted as a high level of institutionalization.

The start-up phase is characterized by an experimental mode of operation, high uncertainties and the risk of failure. New ideas and institutional innovations are developed by governance entrepreneurs, change agents that aim at systemic solutions to pressing societal problems. New governance arrangements are developed and tested in a social niche that provides some protection against the powerful interests of the status-quo actors in the field.

The second stage, competition and growth, is characterized by an increase in the number and scope of governance arrangements. Individual arrangements act largely independent of each other as interactions are uncoordinated and driven by a competitive logic. The initial innovation is further developed and smaller variations occur, reflecting the diverging interests of stakeholders involved.

In the third distinct phase of convergence, consolidation and meta-governance, arrangements start to converge in terms of their core norms, organizational principles and external communication. While the different processes that contribute to policy convergence are less important in this context, it is important to note that convergence should not be understood as leading to a predefined end-point (all arrangements look the same), but rather highlights the procedural character of convergence. Policy convergence is understood as an increase in the similarity between characteristics of a certain policy or in the similarity of the policy repertoire in a certain field across a given set of political jurisdictions over time.

In addition to convergence, the third stage of transnational institutionalization is also characterized by the emergence of meta-governance. Generic rules are developed with a view towards streamlining divergent policies and practices through distinct meta-governance organizations (Brunsson, Rasche and Seidel 2012). A well-known example of meta-governance in the environmental field is the ISEAL alliance (Derkx and Glasbergen 2014; Loconto and Fouilleux 2014), an organization that has developed a standard for developing sustainability standards (such as those administered by the Marine Stewardship Council or Fair Trade International). Meta-governance has also been observed beyond ISEAL (Fransen 2015).

The fourth stage of transnational institutionalization is characterized by the integration of transnational governance arrangements (or parts thereof) into existing national and international public policy frameworks. This integration might lead to better coordination and overall effectiveness; however, the political appropriation of private standards by public actors might also lead to decreased effectiveness as the underlying market-driven logic of transnational institutions is weakened.

System-level. Finally, research has started to map and partially measure the overall institutional structure of global environmental governance, i.e. the clusters of norms, principles, regimes and other institutions generally referred to as the *governance architecture* of an issue area. However, this is a rather recent trend. In the words of Biermann and colleagues (2009):

Most research on global governance has focused either on theoretical accounts of the overall phenomenon or on empirical studies of distinct institutions to solve particular governance challenges.

Only recently have scholars started to investigate larger systems of institutions and governance mechanisms in particular areas of world politics, which are sometimes referred to as regime complexes, clusters, or networks. An important step towards analyzing the macro-level of governance institutions in world politics was Raustiala's and Victor's (2004, 279) conceptualization of *regime complexes* as "an array of partially overlapping and nonhierarchical institutions governing a particular issue-area". While firmly rooted in a state-based, international ontology, their interest was in understanding institutionalization beyond single regimes and clearly demarcated legal boundaries. Keohane and Victor (2011) apply this conceptualization to the realm of climate governance (also with a focus on international cooperation exclusively).⁵ On this account, international regimes can be placed on a

⁵ For an alternative conceptualization, see Orsini and colleagues 2013, 29: "a network of three or more international regimes that relate to a common subject matter; exhibit overlapping membership; and generate substantive, normative, or operative interactions recognized as potentially problematic whether or not they are managed effectively" (2013, p.29).

continuum ranging from fully integrated institutions that regulate via top-down authority to nested regimes (semi-hierarchical) and collections of loosely-coupled institutions (regime complexes) to fragmented institutional structures that lack coordination and linkages among constituent parts.

To better map what Keohane and Victor (2011, 12) described as a “Cambrian explosion”, the emergence of a wide array of institutional forms, Abbott, developed the transnational regime complex of climate change (2012) and displayed participating institutions in a governance-triangle (based on work co-authored with Snidal), based on the dominant actors in decision-making and their mixes.⁶ Figure 3 shows an updated version of the climate governance triangle (as of January 2016, post-Paris), now also including international institutions, in total 95 governance institutions. The triangle is divided into seven *zones*, which represent the major combinations of actor *types*. Institutions in the vertex zones (1-3) are dominated by a single type of actor; those in the quadrilateral zones (4-6) involve two types of actors; and those in the central zone (7) involve actors of all three types. Additionally, the two dashed horizontal lines divide the triangle into three “tiers”, defined by the nature of government involvement – *state-led* (public institutions are dominant), *private-led* (Firms and CSO are dominant), and *hybrid* (government bodies share governance with firms and/or CSO in public-private partnerships).

