

Methods and Global Environmental Governance

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Abstract

This review analyzes the methods being used and developed in global environmental governance (GEG), an applied field that employs insights and tools from a variety of disciplines both to understand pressing environmental problems and to determine how to address them collectively. We find that methods are often underspecified in GEG research. We undertake a critical review of data collection and analysis in three categories: qualitative, quantitative, and modeling and scenario building. We include examples and references from recent studies to show when and how best to utilize these different methods to conduct problem-driven research. GEG problems are often characterized by institutional and issue complexity, linkages, and multiscaleity that pose challenges for many conventional methodological approaches. As a result, given the large methodological toolbox available to applied researchers, we recommend they adopt a reflective, pluralist, and often collaborative approach when choosing methods appropriate to these challenges.

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1. INTRODUCTION

Scholars of global environmental governance (GEG) are motivated not only to understand and explain the forms, functioning, effectiveness, and underlying dynamics of global governance, but also to apply insights from their findings to address complex and pressing environmental challenges (1). These goals demand approaches that tackle, rather than bypass, major research challenges. Moving targets, complexity, and incomplete information make it difficult to adjudicate between competing alternatives for explaining GEG and, by extension, the policy prescriptions that flow from such research to address global environmental problems. What then, are the most appropriate ways to design and conduct rigorous problem-focused research in GEG? What methods are available and most useful? What pitfalls must GEG scholars collectively avoid? Although other social science researchers face similar challenges, and thus our arguments

may apply more broadly, this review draws on and speaks most directly to GEG scholarship.

Our central argument is for problem-driven research that confronts, rather than assumes away the challenges of researching global environmental politics and governance. Although three decades of GEG research have produced sophisticated analyses of global environmental problems, we also detect a tendency for researchers to choose methods based on their own theoretical preferences or training. Although a variety of methods may be fruitfully applied to understand particular aspects of the same environmental problems, some methods can better address certain questions and research challenges. Thus, methodological choices should be adopted and justified on the basis of their utility to explain and understand the questions that motivate our research—usually to address an environmental problem—rather than choosing methods first and then selecting research questions those methods can address.

How, then, might GEG scholars develop research designs that avoid being driven by methodological predispositions? We answer this question in four related steps. First, we identify the study of GEG as a problem-driven field with roots in political science and international relations (IR) theory relevant for improving global governance of the environment or, at the very least, our understanding of GEG. Second, we identify four research design and methodological challenges confronting GEG research. Third, we review strengths and weakness of prevailing methodological approaches, techniques, and innovations within qualitative and quantitative methods as well as within a relatively new methodological approach to GEG scholarship: modeling and scenario building (MSB), which has developed distinct quantitative and qualitative approaches. We draw on examples from our own and others' research to illuminate these challenges. Fourth, we discuss strategies for choosing methods to carry out problem-focused GEG research, including the potential of multiple methods and collaborative research. We argue for greater methodological pluralism as a starting point and for research

problem-methodology coherence as the goal. Thus, we urge GEG researchers to undertake a reflective approach to research design in which they frame and make methodological choices that fit with the question(s) they ask. Scholars trained in one tradition should learn to step outside their methodological comfort zone to learn or appreciate other techniques, or they should work with others on collaborative projects that get at a central question from different methodological directions.

This openness is especially important, as many GEG researchers contribute to two sometimes countervailing academic communities: (a) specific disciplinary fields such as (but not restricted to) political science and its subdisciplines of IR, political economy, and comparative politics; and (b) problem-focused interdisciplinary environmental studies programs that include public policy, administration, and management. We also have in mind the needs of a new generation of GEG scholars, who often want, and are expected, to draw on a wider range of tools and methods to address complex, multiscale problems.

2. GLOBAL ENVIRONMENTAL GOVERNANCE SCHOLARSHIP

GEG scholarship can trace its origins primarily to those scholars within IR who created the subdiscipline of international environmental politics (IEP) (2, 3) (see the sidebar Approaches to Global Environmental Governance). Largely situated within the overarching framework of regime theory (4), IEP researchers have addressed questions of why and how states came to cooperate over environmental problems as well as what explained the negotiating outcomes that emerged in the form of environmental institutions (e.g., 5, 6). IEP scholarship has made important contributions to IR theory, notably regarding the role of science in international politics (e.g., 7), North-South politics (8), and the impacts and effectiveness of international environmental cooperation (for example, 9–11). Despite its initial focus on intergovernmental cooperation, this work supplied insights into the influence of nonstate

APPROACHES TO GLOBAL ENVIRONMENTAL GOVERNANCE

Global environmental governance (GEG) is a field that includes the institutions, processes, initiatives, actors, and organizations that shape environmental actions and outcomes in the global realm. Although GEG is studied from several disciplinary perspectives in the social sciences, we start by focusing on GEG research that has emanated from scholarship on global environmental politics, which, in turn, has its origins in the political science discipline of international relations. As the study of global environmental politics matured, the questions it asks and theoretical approaches it applies have, however, increased its connections to other disciplines that study GEG, including geography, sustainability science, and sociology.

actors, including activists and corporate-sector actors, on international negotiations and regime outcomes (e.g., 12, 13).

Later, comparative politics and policy scholars drew attention to the important influence of international actors and ideas on domestic environmental policies, and vice versa, across different countries and regions (14–17). These insights also generated work on transnational environmental politics, including advocacy networks and governance arrangements that form networks across boundaries (e.g., 18–21). Scholars of the political economy of GEG have also had a major impact on the field. By focusing on the challenges of governing environmental problems driven by the globalization of production and consumption chains or the marketization of environmental governance (e.g., 22–24), they highlight the importance of the global economy and economic inequality. Others demonstrate how structures of power and authority in the international system or particular discourses define or delimit particular forms of governance (e.g., 22, 25, 26).

