

Part I

The Building Blocks

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Intergovernmental Institutions

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Intergovernmental institutions are key building blocks in the architectures of earth system governance. This chapter reviews two research programmes on intergovernmental institutions that have dominated the past decade: one into factors that explain their *formation and design*, and another into factors that explain their *effectiveness*. We organize our review around the structures, agents and processes that scholars use to understand how intergovernmental institutions form and operate. We summarize recent theoretical insights and empirical findings and identify some remaining open questions. Our empirical focus is research on intergovernmental institutions in the field of earth system governance, while we believe that our findings have a broader theoretical value ~~also~~ for other ~~areas~~ of world politics.

Conceptualization

Early research on international cooperation focused on intergovernmental institutions as dependent variables, explaining when and why states created them despite the disincentives generated by the anarchy of international society (Krasner 1983). Beginning in the 1990s, scholars took up follow-on research assessing the influence of such institutions as independent variables, seeking to distinguish conditions under which they did or did not affect state behaviour (for reviews, see Mitchell 2010; Young 2011). Despite different terminologies, such as treaties, regimes or institutions, all of these scholars study intentional cooperation among states to solve shared problems. Chapters 3–13 in this volume elaborate in more detail on research on the many alternative strategies of earth system governance (see also Andonova and Mitchell 2010).

We focus this chapter on research into intergovernmental institutions in earth system governance, which we define as *cooperative arrangements among national governments to address transboundary environmental problems*. Such institutions

vary considerably in their levels of institutionalization and legal formalization (Böhmelet and Pilster 2010; Vabulas and Snidal 2013). We concentrate on formal intergovernmental cooperation common to treaties and other legal instruments, but our definition is broad enough also to capture informal intergovernmental cooperation and the often-unwritten norms, rules and decision-making procedures that underpin formalized instruments and institutions. Our review notes the many agents that help develop, manage and implement intergovernmental institutions but leaves in-depth discussions of other important aspects to other chapters in this volume, notably regarding international bureaucracies (Chapter 3), institutional interlinkages (Chapter 6), regime complexes (Chapter 7), governance fragmentation (Chapter 8) and interplay management (Chapter 10).

Creating, Designing and Adapting Intergovernmental Institutions

Scholars have asked three key questions about intergovernmental institutions as dependent variables.

(1) First, what explains the *pattern* and *timing* of intergovernmental efforts to address human impacts on the earth system? Most studies focus on explaining the emergence of *formal* intergovernmental institutions, especially those grounded in international law (Brunnée, Bodansky and Hey 2007; Bodansky 2010). Although governments sometimes create ‘soft law’ institutions, most scholars focus on formal legal instruments such as treaties, conventions or protocols, if only because they help document the ‘that’, ‘when’ and ‘what’ of intergovernmental cooperation (Bodansky 2015).

(2) Second, what explains how states *design* the requirements, organizational structures and processes of intergovernmental institutions (Young 2010; Biermann and Pattberg 2012; Jinnah 2014)? Scholars seek to explain variation in treaty goals, membership rules, obligational precision, ambition and depth, the form of monitoring and implementation strategies.

(3) Third, when and why do intergovernmental institutions *learn, develop* and *adapt* (Siebenhüner 2008; Abbott and Snidal 2013; Abbott and Bernstein 2015; Beunen and Patterson 2016)? The profiles of intergovernmental institutions vary considerably: some are signed but never enter into force, others take effect but are never modified, others are designed to make regular decisions in response to changing circumstances and yet others significantly expand their substantive scope over time (Young 1999: 28).

In all three questions, scholars focus on intergovernmental environmental institutions as dependent variables and explain their creation, design and adaptation by reference to structural forces, the interests and power of political actors and the strategies by which the latter pursue their goals in light of the former. We now

discuss such structural forces, the interests and power of actors and their strategies in turn.

Structures

Objective environmental and behavioural conditions and subjective social conditions constitute the structural context that influences the ‘whether’, ‘when’ and ‘what’ of intergovernmental environmental institutions (Underdal and Hanf 2000; Bernauer 2002). Examining a range of cases, Miles and colleagues (2002) posited that problem structures (particularly the arrangement of states’ interests and power) made resolving transnational environmental problems easier (benign) or harder (malign). Their distinction reflected earlier typologies of problem structure (see the review in Dombrowsky 2007). Government support, opposition or indifference to resolving transboundary environmental problems reflects the material costs of both action and inaction, as evident in many negotiations including those on climate change (Sprinz and Vahtoranta 1994; Dimitrov 2016; Falkner 2016). Negotiations prove easier for tragedy-of-the-commons problems among mixed-motive states that both cause and are impacted by a problem than for those between upstream states that cause the problem and downstream victim states (Mitchell 2010). Capacities also matter: developing states often have incentives to protect endangered species and habitats as sources of ecotourism but may fail to do so because of financial and administrative incapacities (Mitchell 2010).