Figure 3: Climate change governance triangle; based on Abbott and Snidal 2009; Abbott 2012; own data.

Related to the observed governance architecture, a major theoretical debate focuses on the expected outcomes, positive and negative, of what frequently has been referred to as *governance fragmentation* (Biermann et al. 2009; Zelli 2011; Zelli and van Asselt 2013). Negative consequences of fragmented governance might include regulatory and legal uncertainty (Zelli and van Asselt 2012). Other negative outcomes associated with fragmentation include high transaction costs and duplication of efforts, as well as that it may lead to significant lack of coordination institutions, actors, sectors and levels. For example, in the case of regime complex for food security, Margulis (2013) found that overlapping rules increased uncertainty for policy actors and have been a source of transnational conflict between the states and international organizations. In the same line, analyzing the growing problem of maritime piracy, Struett, Nance, and Armstrong (2013) show that fragmented regime complexes are subject to tension as overlapping rules can introduce uncertainty, cause coordination problems by altering the incentives for international cooperation. Moreover, other argue that fragmentation of the international regulatory order resulted in an increased and steady influence of the powerful states lead by their own domestic interests (Benvenisti and Downs 2007; Biermann, Pattberg, Zelli 2010).

Others have highlighted the positive consequences of fragmented governance architectures. Abbott (2013), for example, argues that some of the benefits relate to flexibility of the system to adapt and address emerging and dynamic problem issues across different scales, opportunities for the actors sharing similar interests and values to form productive clubs, as well as opportunities for learning and experimentation. Along the same line, Keohane and Victor (2011) emphasize the value of flexibility and adaptability of a regime complex in coping with uncertainties associated with the process of governing complex human-environment interactions. Accordingly, a great deal of literature emphasized the

⁶ Institutions are placed in a governance triangle in accordance with the identity of their constituent actors – *State*, *Firm* and *Civil Society Organization* (CSO) (Abbott and Snidal 2009). The placement of an institution is determined by judging each actor group’s approximate “share” in the governance of the scheme: in principle, the *State* category includes individual states and collections of states or international organizations (IOs) along with public bodies below the level of central states, e.g. cities and regions. Similarly, the *Firm* category includes individual business firms, groups of firms and industry associations; and ultimately, the *CSO* category includes individual CSO as well as CSO coalitions and networks. All three actor groups are defined broadly, so that among them they encompass virtually all participants in transnational governance.

potential of fragmented governance in diffusion of innovations and opportunities for the innovation of policies and policy instruments (Kellow 2012), experimentation of alternative regulatory frameworks, and learning (Zelli and van Asselt 2012).

Next to theoretical debates about the expected benefits or disadvantages of fragmented governance architectures, research has focused on better empirical mappings of institutional complexes, their explanations (e.g. Keohane and Victor 2011; Abbott 2012) or proposals for improved management (van Asselt 2007). However, the current state of knowledge, by and large, is inadequate; descriptions and lists abound, while meaningful mappings are lacking, in particular in a comparative perspective. It is here where the CONNECT project tries to make a difference (see Pattberg et al. 2014 for an overview of our approach; Widerberg 2016 for an application to climate change). As of 2016, we have mapped the governance architectures of climate change, forestry, marine fisheries, and energy (with biodiversity and ocean governance being under construction).

In sum, non-state contributions, together with various international agencies, have created regime complexes of environmental governance across a number of policy fields. The proliferation of transnational institutions and international organizations related to climate change, as just one example, has created a dense institutional architecture in which goals, instruments, discourses, and actors overlap, interlink and interact to create a complex governance system. However, while we witness the institutionalization of climate governance beyond the state, we have little evidence about the impacts of increased institutional complexity and fragmentation. Comparable to a hypochondriac, we continue to go to a doctor and get prescription after prescription, with the result of an overlap in remedies of which little is known in terms of unintended side effects. I content that, to better understand the emerging institutional architecture of global environmental governance, we can learn from existing strands of complexity theory and utilize new methodologies and approaches.