GEG scholarship is both theoretically informed and diverse, and the range of GEG scholars goes beyond the more narrowly bounded IEP field. It includes “applied” research that aims to help ameliorate environmental problems, but it does this best

when expanding knowledge about the politics surrounding problems and their solutions by translating the politics and practices of environmental policy across multiple scales. Accordingly, the study of global environmental problems and politics is an interdisciplinary and collaborative field, drawing from multiple and varied theoretical frameworks and epistemologies to explain environmental policy outcomes to both scholarly and policy communities.

Despite its growth, however, this field has produced very few methodological overviews (for exceptions, see 27–29), especially ones that go beyond the basic tools and methods of IR theory. Likewise, although some reviews discuss recent innovations in GEG theory (e.g., 30), few of these provide in-depth discussion of methods. Unfortunately, many research articles, especially those that have a qualitative perspective, do not include methods sections, perhaps owing to article length constraints, an omission that gives other scholars fewer examples from which to work.

To get a sense of how or whether scholars are referring to their methods in peer-reviewed articles, we turned to *Global Environmental Politics* (*GEP*)—the leading journal most

directly associated with GEG research. According to the 2012 Thomson Reuters ISI Journal Citation Reports, *GEP* ranked third in political science and tenth in environmental studies. We focused on *GEP* because of its political science origins and for manageability (we encourage similar exercises using other journals in the field). Our review of the 298 forum/commentary and research articles published since its first issue in 2001 found only 7 out of 65 forum/commentary articles (or 11%) and 96 out of 233 research articles (or 41%) included a discussion of, and justification for, the methodological techniques employed. Only three articles were explicitly devoted to the topic of methods (**Figure 1**) (31–33). Nonetheless, we found an increase over time in the number of articles discussing methods.

3. FOUR CHALLENGES

Our review addresses four challenges facing problem-relevant GEG scholarship: complexity and uncertainty, vertical linkages across multiple scales, horizontal linkages across issue areas, and (often rapidly) evolving problem sets and institutional initiatives. These challenges

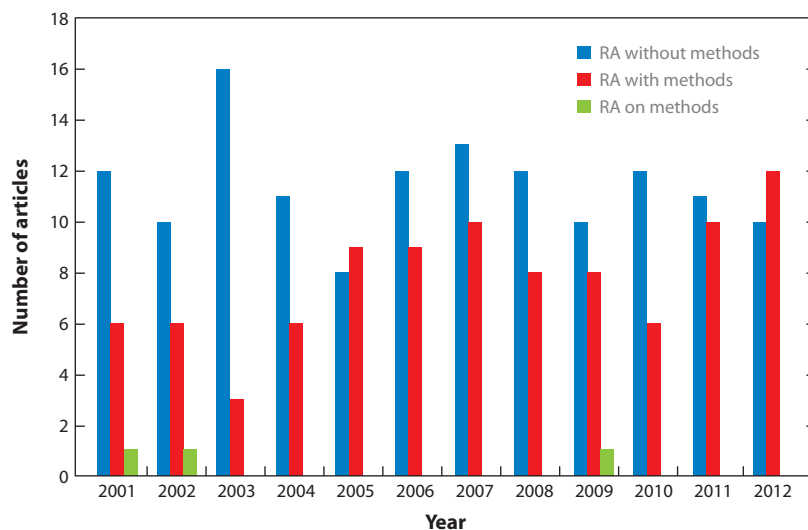


Figure 1

Survey of methods discussions in *Global Environmental Politics*, 2001–2012. Abbreviation: RA, research article.

are not unique to GEG; they also apply to other areas of applied research. However, we draw on particular examples from and challenges posed by the GEG arena in what follows.

First, some of the most profound changes in human behavior and notions of appropriate or legitimate governance are unpredictable. Studying environmental governance and policy from a social science perspective requires attention be paid to the dynamics, power, and authority relations underlying formal and informal governance systems and initiatives as well as their origins, (often nonlinear) trajectories, and impacts. This unpredictability, as constructivists (34), organizational sociologists (35), and institutional theorists (36) have elaborated, necessitates that research methods balance a quest for precision and predictability (the goals of deductive nomothetic theory) with the need to recognize messy contingency and to study path dependencies and ruptures (37).

GEG scholars have often highlighted the scientific complexity and uncertainty inherent in environmental problems, such as climate change, in their research as an additional barrier to fostering environmental governance and cooperation (38, 39). In terms of GEG, uncertainty as a methodological problem exists for looking both forward (assessing future directions and impacts) and backward (assessing how events/behavior would have unfolded in the absence of the institution). These problems are especially acute for GEG. As Levin et al. (37) elaborate,

[W]hile the political system may mediate interest group interactions regarding climate change policy in similar ways as it does regarding universal health care, the natural environment has its own response that stakeholders and governments cannot wish away. Indeed, the powerful image of “compromise” that shapes most public policy processes does not fit. Human beings can, of course, control their behavior to alter their impacts, but they cannot control the response of the natural system once a decision is made. (37, p. 127)

Lemos & Agrawal (40), moreover, have recognized complexity as a characteristic of new environmental governance, which they link to the challenges of multiscale and linkages. Nelson et al. (41) use the notion of complex systems and environmental change as a foundation for understanding adaptive governance and resilience. Complex and unpredictable problems, as we discuss below, necessitate diverse methods including historical process tracing and scenario development. Years of research on the politics of climate change have revealed the need to develop methodological approaches and models that adapt over time and space as a result of the feedbacks and underlying complexities of the problems at hand, precisely because historical norms and explanations for past behavior may change and, hence, not serve as a guide to future norms and behaviors. Although recognition of this frustrates most social science researchers and may help explain the largely backward-looking focus in our analysis of things that have already happened, we also note a potential positive feature of an unpredictable future: As most GEG scholars agree, profound normative and behavioral changes must occur to address exceedingly intractable problems. The trick is to apply methods that can help us understand the causal mechanisms through which such processes may be initiated.