The nature of environmentally harmful activities also constrains institutional design. Environmental problems vary in the number of responsible and concerned states (Koremenos, Lipson and Snidal 2001). Problems among few states (e.g., river basins or polar bears) are easier to resolve than global problems (e.g., marine pollution and climate change), and choices of membership rules matter in both. Concern among powerful states promotes institutional creation, especially if they have interdependencies or resources that states causing the problem value. States will accept more ambitious institutional rules if they share high levels of concern but will require weaker rules and escape clauses if concern is weak or contested. States’ power, interests and capacities influence whether states base treaties on reciprocal obligations or on asymmetric bargains of side-payments or coercion (Mitchell 2009). The ability to readily observe problematic behaviours and their perpetrators (e.g., marine oil versus chemical pollution or terrestrial point versus non-point pollution) can foster agreement about the existence of an environmental problem, its causes and appropriate regulatory responses. Problems in which member states have strong incentives to cheat on any solution are likely to include strong monitoring, enforcement and withdrawal provisions. Existing intergovernmental institutions, environmental or otherwise, can provide venues that,

depending on their mandates, foster or inhibit the creation of new institutions to address environmental problems. All of these structural factors help determine the emergence and form of intergovernmental environmental institutions.

Yet, environmental problems are not objective and unproblematically identifiable. Knowledge and social construction play important roles in the creation of intergovernmental institutions. Material aspects of environmental problems influence the impacts, knowledge and concern states have about a problem. The causal links between human behaviours and environmental harm are clear and immediate for some problems but more complex and temporally and spatially attenuated for others. Debates on climate science clarify that scientific uncertainty depends as much on politics and the incidence of costs and benefits as it does on the science itself (Oreskes and Conway 2010). Problems differ in whether economic interests align with or oppose environmental interests. Movement towards intergovernmental environmental cooperation begins only when concern in one or more states prompts them to put 'the problem' on the international agenda (Carpenter 2007). Such concern, in turn, depends on governments having compelling knowledge of impacts and causes, accepting framings of the problem as warranting international action and coming to see the material and normative implications of action as outweighing the forces of political, social, economic and normative inertia (Jinnah 2011; Vanhala and Hestbaek 2016; Allan and Hadden 2017).

Finally, structural factors can change over time, promoting or inhibiting institutional formation and change (Young 2010). Dynamic human–environment interactions ~~that are present~~ require institutional designs that promote adaptive management and institutional modification to deal with incomplete contracting, as when setting annual fishing quotas or modifying endangered species lists. For other problems, states recognize that levels of scientific knowledge or political concern are likely to change rapidly and, therefore, include provisions that make it easier to adopt protocols and amendments that strengthen obligations or expand institutional scope (Shi 1999; Urpelainen 2013). In yet other problems, technological and economic changes may generate reductions in environmental impacts, reducing the need for institutional modification. Research on such institutional dynamics and life cycles remains underdeveloped (see Young 2011).

Actors, Agency and Strategies

Structural factors generate patterns in institutional formation and design, shaping choices in ways that make certain institutions more likely than others. However, those patterns emerge only because specific actors use specific social and institutional strategies to pursue their material and non-material goals. Actors' strategic choices (and non-choices) determine whether institutions incorporate designs that

neatly match structural predictions or reflect innovations that contradict them. We contend that the ‘structure–agency debate’ poses an overstated dichotomy: structures influence outcomes by making certain institutional choices less available or attractive or by creating incentives to create innovative alternatives (see Betsill, Benney and Gerlak 2019). Institutional choices at one point in time, in turn, can transform the structural context, either freeing up or locking in constraints that favour certain outcomes over others (Seto et al. 2016).