Governance architectures are complex systems: What we can learn from complexity science?

Global problems (from climate change to the financial crisis) are increasingly perceived as complex, as are the governance arrangements that have been devised to address them. Complexity science therefore seems to be a natural starting point for understanding the increased complexity of world affairs. Complexity science includes many fields of application and is genuinely transdisciplinary in nature, as it promises to provide concepts that apply to multiple domains. I prefer the term *complexity science* over *complexity theory* as no general theory is so far able to explain different complex phenomena, such as hurricanes, financial crises, cities, organizational ecologies, and regime complexes.

The application of complexity thinking is not new to the environmental sciences domain. For example, debates about adaptive governance and resilience use complexity as a key concept (see Duit et al. 2010). New forms of governance (including transnational institutions) are seen as a reaction to more complex problems and more interactions among causes and effects. This line of inquiry is interested in a complex systems perspective on governance with a view towards governance as a reaction to complex change. In the words of the editors of a recent special issue for *Global Environmental Change* (Duit et al. 2010, 366):

A central question is whether there are certain forms of governance that are better equipped for addressing and managing processes characterized by complex change?

While this question indeed demands further attention, what interest me here today are the complex interactions of multiple institutions within a given policy field. In short, I am scrutinizing the *complexity of global governance* and governing itself.

It is therefore appropriate to briefly summarize how complexity science has been used in the discipline of IR (as the global governance paradigm falls under its purview). The increased interest in complexity and complex systems can be understood as a reaction to the observed dynamism of world politics after the end of the Cold War and deepening globalization. The work of Rosenau⁷ (e.g. 1990; 2003) is an early example of how complexity approaches have been incorporated into an analysis of world affairs. In the words of Kavalski (2007, 437):

...James Rosenau [...] insists that the recognition of the widespread normative and empirical uncertainties that mark world affairs made it impossible for social scientists to persist in relying on previous parsimonious models while ignoring the premises of CT [complexity theory].

Other notable contributions include Jervis (1997), Harrison (2006), Kavalski (2007) and Bousquet and Curtis (2011). However, as Bousquet and Curtis (2011, 44) aptly phrase it: complexity theory “continues to stubbornly remain on the margins.” I therefore feel the need to renew our efforts to bring the insights of complexity science to bear on the challenge of governing in the Anthropocene. Consequently, I argue that regime complexes and governance architectures are *complex systems* and should therefore be analyzed from a complexity perspective.

But what are complex systems? A straight-forward way to understand them (if such a thing exists in the context of complexity) is to understand that the whole is greater than the sum of its parts. As a result of systemic interactions (to quote Kavalski 2007, 437): “alterations occur whose outcomes are wholly unexpected and nearly impossible to predict.” A complex system approach considers actions of agents (e.g. organizations/members to governance institutions) that produce macro-level phenomena by aggregation. We can speak of emergent properties⁸ and phenomena that are qualitatively different from those of the individual units/agents that are aggregated (think of the difference between water molecules/water and brain cells/consciousness). Complex systems are more than the sum of their parts (the mantra of complexity science). Complexity science consequently assumes that change (and not equilibrium) is dominant, that self-organization and emergence are defining properties of complex systems and that, consequently, reductionist approaches don’t go far in analyzing many real-world phenomena (Kavalski 2007; see also Rosenau 2003).

Governance architectures or regime complexes are complex systems; sometimes complex systems create complexity. For example, the global financial system is a complex system that has parts that are predictable while other parts have emergent properties, i.e. properties that do not fully derive from the simple sum of all individual parts. Complexity as a possible state of a complex system is characterized by the following attributes: a substantial description length (Kolmogorov complexity⁹), excess entropy and the inclusion of substantial information (Page 2015). Other often mentioned properties of complex systems include: self-organization¹⁰ (adaptation and co-evolution), emergent properties, boundaries and

⁷ For a more extensive acknowledgment of Rosenau’s work on complexity, see Kustemans 2011.