Second, multiple levels of governance are always at play. Like scholars who study the interface of human-ecological systems (42), scholars of GEG confront the challenge that governance institutions operate at different levels of scale—physically, temporally, and across different actors (e.g., see 30, 43). In addition, scholars of local institutions posit that institutional analysis must take place not only at different levels of scale, but also across different fields of action (e.g., 44–46). The issues we choose to study pose significant challenges for individuals, firms, communities, nation-states, and the world as a whole. GEG researchers must assess and understand how choices made at one level affect and influence interactions and choices across and within many governance arenas that often lack formal rules and interrelationships

(30). Because there are only a few attempts from which to draw lessons regarding the study of local institutions for managing the global commons (47), understanding these multiple levels requires that particular attention be paid to the development of appropriate methodological tools to introduce new actors into a field that has traditionally focused almost entirely on global and domestic-international interactions.

As has been asserted for GEG scholarship, interactions across levels can lead to unintended consequences including complex interactions ranging from global supply and consumption chains where apparent advances merely displace pollution or waste elsewhere (e.g., 48). Likewise, different types of knowledge, ideas, and initiatives move across political levels, creating complex interaction effects (e.g., 49). This shift toward an increasingly explicit study of scale and the movement of actors, ideas, and knowledge up, down, and across scales has required GEG scholars to look for new tools to make these phenomena visible. Such tools must then be incorporated into GEG research. Accordingly, insights from geography, anthropology, and other fields for which scale has long been a central concern have had to be incorporated, even though findings from these fields have not always scaled up to global governance institutions and/or addressed the global nature of the issue in question.

Third, the horizontal interplay between governance regimes, which often overlap on issue areas or governance functions, must be addressed. Linkages occur across issue areas and regimes, for example, across climate and deforestation regimes via a program aiming to reduce emissions from deforestation and forest degradation that also includes conservation and sustainable management of forests (REDD+). Moreover, the deepening institutionalization of international trade and the relationship between the World Trade Organization and environmental regimes have given new salience to trade-environment linkages. These developments have generated a literature on the mitigation of regime conflict and the opportunities for creating synergy

across regimes, in particular, how these are managed and by whom (50, 51). Untangling these linkages across governance regimes poses significant challenges for researchers in terms of understanding how they work, which way influence runs, and how (or whether) an interconnected set of regimes can add up to more than the sum of its parts. The work we examine below has focused attention on actors, such as treaty secretariats (52), and policy diffusion across regimes (53, 54). It is nearly, but not all, qualitative in nature, often involves triangulating methods, and may require multisited work on the part of the researcher.

Fourth, at its core, environmental governance research concerns the study of governance institutions that continue to evolve. This directly contravenes the conventional wisdom in public policy research (e.g., 55) that scholars can gain insights only for policy that has been in place for more than 20 years. Despite recognizing the need to look forward, the literature on how to think about, and research, evolutionary processes is relatively limited. Arguably, the most relevant analysis is on scenario building, which, as discussed below, has developed a literature applying quantitative and qualitative techniques. However, even this literature tends to sidestep key challenges—namely, that norms and preferences can, and do, change.

One way researchers have tackled this problem has been by identifying pathways that have “plausible logics” for evolving in ways that build GEG (e.g., 56). Such analysis starts with the understanding that environmental policy initiatives may change behavior and moves on to examine how and under what conditions they may actually shape the preferences of participating actors and systemic norms. For example, in the case of global coalitions working to address illegal logging by tracking legally produced forest products, Cashore & Stone (56) posit that a two-step “evolution” and “interaction” process may be triggered. First, tracking systems may evolve so they become entrenched while expanding the number of actors involved in the supply chain supporting this approach. Second, as a result, higher standard certification

programs may be able to work more efficiently despite their current struggles associated with the difficulty in tracking certified forest products. Cashore & Stone (56) argue that this potential evolution and interaction can never fit within the realm of a predictive model. Their approach illustrates the importance of imagining futures that have “some plausible logic” and of using GEG scholarship to help translate this knowledge to forward-looking strategic interventions capable of creating “sticky” institutions.

Recognizing that we are always on an evolutionary trajectory means that research designs and methods that focus solely on generalizable patterns of the past, even leaving aside the range of assumptions that must hold for that knowledge to apply in the present, has limited utility in building practical knowledge or analysis that takes account of nonlinearities, feedback effects, and learning. Traditional GEG theory, still circumscribed by its ontological focus on the nation-state system and international diplomacy, has been slow to develop the tools and analytical skills to address new and evolving institutions, such as carbon markets or REDD+ (57). As a result, less attention has been paid to questions of power, legitimacy, and authority that characterize GEG dynamics (for exceptions, see 22, 58) and an overemphasis on economists’ analyses of the impacts of these initiatives.

Arguably, the methodological challenges facing GEG scholars are an important reason for this gap. Below, we cite other examples ranging from multisited analysis of fisheries overexploitation to the complexities of interactions at global summits that illustrate these challenges. Likewise, GEG scholarship has spent little effort attempting to articulate a coherent approach regarding which methods to employ or when to employ them. Even articles and books that are explicit about methods lack a coherent approach to a broad suite of methods or, indeed, an effort to identify or contribute to a new methodological/theoretical “canon” from which research questions can be drawn. For example, although the edited volume by

Sprinz & Wolinsky-Nahmias (59) on methods provides a comprehensive survey of the application of quantitative and formal methods to the study of international environmental policy, its focus remains restricted to traditional IR frameworks. The next section seeks to expand this canon.