A paradigmatic story of the roles of different actors in institutional formation and design might go as follows. Scientists identify a previously unrecognized, apparently harmful human impact on the environment; non-governmental organizations and the media disseminate and frame that information and domestic politics express growing concern, as exemplified in climate change negotiations (Schroeder and Lovell 2012; Betzold, Bernauer and Koubi 2016). In response, some governments call for collective international action because unilateral solutions seem inadequate. Highly concerned states and environmental non-governmental organizations push to establish an intergovernmental institution, facing opposition from states that are less vulnerable or less concerned and economic actors whose interests are harmed. Opposing forces may prompt advocates to accept broad institutions that stop at fostering scientific research or delineating hortatory goals or, alternatively, to design institutions with more selective memberships of powerful countries willing and able to implement meaningful actions (Victor 2011: 6). State and non-state advocates can propose designs that make it costly to oppose action or can design institutional obligations and incentives that attract participation by reluctant states. Over time, advocates can use institutional inertia to promote increasingly stringent obligations, greater participation and more effective implementation.

The developmental trajectories of intergovernmental institutions protecting the stratospheric ozone layer and mitigating climate change align reasonably well with this paradigm, but so do those of many less-visible institutions. Many institutional origin stories reflect the influence of epistemic communities and global environmental assessments, pressures from environmental non-governmental organizations and civil society, opposition by multinational corporations and proactive leadership by countries and individuals (Mitchell et al. 2006; Ivanova 2010; Böhmelt and Betzold 2013; Brun 2016). Narratives of particular institutions focus on within-case variation, highlighting the choices, actors and processes that explain the timing and design of an institution. Structural forces fade into the background, if only because they are better suited to cross-institutional explanations.

At their most convincing, such narratives either identify how the indeterminacy of structure allows actors leeway in institutional design or clarify how actors’

strategies at critical junctures promoted outcomes contrary to those favoured by structural forces. Thus, the role of UNEP's executive director, Mostafa Tolba, in the ozone depletion negotiations is compelling precisely because those negotiations succeeded *before* scientists had fully resolved scientific uncertainty on the problem (Parson 2003). Many scholars have documented how structural conditions favour creation of a new institution but that the institution emerges only because of the leadership of individuals, states or non-state actors (Ivanova 2010; Corneloup and Mol 2014; Hale 2016).

Negotiators have choices and those choices matter for the shape an institution takes. States must make choices about membership. For example, although few states were harvesting whales, fur seals or polar bears, the 1911 fur seal and 1973 polar bear treaties limited membership to states engaged in those harvests, but the 1946 whaling treaty allowed any state to join. ~~Those~~ rules, when combined with rules allowing quotas to be set by a three-quarter majority, allowed adoption of a 1982 ban on commercial whaling over the opposition of most whaling states (Epstein 2008). Negotiators have chosen to regulate many environmentally harmful behaviours directly but only to regulate the *trade* in endangered species, tropical timber and hazardous waste (Curlier and Andresen 2002; Khoo and Rau 2009; Nagtzaam 2009; Lucier and Gareau 2015). The types, specificity, ambitiousness and flexibility of institutional rules usually reflect both structural constraints that rule out certain options and strategic choices ~~and~~ framings designed to create winning coalitions, generate agreement and attract states to join (Newell et al. 2015). The 1911 fur seal treaty proved effective because negotiators rejected reciprocal exchanges of restraint in favour of Russian and US payments to Canada and Japan to completely halt their fur seal harvests (Barrett 2003). The appearance of a 1.5 degrees Celsius target and loss and damage clauses in the 2015 Paris Agreement (but not prior agreements) reflected enabling structural conditions that made their inclusion *possible* and the strategies of states, non-state actors and individuals to ensure that negotiators *actually included* those provisions in the final document. Those same influences help explain the shift from top-down obligations that bound only industrialized states under the Kyoto Protocol to the bottom-up pledge and review obligations of the Paris Agreement (Falkner 2016; Keohane and Oppenheimer 2016).

Finally, successful institutional formation requires that states join the institutions they negotiate. Both state and treaty characteristics help explain membership choices (Seelarbokus 2014b). Although most of the literature examines correlations between national economic and political traits and treaty membership, increasing attention is being paid to treaty design features such as legalization, formalization and obligational depth (Von Stein 2008; Perrin and Bernauer 2010;

Bernauer et al. 2013; Baccini and Urpelainen 2014; Seelarbokus 2014b; Spilker and Koubi 2016).