⁸ Emergent properties defined as the ‘intricate intertwining or interconnectivity of elements within a system, and between a system and its environment’ (Mitleton-Kelly 2000).

⁹ On Kolmogorov complexity: consider this string of lower case letters “phpphpphpphpph” and compare it to this string: “elf54thd87jdn19dzn65”. The first can be written as “php 6 times”, which consists of 9 characters. The second one by contrasts has no obvious shorter description other than the string itself (20 characters). More formally, the complexity of a string is the length of the shortest possible description of the string in some fixed description language.

¹⁰ “‘Self-organization’ refers to the process by which the autonomous interaction of individual entities results in the bottom-up emergence of complex systems.” (Bosquet and Curtis 2011, 47).

levels, path-dependence, threshold phenomena, and the production of novelty. To quote Page (2015, 24), complexity can be understood as DEEEP: difficult to explain, evolve, engineer, or predict. In addition, complex systems are usually open systems, i.e. they have porous borders and exchange information and energy with their environments. It is, however, an empirical question how open they are (Singer 1971, 13). The assumption of openness contradicts most analysts of political systems, who posit that these are closed: “disturbances are temporary and the system tends to return to equilibrium” (Harrison and Singer 2006, 28). The international system, according to Walzian Structural Realism, does not change in its fundamental features as anarchy and sovereignty construct the conditions of a closed system.

Simple system	Complex system
Few agents	Many agents
Few interactions	Many interactions
Few feedback loops	Many feedback loops
Centralized decision-making	Decentralized decision-making
Decomposable	Irreducible
Closed	Open
Static	Dynamic
Tends towards equilibrium	Dissipative
Predictable outcomes	Surprising outcomes

Table 1. Differences between simple and complex systems (adapted from Harrison 2006b, 3)

Examples of simple systems are bicycles and pendulums while the immune system and ecosystems are complex systems.

The complexity of complex systems derives from the relationships among constituent parts, not from the parts themselves. In other words, complex systems are complex because of the interactions of their components and not because of additive effects of all parts. It is therefore not sufficient to map all governance institutions in the climate change regime complex in order to deduce outcomes; in fact, interactions among constituent parts, including feedback loops and non-linearity, results in system-wide, emergent properties. Non-linearity is a key characteristic of complex systems, and networks are a perfect embodiment of non-linearity. In the words of Capra (1996, 82):

The first and most obvious property of any network is its non-linearity—it goes in all directions. Thus the relationships in a network pattern are non-linear relationships. In particular, an influence, or message, may travel along a cyclical path, which may become a feedback loop. The concept of feedback is intimately connected with the network pattern.

What follows from this is that network theories and relational ontologies¹¹ will feature prominently as an analytical tool to unravel complex systems. While networks as a specific mode of organization

¹¹ On the notions of relational ontologies and relational thinking, see Emirbayer 1997.

(opposed markets and hierarchies) have been recognized in International Relations and global governance scholarship for a while (an example is Keck and Sikkink's concept of transnational activist networks, 1998), network analysis as a formal method of inquiry has been applied less frequently. This is rather regrettable, as network analysis allows for fine-grained but robust measurements of structure (e.g. interactions among institutions in the climate change regime complex). Network analysis is grounded in three principles that make it an ideal approach within complexity science (Hafner-Burton, Kahler and Montgomery 2009, 562): first, nodes (i.e. agents) are behaviorally interdependent; second, ties between nodes can be channels for resource exchange (material and non-material); and third, repeated and persistent patterns of interaction among nodes create structures that exert influence on the behavior of agents.

Four attributes of complex governance systems

After having outlined some general ideas about complexity science and its applicability to the field of regime complexes and governance architectures, in the remainder of this section, I will present some preliminary empirical results to illustrate my assumption that the current governance architecture of climate change is indeed a complex system.

Complex systems are thought to have four attributes (Page 2015, 24): diverse entities; interaction structure, behavioral interdependence, and adaptation and learning. These four attributes can be used to establish whether an observed system is indeed complex (these four attributes and their values are also important for understanding the aggregate properties of a given system). I will briefly illustrate these attributes for the climate governance regime complex with data from the CONNECT project (see www.fragmentation.eu).