4. METHODOLOGICAL CHOICES FACING CONTEMPORARY GLOBAL ENVIRONMENTAL GOVERNANCE: A CRITICAL REVIEW

This section reviews existing and new methodological approaches in GEG, particularly as they have evolved over time. Here, we focus on three primary categories, or “families,” of methods: quantitative, qualitative, and MSB. For each section, we review how methods within each category have been used over time, some of their strengths, and some of their limitations in meeting the four challenges posed by the contemporary GEG issues outlined above. Many of the methods we discuss here have long been applied by scholarly communities, including GEG, but some are new to GEG research. We see this trend related to the growth in the breadth of the field in terms of problems and institutions that have emerged or are recognized as important for GEG scholarship. We also see more researchers, especially graduate students, entering the field with interdisciplinary training and perspectives. Finally, because we are interested here in applied or problem-solving GEG research, alternatives must be explored and existing approaches must be adapted to get at complex, linked, and rapidly changing questions and problems.

4.1. Qualitative Methods

Qualitative methods have great potential for meeting the four challenges we identify in this article (see sidebar Qualitative and Quantitative Methods in the Social Sciences). Recent qualitative studies have taken up these challenges, utilizing innovative methods, ranging from

QUALITATIVE AND QUANTITATIVE METHODS IN THE SOCIAL SCIENCES

In the social sciences, qualitative methods generally focus on explaining outcomes, making causal inferences, identifying causal mechanisms, or identifying historical processes within a single or small set of cases. Commonly used techniques include structured, focused comparisons of cases, typological theory, process tracing, congruence testing, and counterfactual analysis. Qualitative methods may include interpretive approaches to understand social and political phenomena or cases through techniques such as discourse analysis, ethnography, or hermeneutics. Quantitative methods include a range of mathematically based methods that generally employ statistical techniques to map simple and complex relationships, assess correlations, and/or make descriptive and causal inferences by analyzing large sets of data. Specific techniques range from network analysis to inferential statistical techniques. This category may also include mathematical or formal modeling. Although there is some debate in the literature over whether both quantitative and qualitative methods are essentially concerned with techniques to make descriptive and causal inferences or whether different epistemological or ontological assumptions underpin them, in this review we adhere to the line of reasoning that quantitative and qualitative data and methods provide both synergistic and countervailing epistemological assumptions.

multisite research to large-scale collaborative data gathering and analysis projects, thereby building on the existing body of qualitative, case-based research in the GEG field. As described below, GEG researchers have drawn on methods used in other social science and humanities disciplines, including collaborative ethnographic methods. We find that the repertoire of objects of study and questions have evolved to encompass the four challenges and that data collection techniques have expanded. Scholars still rely on long-established modes of data analysis, but more often, they are combining methods of data collection and analysis into forms of triangulation that are applied in different ways to new sets of cases. These cases, which include commodity chains and cross-scale institutions, have not traditionally been part of mainstream GEG inquiry. In terms

of developing methods to extrapolate into an uncertain environmental future, the momentum resides with new approaches (qualitative as well as quantitative) that allow for scenario building. Therefore, we also discuss some of the limitations of qualitative approaches, even given recent innovations. Debates over the distinction between qualitative and quantitative methods continue (see also 60–62). This section and Section 4.2 demonstrate some common concerns as well as differences between qualitative and quantitative methods.

4.1.1. Fewer cases, more dilemmas. Case studies form the bulk of qualitative methods-based research. They are particularly useful for generating hypotheses, identifying key variables, building theories, and “achieving high construct validity” (63, p. 34), because they allow researchers to tease out causal mechanisms, often through process tracing, structured, focused comparison, and/or counterfactual analysis. During the first few decades of research on global environmental regimes, scholars frequently selected a particular regime and meticulously traced out the linkages between “possible causes and observed outcomes”—that is, using process tracing (64)—to identify the causal mechanisms at each critical stage to explain the emergence and, sometimes, the evolution of the regime. Analyses took the form either of individual case studies (7, 65) or of data collected in edited volumes to enable cross-case comparison (e.g., 5, 66) to examine primarily the negotiation, impacts, and effectiveness of international environmental regimes.

Frequently employed in single case studies, counterfactual analysis (or the construction of “thought experiments”) has enabled scholars to evaluate multiple causal variables (67). Counterfactual analysis has been deployed in qualitative studies to assess whether an environmental problem such as acid rain in Europe would have been worse off without an institution (68). Such analysis also explores why some alternative pathways of institutional development (e.g., ecodevelopment) failed, whereas others (e.g., sustainable development) succeeded (69).

The utilization of structured focused comparison further enabled researchers to analyze the same set of questions and variables across cases (64). Several of these studies allowed for cross-scale and cross-national comparisons too. Examples include work by O'Neill (16) on hazardous waste trading, Weinthal (15) on domestic sources of international cooperation in Central Asia, and Cashore et al. (70) on forest certification. In many cases, a team of researchers worked under a unified framework to draw out causal inferences from a larger number of cases than could have been covered by an individual researcher (e.g., 5, 9, 66). For example, the contributors to Weiss & Jacobson (9) applied common sets of factors to demonstrate what shaped compliance across five regimes and nine countries and blocs, whereas the authors in Young (66) applied six behavioral pathways through which regimes exert impacts to three case studies. These benefits of collaboration are echoed in some of the emerging qualitative methods we examine below.

Like their IR counterparts, GEG researchers have also begun to deal with small-*N* problems, long cited as a major drawback to understanding generalizable causal conditions (60), through the construction of what could be called “medium-*N*” analysis. One such method, fuzzy-set qualitative comparative analysis (fsQCA), aims to identify complex causal patterns by specifying potential combinations of drivers of change and then grouping cases accordingly (71). The approach draws on the in-depth knowledge the researcher has on each case to identify potential independent and dependent variables that may interact to produce an effect. Rather than separating out independent variables to understand their effects, fsQCA, often as part of a broader suite of methods, allows researchers to examine how combinations of variables work together to produce an effect (72–74). The strength of the approach rests in its ability to identify multiple complex causal mechanisms, which can be lost in more standard quantitative techniques, and to produce generalizable explanations without sacrificing either the richness of case

studies or the elegance of parsimonious causal explanations.