Explaining the Influence of Intergovernmental Institutions

States create, design and adapt intergovernmental institutions to reduce the environmental impacts of human behaviours. The factors and forces (noted in the previous section) that shape institutional emergence and design also shape whether, how and how much influence institutions have on state behaviour. The influence of intergovernmental environmental institutions, that is, their effectiveness, has been a major thread in earth system governance research for decades and has contributed significantly to broader international relations scholarship. Here we review recent contributions that build on a long tradition of scholarship by individuals and teams, including Thomas Bernauer, Edith Brown Weiss and Harold Jacobson, Abram Chayes and Antonia Chayes, George Downs, Peter Haas, Robert Keohane, Edward Miles, Ronald Mitchell, Arild Underdal, David Victor and Oran Young.

Such research initially responded to the neo-realist claim that intergovernmental institutions are, by their nature, ineffective: if states negotiate institutional provisions to reflect their interests, then only join those that fit their interests and are not subject to an overarching authority that enforces institutional commitments, those institutions can have no independent influence on their behaviour (Strange 1983). However, over time, institutionalist scholars developed compelling theory and convincing evidence that, despite these considerations, intergovernmental institutions can alter state behaviours under identifiable circumstances.

A central debate has revolved around the distinction between compliance and effectiveness. Downs, Rocke and Barsoom (1996) claimed that states accept and fulfil 'shallow' obligations because they require little behavioural adjustment or, alternatively, accept but then renege on 'deep' obligations because they require too-costly behavioural adjustment. Scholars of intergovernmental environmental institutions take this claim seriously, accepting that states negotiate institutional obligations to reflect their narrow and short-term interests, reject membership in agreements that harm their interests and behave in ways that reflect their interests (Mitchell 2009). They have clarified that high compliance need not correspond with high effectiveness (Mitchell 2010; Breitmeier, Underdal and Young 2011; Spilker and Koubi 2016). But, scholars have also shown that these considerations do not preclude the *possibility* of institutions independently influencing state behaviour. States expend considerable effort to negotiate intergovernmental institutions, so they *do* influence state behaviour. They design obligations and supporting provisions so that the benefits to member states exceed their costs and minimize risks. And scholars have documented many cases in which intergovernmental

institutions have led states to engage in less environmentally harmful behaviour than they would have in the institutions' absence (Bernauer 2002, Mitchell 2009, Wettestad 2011).

Accurately assessing institutional influence requires overcoming problems of endogeneity. Institutional endogeneity makes it hard to separate the influence of an institution from the spurious correlation that arises because both the obligations a state negotiates and accepts and the behaviours in which it later engages are driven by their pre-institutional interests. To address endogeneity, scholars have sought to replace the legal terminology of compliance with a social science terminology of effectiveness. International relations scholars distinguish effectiveness as an institution's causal influence, which contrasts with the correlation between behaviours and legal standards that we expect to arise because of institutional endogeneity. Documenting effectiveness requires (a) identifying deviations of state behaviours from otherwise-similar 'no-regime counterfactuals' and (b) demonstrating (through process-tracing) that such deviations reflect the independent influence of the institution (Helm and Sprinz 2000; Ringquist and Kostadinova 2005; Dombrowsky 2008; Böhmelt and Pilster 2010). The Oslo-Potsdam solution (named after the locations of key scholars involved) argued, further, that meaningful and comparative measuring of effectiveness requires placing an institution on an (ordinal) scale ranging from a specified no-regime counterfactual to the 'collective optimum' of what that institution could have accomplished, given its membership, decision rules and internal allocation of power. Clearly, measuring effectiveness poses a demanding challenge that scholars must face head-on if they seek to assess the relative performance of institutions (e.g., Young 2001; Hovi, Sprinz and Underdal 2003; Young 2003; Mitchell 2006; Andresen 2013). Addressing endogeneity requires that scholars develop counterfactuals that 'net out' the effects of non-institutional variables and the effects of power, interests, capacities and the like on institutional design, institutional membership and state behaviour. Failing to do so will systematically overstate the influence of international institutions.

Earth system governance has attracted attention from a new generation of scholars of international law and economics as well as political science and international relations (Barrett 2007; Bodansky 2010; Victor 2011; Young 2017). Some have addressed less-studied yet timely questions. Some examine how non-governmental organizations and corporate actors increasingly finance, monitor and shame actors in ways that foster the effectiveness of intergovernmental institutions, rather than serving as alternatives to them (Gupta 2010; Hale 2016; van der Ven, Bernstein and Hoffmann 2017). Others highlight the power of norms and ideas (as distinct from self-interest) in promoting earth system governance (Pettenger 2007; Dryzek 2013). These and other innovative lines of inquiry, especially

cross-disciplinary ones, provide more nuanced and sophisticated views of how institutions work and the actors and processes that promote their effectiveness.