Diverse entities. Complex systems are made of diverse entities (agents in the parlance of agent-based modelling approaches). The climate regime complex – as mapped using the heuristic of a governance triangle – contains seven zones of interaction, depending on the type of actors involved: public actors (e.g. governments); for-profit actors (e.g. corporations); non-profit actors (e.g. non-governmental organizations). The actual diversity of the climate change regime complex is displayed in figure 4.

Figure 4: Actor types in the climate governance architecture (source: CONNECT)

Interconnectedness. The diverse entities interact within an interaction structure, i.e. they are interconnected as a network. Four such networks have been analyzed in more detail in our recent work on the fragmentation of the climate change governance architecture: networks of members connecting institutions; networks of institutions via hyperlinks; networks of institutions via discourses; and networks of institutions via topics/themes. To select just two examples here, figure 5 displays the full network of 80 institutions in the climate governance architecture connected through membership of organizations. Figure 6 in turn shows the network of institutions as connected by hyperlinks between their websites. What we can see here is that the climate regime complex is not just made of many different institutions (and some 10.000 participating organizations), but is highly interconnected. Similar results have been obtained by analyzing the dominant discourses among institutions (see Sanderink 2015).

Figure 5: Mode-1 network of the climate governance architecture (source: CONNECT)

Figure 6: Hyper-link network of the climate governance architecture (source: CONNECT)

Behavioral (inter)dependence. Within a network, agents depend on resources that flow through the network (e.g. information). Within the CONNECT project, we have identified central actors that hold key positions in the network and therefore influence the flow of resources (and create forms of dependence). Figure 7 shows central actors in the climate governance regime complex.

Figure 7: Key actors in the climate governance architecture (source: CONNECT)

Adaptation and learning. Learning can occur at the level of institutions (and their constituting members) as well as at the level of the entire population, i.e. at the regime complex itself, and it can occur via various mechanisms, including mimicry and experimentation. Assessing learning is inherently difficult and will require observations over longer periods of time.

In sum, the regime complex of climate change displays key attributes associated with complex systems. Utilizing complexity science to further investigate dynamics, distribution of outcomes and the functional properties of complex systems therefore holds many promises for an improved understanding of governance complexity in the Anthropocene.

Conclusions: the way ahead

The chair in Transnational Environmental Governance and Policy, located within the Institute for Environmental Studies, the Amsterdam Global Change Institute, the Faculty of Earth and Life Sciences (with its focus on Science for Sustainability) and the collaborative institute with the working title EEE (among VU and UvA), provides me with ample opportunities to pursue some of the ideas discussed above in the years to come. In a complex world full of surprises and unexpected outcomes, planning might not extend too far into the future. Therefore, I will only outline some building-blocks of how to develop a theory of complex (environmental) governance.

First, analyzing discrete issues areas (and treating them analytically as closed systems) contradicts complexity approaches as discussed above. Therefore, rather than analyzing various environmental sub-fields (such as climate, energy, biodiversity etcetera) in isolation, we should aim at scrutinizing interactions across policy-fields (both environmental and between environmental and non-environmental regime complexes). Focusing on these meta-complexes will be analytically challenging but empirically rewarding.

A second ambition is to model complex governance systems. While inherently difficult, this line of work can build on previous attempts to integrate social science knowledge on the success conditions of governance institutions into formal modelling (see de Vos et al. 2013; Dellas and Pattberg 2013). This is also not the time and place to discuss the challenges of agent-based-modelling¹² (cf. Axelrod 1997; Bousquet et al. 2001) as a key tool for understanding complex systems. Suffice to say that I am confident that the existing expertise at IVM/FALW/VU will greatly aid me in this endeavor.

Finally, we urgently need to improve our visualization of complexity with a view towards aiding decision-makers with decision support tools. We have started working on a first version of a web-based tool for

¹² For critique of complex systems theory, simulations and agent-based-modeling, see Earnest and Rosenau (2006).

exploring the climate change regime complex that I want to briefly show you here. The complex interactions and available information can be viewed from multiple perspectives, including a geographic overview, a governance triangle, a disc-view and a network view, among others. Information can be displayed and sorted in many ways, allowing for example to compare institutions according to their size of membership, thematic focus or date of establishment. I believe that this interface is a necessary first step towards making complex governance systems comprehensible for a broader audience.