Although fsQCA can be a useful tool to study GEG, there are some limitations to its use. In particular, because it relies on an intimate knowledge of the cases to calibrate membership in a group, its use for very large-*N* studies is circumscribed. As always, with new approaches in the social sciences, careful attention must also be paid to establishing “best practices” for employing fsQCA (75).

4.1.2. Expanding the qualitative repertoire: data, analysis, and cases.

Over the past decade, GEG researchers have sought to integrate or adapt additional methodological approaches into the suite of qualitative methods and research design. These approaches are often more adept at capturing complexity, linkages, and scale in contemporary GEG that characterize, for example, the interactions across different issue areas, or mapping the networks of diverse actors that characterize global and transnational policy arenas. Moreover, individual researchers and teams of researchers now have access to more and better data sources and techniques for data collection and sharing and to innovations in data analysis. Nevertheless, many studies continue to use the traditional tools of process tracing and structured, focused comparison, including interviews and archival research.

To address the complexity that characterizes contemporary GEG, researchers require larger data sets. Under the rubric of qualitative methods, methods and tools for data collection and analysis include collaborative event ethnography (CEE), participatory action research (PAR), and survey methods, some of which require researchers, particularly from IR backgrounds, to learn techniques not always taught in disciplinary programs. Whereas prior collaborative studies often consisted of edited volumes, a new generation of scholars is engaging in more direct collaboration in terms of data collection and analysis. These scholars are also working on multiple sites across and within

scales. We chart the highlights of these developments below.

4.1.2.1. Observing mega events: new tools for analyzing complexity. New data collection techniques, subsequently used for analysis by teams of researchers, have emerged as tools for studying international negotiations as complex, linked, and cross-scale processes and events. CEE is one such method that holds potential for tackling problems pertaining to GEG across multiple governance spheres. CEE combines “rapid or time constrained ethnographic assessment...with institutional and organizational ethnography” (76, p. 248) to capture interactions and dynamics among networks of actors at large international meetings; ultimately, CEE may be used to gather data that can be accessed by a variety of actors. CEE research teams have attended various GEG “mega events,” including the 2008 World Conservation Congress in Barcelona, the 2010 Nagoya Conference of the Parties (COP) of the Convention on Biological Diversity, and the Rio+20 Summit in 2012, where they have studied actors inside and outside the negotiating halls.

CEE rests on the assumption that GEG is not simply a function of the interplay among state actors in a negotiation room and is best suited to scholars tracking the emergence of ideas around particular themes or topics, such as the establishment of conservation targets, decisions on forest management, or how particular principles or norms are embedded within decision-making processes. However, it would be very difficult for individual researchers to tackle mega events in a way that illuminates the complex relationships among actors or the horizontal and vertical linkages between institutions and that captures the role of knowledge and power in determining institutional outcomes. At a global event such as the COP, there are hundreds of events including official negotiations, working groups, chair groups, side events, media sessions, demonstrations, poster sessions, and public information expos—all of which contribute to shaping the agenda at the

COP. Through collaborative approaches for data collection such as CEE as a research technique (e.g., see 77, 78), researchers gain broader analytical insights into governance processes by blending the specialized contextual knowledge that each individual researcher holds with the broad data set gathered at the global event.

For example, Marion Suiseeya (79) studies the role of justice norms in the institutional dynamics of global forest governance. Through collaboration as part of the CEE, Marion Suiseeya was able to examine the evolution of the forest justice discourse at the Convention on Biological Diversity by mapping out who was present at particular events, their articulations of justice and claims of injustice, and how these shifted or changed depending on the conditions and substance of the event. CEE allows researchers to gather a broad data set that illuminates the diversity of and relationships between actors involved in GEG and includes how issues are linked (76). It enables researchers to investigate important political moments in which actors that are generally dispersed but working on the same agenda interact in direct proximity to each other.

Although the findings from these examples would not have been possible without CEE, there are some potential weaknesses or pitfalls to using CEE. First, research findings may be mainly descriptive, missing the opportunity for more in-depth analysis on potential causal mechanisms or pathways. Scholars using CEE need to be explicit regarding their methods of data analysis and question construction as well as what they are gaining from the use of CEE. They should also clearly define their hypothesized mechanisms that explain the phenomena they are examining. Otherwise, it may be hard to separate signal from noise over short meeting time frames. Second, some general concerns about the collection and use of CEE data revolve around the completeness or generalizability of data gathered on-site by the particular team in place. These concerns raise comparisons with other leading data sources on environmental negotiations and meetings, such as the highly regarded daily and

weekly reports compiled and written by the *Earth Negotiations Bulletin* team at hundreds of meetings since 1992 and made available online (80). However, the emergence of multiple databases from COPs of different regime processes is likely to allow for better replication and/or confirmation of data. Likewise, the Leverhulme Trust-sponsored network on transnational climate change governance includes many political scientists, all working from a common database jointly developed on transnational climate initiatives (81).

4.1.2.2. Linkages across and within scales: multisited research. Recent qualitative GEG research focuses on the complexities of entire governance systems that operate at multiple levels with multiple actors who straddle or cross “traditional” regime borders. This research also focuses, for example, on the flows of ideas and knowledge, policies, actors, and commodities across scales. The associated literature has introduced the concept and method of commodity chain analysis to GEG scholarship (82–84), employing concepts of scale, linkages, or networks that draw from geography, sociology, and anthropology (e.g., 85). Researchers in this tradition have embraced multisited research as a way to address “questions of scale and the processes of globalization” (86, p. 262) that are critical to understanding and addressing global environmental challenges.