Structures

Accurately assessing institutional effectiveness requires generating no-regime counterfactuals that identify how we expect states to behave in the absence of an institution by estimating the influence of pre- and non-institutional factors on state behaviour. For example, the incentives to generate externalities that produce tragedy-of-the-commons or upstream/downstream problems support a strong presumption that those states will continue their behaviours unless and until they join an institution designed to constrain them. Counterfactuals carefully specified to reflect those incentives and other influences on state behaviour provide a baseline, divergence from which we can interpret as plausible evidence of institutional influence. Such counterfactuals allow us to distinguish, for example, states that become greener over time because of an institution from those that do so for domestic political or economic reasons. Attention to endogeneity suggests that the leader states pushing institutional creation are likely to become greener over time anyway and that it will be the green behaviour of *important laggards* that have few other explanations that provide more compelling evidence of institutional influence. We note that institutions may have perverse effects, but that most scholars define *effectiveness* as behaviours that are in line with institutional goals.

A problem's structure helps identify both the type and difficulty of the task an institution faces (Miles et al. 2002). Some institutions must prompt states to halt a harmful behaviour; others must induce states to increase a beneficial behaviour already within their capacities; others must get states to pool financial or informational resources; and others must remedy the incapacities of some states to engage in desired behaviours. Some institutions must encourage adoption of alternatives that are numerous and cheap, while others must encourage adoption of alternatives that do not exist, are expensive or are not available to important actors. As the ozone and climate cases illustrate, the institutional task of reducing emissions is easier when cheap and profit-generating alternatives exist (as with chlorofluorocarbons) than when they do not (as with fossil fuels).

Material, ideational and normative considerations also should influence how we assess institutional effectiveness. Institutions face an easier task when powerful states support their objectives and are not engaged in the behaviours in question and a harder task when such states are committed to such behaviours and have strong counter-institutional interests. Powerful states sufficiently concerned about a problem to take unilateral pro-environmental action become examples and test sites for policies that weaker states may imitate even absent an intergovernmental

institution. The size of such positive effects may depend on the framing of relations between weaker and stronger states: in climate change, both historical responsibility and economic asymmetries led developing countries to demand that industrialized states act first. Normative concerns also matter in other ways: institutions will find it easier to alter behaviours that are inconsistent with broadly accepted norms than those that align with such norms. Over time, the task of altering behaviour may ease as actors increasingly accept regulation as legitimate and appropriate.

Identifying one institution's influence requires that we also account for how other institutions influenced observed behaviours (see Chapter 7). One institution's influence may reflect synergies with other institutions (Young 2008; Keohane and Victor 2011; Oberthür and Stokke 2011; Stokke 2013). This can reflect either unintended interaction effects or self-conscious coordination among intergovernmental institutions (Andresen and Rosendal 2009). European air pollution may have declined in response to the Convention on Long-range Transboundary Air Pollution and its protocols, European Union directives or some combination of both (Byrne 2015). Parsing the influence of multiple institutions requires distinguishing their additive, synergistic, conditional and alternative effects.

In general, accurate assessments of institutional influence require accounting for these and other systemic and state-specific factors as both alternatives to and conditioning factors on institutional influence. Features of the behaviours in question, the states involved in them and the material, normative and institutional landscapes mean that institutions differ in the challenges they face. Future researchers seeking to compare institutional effectiveness will need to take such differences into account.

Actors, Agency and Strategies

As with institutional creation and design, structural factors make institutional effectiveness more or less likely but operate through identifiable actors deploying particular strategies to induce states to adjust their behaviours. The efforts of such actors may serve as alternatives to institutional explanations or as the mechanisms through which institutions operate.

Over the past decade, scholars have improved theory, methods and evidence related to institutional influence (Underdal and Young 2004; Young 2011; Sealarbokus 2014a). Scholars have built new hypotheses and models on findings of early multi-treaty comparisons (Haas, Keohane and Levy 1993; Brown Weiss and Jacobson 1998; Victor, Raustiala and Skolnikoff 1998; Young 1999; Miles et al. 2002). The International Regimes Database (Breitmeier, Young and Zürn 2006) and Oslo-Seattle Database (Miles et al. 2002) have informed

development of new datasets that cover more institutions, operationalize variables better and offer aggregate indices to capture empirical variation and facilitate hypothesis testing. Some have created datasets targeted on specific issues like climate change and rivers (Bernauer and Böhmelt 2013; Bernauer and Böhmelt 2014). The International Environmental Agreements (IEA) Database (IEA Database 2019) has been developed, maintained, linked and extended to cover all environmental treaties, all member states and numerous related variables. Scholars are increasingly conducting systematic analyses of a wide range of institutions by combining variables from these datasets with other readily available datasets.