In this inaugural lecture I have argued for understanding the increasing institutionalization of transnational environmental governance and the resulting regime complexes as complex systems. While our research has yielded important findings on both the level of individual governance arrangements and the meso-level of field-interactions, the overall institutional system of governing specific issue areas has not yet received sufficient attention. Our current attempts to map and measure fragmentation (or other properties of regime complexes) are a step in the right direction. However, it is my conviction that new, radical approaches are necessary to overcome what Harrison (2006, 6) has referred to as the “shadow of Newton’s universe”: the idea that discrete parts and not interactions make up the social world. I hope that my work can contribute to rectifying this misunderstanding.

Words of thanks

Academic work is not a monologue, but in fact a continuous – often complex – dialogue with the many colleagues, students, stakeholders, partners and critics that take an interest in one’s ideas (both good and bad). The scientific study of environmental governance is also not static, but a process of searching for the right questions, theories, methods and ultimately answers. Along this way, I have incurred many debts which I am most likely unable to pay back in full. I want to express my sincere appreciation of those that I was fortunate to meet along the way.

My thanks go first to the Vrije Universiteit Amsterdam, the academic community embodied in it, for offering me an intellectual home and appointing me as chair in Transnational Environmental Governance and Policy, to the Executive Board (College van Bestuur) and the Supervisory Board (Rad van Toezicht), and to the dean and vice-dean of the Faculty of Earth and Life Sciences, Prof Karen Maex and Prof Hubertus Irth for the support.

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At the very foundation, there is love that motivates us to live in a world of complexity, even chaos, as it appears sometimes. To have guidance, a compass and purpose is essential. My parents have put me on this trajectory early on by encouraging my curiosity and their love for knowledge, books, intellectual debate and humor. For this and all other things you have done for me my sincere thanks. My deepest felt appreciation goes to my wife Xenia for accepting me as I am, and to my children, Adam (at home) and Aleksandra (sitting in the first row) for being around me when I come home.

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CV

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Pattberg has authored, co-authored or edited 8 books, and published more than 40 articles in peer-reviewed journals and 35 chapters in academic books, along with more than 80 papers, reports, and contributions to policy-oriented journals. His most recent books are the *Encyclopedia of Global Environmental Governance and Politics* (co-edited with Fariborz Zelli, Edward Elgar 2015) and *Environmental Politics and Governance in the Anthropocene* (co-edited with Fariborz Zelli). Pattberg's research has been cited over 3400 times, and his Hirsch-index in Google Scholar is 28. Several of his papers belong to the top-10 most cited papers in their respective journals. Pattberg is the co-editor (with A. Kalfagianni) of the *Routledge Research Series in Global Environmental Governance*, and reviewer for more than 20 academic journals. His work has appeared, among others, in *Ambio*; *Annual Review of Environment and Resources*; *European Journal of International Relations*; *Global Environmental Politics*; *Global Governance*; *Global Policy*; *Governance*; and *Science*. He also regularly serves as reviewer for research foundations and universities in Europe and North America and Australia, and has been an invited speaker at universities, companies and public agencies from Paris to St. Petersburg.

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Earlier professional or visiting affiliations include American University (Washington DC), the Freie Universität Berlin, the London School of Economics and Political Science (LSE), SciencesPo Bordeaux, and TU Darmstadt. Pattberg has 12 years of teaching experience in Germany, the Netherlands, the United Kingdom, and the United States. At present, he teaches in the MSc Environment and Resource Management and the specialization Global Environmental Governance in the MSc Political Science at VU University Amsterdam. He is currently supervising 9 PhD students.

Pattberg has won several scholarships, grants and awards, including the 2009 Science Prize of the German Political Science Association (DVPW), a Innovational Research Incentives Scheme Grant (VIDI) from the Netherlands Scientific Organization (NWO), and a PhD research grant from the German Federal Environment Foundation. Pattberg holds a PhD *summa cum laude* from Freie Universität Berlin (2006), a master's degrees in political science (University of Bonn, 2000) and a post-graduate diploma in International Relations from the John Hopkins University, School of Advanced International Studies (SAIS, 2001).