One type of multisite research focuses on capturing the regulatory and production processes that shape a single commodity sector—such as tuna, timber, or green beans—and the environmental relations associated with it (87–89). For example, to anchor their study, Havice & Campling (87; for more explication, see 90) place scalar concerns at the forefront of their analysis of the global political economy of tuna fisheries in the Western Pacific Ocean. They argue that most scholarship on the tuna industry identifies environmental failures as emanating solely from “weak governance” at the state level; thus, it ignores the context in which states operate (87). By contrast, they highlight that transnational (state and private),

institutional, ecological, historical, geographic, and economic variation as well as the interactions among actors across scales are critical to understand environment and resource-related development trends in the tuna industry. For these reasons, problem-focused researchers who examine issues that cut across scales are increasingly identifying multiple levels of governance that are situated within the systems of states, in the private sector, and in state-firm relations. These researchers also often incorporate multiple methods consistent with the causal pathways they seek to uncover. By collecting multiple data types (such as interview data, survey data, and quantitative trade or environmental data) and using data analysis methods such as comparative historical institutional analysis, they provide a clear explication of the vertical relationships between institutions, economics, states, and industries that create environmental—and political-economic—trends. They also offer sites to address various challenges.

To employ qualitative methods for multisited GEG research, investigators must manage complex methodological tasks in which they must often undertake fieldwork in multiple geographic sites. They also need to pay close attention to mapping the connections between the sites and to choosing between survey and sampling techniques, longitudinal research, archival research, multiple methods, and multisited ethnographies. In her study of khat in Madagascar and its relationship to deforestation, Gezon (86) discusses a number of the theoretical and methodological concerns of multisited research. She looks at the production of khat through a commodity chain framework, investigating the links between economic processes of production, distribution, and consumption. Recognizing that these interconnected processes occur in “multiple geographically dispersed locations, involving many different actors” (86, p. 238), Gezon demonstrates how an investigator could undertake research in multiple locations by using purposive sampling, interviews, and questionnaires. Accordingly, she explores the ways geographically dispersed

variables affect each other and environmental outcomes.

PAR is based on a long multidisciplinary tradition of community-based research and action pioneered in the fields of international development and critical pedagogy (e.g., 91). As such, it has enabled researchers to focus on the connective tissue between global commodity chains and local livelihoods. Specifically, PAR methods bring together researchers and communities seeking to improve their livelihoods or achieve particular goals (92, 93).

Although scholars initially applied PAR to very local levels, researchers have become adept at using this technique to capture the complexities of nonstate actors and social movements operating at a global level. PAR researchers have, for example, demonstrated how to study the impact climate justice organizations have both on climate activism and within the broader sphere of negotiations (94). In contrast to CEE, PAR does not take a particular mega event as a starting point. Instead, it has focused more on a specific group of actors in one arena or across several action arenas.

The deliberate blurring of traditional boundaries between scholars and subjects is both a strength and potential pitfall of PAR, especially when considering the ethics of working with marginalized populations, which include radical activists at global summits. However, use of the PAR approach gives researchers a coherent framework to engage with movements that cannot “be engaged with using the standard toolbox” (95, p. 1). With PAR, investigators also have a position that enables them to take on the role of “empathetic insider” (94, p. 401; 96) while being able to identify struggles, contradictions, and unintended consequences of group action (94).

Although they sit less easily within a positivist framework, works on ideas and discourses (e.g., 26) often generate rich historical and/or constructivist analysis of the changing content and power of ideas across sites in time or space. Discourse analysis is more often attempted than done well, although some systematic works offer good models: For example, Epstein’s (26)

study of discourses on whaling shows how an antiwhaling discourse cast commercial whaling as bad but aboriginal whaling as acceptable, which impacted a range of practices from bans to decision making in the regime.

Another growing body of qualitative work considers horizontal linkages—linkages across GEG regimes and problem areas at the level of global politics. This work focuses on actors and how they manage interactions or otherwise link across regimes and problem areas, given institutional constraints and opportunities. Examples of such linkages may be across problems (such as between climate change and biodiversity or for ozone-depleting gases whose replacements include highly potent greenhouse gases) or across institutions (such that regime actors may work together to ameliorate potential conflicts or duplicate actions). These insights have helped reenergize work on organizations and bureaucracies in GEG, including treaty secretariats and larger organizations such as the United Nations Environment Programme and the World Trade Organization (52, 97, 98). Others have noted how this system is becoming more than the sum of its parts: Researchers have identified what could be termed global governance “architectures” or “regime complexes” (99, 100) and have drawn attention to “institutional density” (54).

This work has necessitated the use of techniques such as interviews and archival research, often including multisited fieldwork. Researchers then triangulate these methods to pinpoint causal linkages to trace out complex and hard to discover processes and relationships, such as which and how actors influence specific outcomes. Triangulation—the use of multiple methods of data collection and analysis to determine or confirm causal hypotheses with more confidence (12)—will become more important with the emergence of more complex questions and more collaborative or interdisciplinary research designs. Many, if not all, of the authors of works cited in this section discuss the use of multiple methods of data collection (interviews, surveys, archival work, content, and textual analysis) and analysis in their research

(52). Performing triangulation well can, nevertheless, be challenging for a researcher who has not been given training in multiple methods, especially given that many of the methods we cite in this section and below are difficult to master.

4.1.3. Critiques of qualitative methods. A number of developments in qualitative methods have made it possible for scholars to work across scale and sites and to use multiple forms of data collection and analysis to triangulate the data, especially through collaborative data collection. However, these developments also raise a number of practical and epistemological issues. First and foremost, some innovations in qualitative methods that deal with the challenges we outline above have resulted in a movement away from conventional comparative case studies to more ethnographic approaches. Such a move calls for a discussion between political scientists and anthropologists similar to the one that transpired between economists and anthropologists over the study of the commons (e.g., see 101). Even though classic works on multisite methods have been influential for anthropologists (85), they remain of limited utility for GEG scholars, perhaps because the target audience of those works are scholars who have been working intensely at a local or single-site level and want to extend their research to broader scales, rather than vice versa. Furthermore, through a focus on the microlevel and community approaches to governance, studies may lose or attenuate their connection with ameliorating global environmental challenges and/or the construction and impacts of governance institutions with a global reach.