Scholars have used both simple frequency counts and sophisticated econometrics to detect institutional effects in statistically significant differences between the pre- and post-treaty behaviours of member states or between member and non-member behaviour (Kim, Tanaka and Matsuoka 2017). Of numerous quantitative analyses of the protocols under the Convention on Long-range Transboundary Air Pollution, most have found them to have little effect on emissions (Ringquist and Kostadinova 2005; Aakvik and Tjøtta 2011; Vollenweider 2013; Houghton and Naughton 2014; Byrne 2015). Scholars have also assessed intergovernmental institutions regulating carbon dioxide, ozone depleting substances, hazardous wastes, river pollution and other environmental problems (Dombrowsky 2008; Cullis-Suzuki and Pauly 2010; Berardo and Gerlak 2012; Myint 2012; Bodin and Österblom 2013; Kellenberg and Levinson 2014; Saleh and Abene 2016). Many of these studies have devised compelling strategies to address the challenges of endogeneity noted above (Downs, Rocke and Barsoom 1996; Bernauer et al. 2013). Statistical approaches have advantages in identifying an institution's average effect across all members and in allowing the analyst to isolate and compare an institution's influence on behaviour relative to other independent variables, after controlling for those variables.

Other scholars approach institutional effectiveness in set-theoretic terms (qualitative comparative analysis), looking for their influence in associations between *combinations* of necessary and sufficient conditions and positive environmental behaviours (Ragin 1987; Stokke 2012). One research team combined multiple techniques to compare findings from the International Regimes Database and the Oslo-Seattle Database (Breitmeier, Underdal and Young 2011). Despite the value of statistical techniques, qualitative comparative analysis was more helpful in documenting that consensual knowledge was more commonly associated with effective regimes than any other variable. Scholars are increasingly deploying novel research strategies, including agent-based modelling, to assess the effectiveness of possible institutions that do not yet exist (Lempert, Scheffran and Sprinz 2009; Gerst et al. 2013; Nordhaus 2015; Hovi et al. 2017).

Alongside quantitative studies, qualitative studies, which dominated institutional effectiveness research in the 1990s, have continued to provide sophisticated, nuanced and compelling insight into the processes by which intergovernmental institutions influence behaviour (Hønneland and Stokke 2007; Brochmann and Hensel 2011; Victor 2011; Wettestad 2011; Young 2011; Mitchell and Zawahri 2015). Refuting the generally pessimistic conclusions of quantitative studies, qualitative assessments often find intergovernmental institutions to be at least moderately effective. In part, this divergence may reflect the fact that quantitative methods define effectiveness as an institution's *average* influence across all member states while qualitative methods seek evidence of their influence on some *specific states*. This suggests the need for future research to integrate divergent quantitative and qualitative findings, determining whether they are different but compatible assessments, reflect methodological artefacts or constitute irreconcilable claims about the same empirical record.

Despite sometimes-divergent findings, both quantitative and qualitative research support some claims about why some intergovernmental institutions are more effective than others. We know that problems prove less susceptible to resolution (more malign) when individual and collective costs and benefits diverge, when states have upstream-downstream rather than tragedy-of-the-commons incentives and when resolution requires a minimum of contributors (~~a threshold~~). Institutions are less likely to be effective in addressing malign problems and may become wholly ineffective if knowledge about the problem is weak or uncertain (Miles et al. 2002). The prospects for institutional effectiveness improve, however, when small homogeneous groups of states share interdependencies, have a source of leadership and can use pre-existing institutional capacities.