Second, there are a number of practical issues that arise in introducing CEE, PAR, or multisite work. Because they entail working at multiple sites, actively engaging communities in the research design, or utilizing multiple qualitative methods to study the same mega event, these new methodological approaches pose significant challenges for a doctoral student or a junior scholar facing the tenure clock (also see 102). In particular, these studies require significant funding, but more critically,

they also require significant time investments for scholars to work collaboratively as well across multiple sites where research subjects speak different languages (89).

Third, replication remains problematic for qualitative methods, although whether it is possible or even desirable depends on the research question. If the question is about a “case” of something that is part of a generalizable phenomenon, then generalization is a valid goal and further investigation of complementary methods may be desirable. However, as discussed above, qualitative methods are often undertaken precisely because the case is the focus and the goal is to attain “internal validity” by examining how a policy trajectory may unfold. Such an approach is also meant to be highly useful in its application to other cases, such as identifying different types of path-dependent “sequences” that help researchers to uncover “hidden” causal pathways that quantitative approaches in other cases failed to uncover (e.g., 34, 37).

Finally, the complexities presented by contemporary global environmental problems often make it hard for researchers to answer the questions they pose. For example, scholars who have sought to evaluate the potential socioeconomic impacts of REDD+ have encountered difficulties in applying counterfactual analysis given the absence of a baseline “no-intervention case” (103). The need to address this sort of quandary has helped drive growing interest in MSB methods (addressed below).

4.2. Quantitative Methods

Using statistics, researchers can aggregate information across many cases across space and time. This method also allows investigators to draw inferences (104). Thus, quantitative methods, particularly statistical methods, have become an essential component of training and scholarship in IR. However, despite the plea by some scholars for greater use of quantitative methods to study global environmental problems (59), advocates have yet to champion such an approach in ways that explicitly incorporate

the four GEG challenges: complex and unpredictable processes, multiple levels of scale, horizontal linkages, and evolving governance institutions. Nevertheless, promising advances in qualitative and quantitative methods have fostered construction of new data sets and use of innovative methods around data gathering and coding across issue areas and scale. In many ways, GEG scholars are rising to the challenge presented by Nils Petter Gleditsch (105) calling for “major improvements in systematic data collection—a Correlates of War project for the environment” (p. 396). One example includes the Social Conflict in Africa Database, which tracks social conflict events from 1990 to 2011 and has been used to study rainfall variability and social conflict (106). Another area we examine that holds promise is the use of network analysis that enables scholars to make connections across scales and to tease out complex interactions among actors.

4.2.1. Statistical analysis in GEG research.

Although scholars working on GEG have largely employed qualitative methods in their research, a smaller number of scholars have applied statistical methods to the study of GEG, especially pertaining to the study of the formation and effects of international regimes and environmental treaties (32, 107–109). Within the broader field of global environmental politics, statistical methods have been used to study the relationship between democracy and environmental performance (110) and the provision and effectiveness of environmental aid (111, 112). Drawing on new project-level data, for example, recent research on environmental aid effectiveness has shown that the strength of a recipient country’s public sector is likely to influence the success of assistance projects.

With regards to carbon abatement, Dinar et al. (113) have used statistical methods to examine the extent to which better business environments, higher levels of governance, and strong international trade relations have led to cooperation in the Clean Development Mechanism market between certain countries, explaining why China and India are the most

heavily involved. To tackle the question of long-term uncertainty stemming from climate change, Lempert et al. (33) applied statistical methods to examine “past patterns in data and project them into the future” (p. 106). These statistical methods, although not a panacea, may hold some promise, as we discuss below, for forecasting and the development of scenarios.

Scholars are motivated by a desire to advance the field from the collections of case studies that have accumulated in edited volumes to the construction of comprehensive data sets that would allow for more systematic comparisons and analysis across multiple observations (28, 114). By the late 1990s, scholars had begun to utilize the range of data points provided by so many multilateral environmental agreements to construct databases, such as the International Regimes Database, that were designed to foster more quantitative work (32, 115) and formal indices of performance, as in the Oslo-Potsdam solution for measuring regime effectiveness (116, 117). These advances have allowed productive debates over what regime/treaty effectiveness means; how to measure it; and the conditions under which institutions, treaties, and organizations could induce compliance. However, such efforts have often been underutilized, although it is not clear exactly why.

In the field of environmental security and conflict, quantification has shifted away from studies of the various causal relations between environmental scarcity/abundance and/or environmental change and conflict (105, 118) and those between water and cooperation and conflict (129) to examination of the relationship between climate change and conflict. As a result, researchers have begun to quantify, for example, the relationship between temperature and/or precipitation and civil war and/or social unrest (106, 119). Although such studies have forced scholars of global environmental politics to shift away from descriptive case studies and to draw broader generalizations about environmental factors and political outcomes (e.g., the relationship between climate variability and conflict), they do not elaborate on the contingent causal mechanisms that may explain how

conflicts transpire (120). Furthermore, they do not explain or capture relationships that transpire across scale. As a result, questions that concern GEG scholars pertaining to how climate change could undermine human security, resilience, and state capacity and, thus, could increase the risk of violent conflict are harder to approach using these methods alone (in contrast, see 121).

Thus, quantitative approaches also have limitations for studying questions that confront GEG scholarship today. First, these methods require already-available data and as such cannot be applied to the study of ongoing processes, which often comprise complex, multiscalar, and linked problems. Because many problems that confront GEG scholars deal with ongoing environmental issues, the focus on produced data often does not comport with the need to explain process and causal mechanisms that are constantly being updated and shifting. Second, quantitative studies often take what may be considered an overly pared-down approach to causal relationships. For example, the literature on the effects of democracy on the environment mentioned above finds an insignificant effect (110). In contrast, qualitative research has demonstrated not only the existence and complexity of this relationship, but also many mechanisms that shape its form from case to case (122, 123).