For institutions within a propitious context, scholars have made major progress in identifying links between institutional design and institutional influence. Treaty design involves trade-offs: more binding, precise, or ambitious treaties may deter some states from participating but lead those that join to larger behavioural adjustments (Böhmelt and Pilster 2010; Bernauer et al. 2013; Spilker and Koubi 2016). Certain designs can mitigate these trade-offs: institutions can convince recalcitrant states to join and meet institutional obligations by offering opportunities to receive side-payments or establish green reputations, or by reassuring them of reciprocity from other states if they make sacrifices for a collective goal (Baccini and Urpelainen 2012; Bernauer et al. 2013). Effectiveness is enhanced when institutions attract support from powerful states that take leadership roles, exercise behavioural restraint unilaterally or credibly threaten sanctions (Cirone and Urpelainen 2013; Sand 2013). We leave to Kalfagianni and colleagues (Chapter 4) a discussion of non-governmental organizations as independent sources of earth system governance, but we do note here the increasing frequency with which

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institutions involve non-governmental organizations in their implementation (Gulbrandsen and Andresen 2004; Betsill and Corell 2008).

A well-developed literature has demonstrated the contributions transparency makes to institutional effectiveness, by enhancing institutional legitimacy and by providing a foundation for sanctioning and shaming (Gupta 2008; Mason 2008; Haufler 2010). Support has accumulated for constructivist claims that effectiveness is a function of norms, legitimacy and equity as much as instrumental strategies for shaping behaviour (Andresen and Hey 2005; Breitmeier 2008; Epstein 2008; Brunnée and Toope 2010; Milkoreit 2015). Institutional promotion of scientific research expands and strengthens epistemic communities, which brings attention and support from national governments and universities, attracts media and public attention and may move domestic policy towards institutional goals. Corporations also shape institutional effectiveness. Their opposition can delay negotiations and reduce institutional influence while their support can do the opposite. Public commitments by chemical companies to eliminate the production of chlorofluorocarbons if such substances were shown to cause ozone depletion play an important role in most narratives of the Montreal Protocol's effectiveness (Parson 2003). Fossil fuel industry opposition has generally delayed carbon emission reductions, but some corporations' investments in renewable energy are helping reduce carbon emissions faster than they would otherwise. Corporate research and investment strategies, normative guidelines, production standards and certification and labelling programmes have contributed to the implementation and effectiveness of intergovernmental institutions addressing climate change, forestry and fisheries (Cashore et al. 2007; Auld 2014; Gulbrandsen 2014).

Conclusions and Future Directions

Our review identifies the many influences on the creation and design of intergovernmental institutions in earth system governance and on their effectiveness. With respect to institutional creation and design, structural factors (both material and socially-constructed) condition whether, when, how easily and how states address a shared environmental problem. Scholars are enhancing our ability to diagnose environmental problems and to identify promising cures. Institutional emergence depends on structural conditions such as (a) the degree of shared, science-based knowledge about cause-effect relationships; (b) the nature of the behaviours that cause the environmental problem; and (c) the availability of attractive substitute behaviours. Within structural constraints and opportunities, states, existing institutions, non-governmental organizations and the private sector deploy strategies that either foster institutional creation in malign conditions or hinder it in benign conditions. The interaction of structural conditions

and strategies determines whether and what type of institutions emerge. All these factors help explain variation in institutional emergence, as evident in the more rapid and effective efforts to address ozone depletion relative to climate change.

With respect to effectiveness, institutions succeed best when decision-makers and stakeholders identify designs that fit the problem, reflecting the structural constraints and opportunities, the power and incentives of important actors and a range of other important political, economic and social dynamics (Young 2002). Institutions become effective when proponents design them to alter behaviours within existing material, ideational and normative constraints. Solutions may require support from powerful actors and the availability of low-cost alternatives, but individuals and institutions often are crucial to identifying and directing efforts towards common interests (Miles et al. 2002: 450). The power and concern of the United States related to ozone depletion led to efforts that generated support among OECD countries and offered assistance to developing countries, leading to rapid and substantial emission reductions. By contrast, intergovernmental efforts on climate change have been far less effective because of a more complex and malign problem structure, greater resistance from powerful states and corporations and weaker capabilities among the many institutions in the climate change regime complex. Deepening our knowledge of why some intergovernmental institutions succeed while others do not will require scholars to continue researching complex interactions at and across the international, transnational, domestic and sub-national levels of earth system governance.

Future research opportunities abound. Scholars can assess what factors explain the creation and success (or failure) of hundreds of existing intergovernmental institutions in earth system governance. They can do so by building on already-robust analytic frameworks and methods. And the interdisciplinary skills of scholars of earth system governance position them well to make unique contributions to global efforts to address climate change, biodiversity loss, the hazardous waste trade, ocean and freshwater pollution and the myriad other environmental problems facing our planet.

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