However, such a limitation does not have to result from a quantitative approach. For example, where the literature on resource wars has tended to conflate the link between oil and international conflict, Colgan's (124) statistical study provides a more nuanced account that examines the role of revolutions and revolutionary governments. In a different vein, Axelrod (125) uses statistical methods to examine the extent of the "chilling effect" in trade-environment politics, and the fsQCA work cited above seeks to bridge the "qualitative/quantitative" divide. Bernauer et al. (126) find a "democracy-civil society paradox" in global environmental governance that had eluded qualitative researchers and that calls for additional research. Hence, the fault of some

earlier-cited quantitative studies lies less with the method per se than with the sorts of questions researchers use these methods to address or, indeed, their pursuit of often purely binary answers to those questions. One of the main strengths of quantitative approaches is their ability to address the limitations of qualitative methods for achieving external validity. However, even methodological critiques toward the quantitative end of the spectrum (such as matching-based statistical, pseudoexperimental, and experimental approaches) are valid only for the universe of cases they examine, which may be limited in the GEG field (see 127, 128).

4.2.2. Data collection and database construction across scale.

Quantitative approaches can, and ought to be, part of the global environmental politics methodological tool kit. Such an orientation has proven fruitful, especially as scholars have begun to utilize innovative techniques for data collection and construction of large-*N* databases for individual and collaborative research that extends across scale (including both ecological and human/political). For example, scholars have started addressing a wider range of real-world outcomes and impacts of GEG, moving beyond their early emphasis on questions of formal institutions and compliance. In part, this trend is led by greater data availability on ecosystem impacts and by the greater sophistication of tools and methods for mapping, estimating, and modeling environmental change. Others have turned to large-*N* quantitative studies to generalize results and correlate variables across a large number of cases (e.g., 53). The construction of the Transboundary Freshwater Dispute Database, housed at Oregon State University, has enabled scholars to dispute systematically the proposition that riparian states are more likely to engage in conflict over their shared water resources (129, 130). The existence of such a large database has allowed subsequent scholars to examine the design of the treaties that comprise the database for more specific questions that address temporal, spatial, and jurisdictional scales (131). Likewise, the

construction of the AIDData database, housed at the College of William and Mary and consisting of information on aid activities worldwide, has come with a resurgence in the application of quantitative methods for analyzing the delivery and impact of aid (132, 133).

The International Forestry Resources and Institutions (IFRI) database, housed at the University of Michigan, focuses on examining how governance arrangements affect forests and forest-dependent communities. With it, researchers are attempting to generate a systematic way of collecting data about institutions and outcomes as well as a rich data set that spans the globe. Starting in 1993, data have been collected using 10 core measurement protocols that encompass biophysical measures of forest conditions, climatic and soil conditions, demographic and economic indicators about forest users, and details on institutions (134). Unlike many other databases mentioned above, the IFRI data set relies on a process of collaborative engagement of scholars working independently at different sites across the globe, collecting the same set of information repeatedly at many sites every 3–5 years (134). Collaborative data sets are likely to become more commonplace, especially as the Internet facilitates data sharing and access. A less systematic, albeit collaborative, data set is Aquapedia. According to its website (<http://sites.tufts.edu/waterdiplomacy/aquapedia/>), it is an interactive repository of “water management information and wisdom collected and synthesized by users and producers of explicit (water information) and tacit (water wisdom) knowledge” where individuals can directly submit case studies of water basins. Housed at Tufts University and with National Science Foundation funding, the repository relies on crowd sourcing for its contents.

IFRI’s innovation has been to probe correlations between biophysical data and socioeconomic and institutional data in specific sites, shedding light on the causal pathways through which institutional architectures impact livelihoods and forests. Such databases are

increasingly relevant for GEG studies in at least two ways. First, their methodological approach is geared toward uncovering causal mechanisms in governance arrangements, which can be informative for GEG scholars and may be adapted for use at multiple scales. Second, because the IFRI database contains information on more than 250 sites across 15 countries from 1992 to the present, the data allow for cross-case comparisons that can inform how new governance arrangements are developed at multiple scales. To date, researchers have drawn on IFRI data to answer questions about the effectiveness of different types of forest governance approaches and arrangements that are useful for forest protection within local institutional settings (135). Researchers have also used these data to examine the extent to which monitoring and enforcement of rules are necessary conditions for successful commons management (136). Although few metastudies using IFRI data currently exist (but see, e.g., 137), such data sets are likely not only to help scholars identify phenomena across multiple scales but also to tease out the interactions among different variables in complex socioecological systems.

Despite the potential usefulness of IFRI and other large databases for the study of GEG, some limitations should be noted. First, data collection for IFRI is enormously intensive and requires substantial resources both in the field and to process the data once they are collected. A significant portion of the IFRI data is qualitative and must be coded and quantified—i.e., by assigning a numerical value for each data point to turn words into numbers—to be used for large-*N* studies. What is coded also affects the questions we ask and the results identified: McDermott et al. (138) suggest that, even though regulatory practices are recognized as essential to understanding forest management practices, they are often not systematically coded given their measurement complexity. Furthermore, by coding, categorizing, and assigning numerical values to the ideas, opinions, recollections, and reflections provided by informants, much of the richness of the qualitative data is necessarily lost as the data become

simplified (139). Balancing data richness versus generalizability is perhaps one of the most significant trade-offs that researchers confront when navigating their methodological choices.

4.2.3. Using network analysis to map complex relationships.

Network analysis is an innovative method applied to study relationships either among large numbers of actors or between complex human and natural systems. It often utilizes the sorts of databases described in the previous section. According to Johnson & Griffith (140), network analysis can be used to reveal patterns that would not be evident with other methods that are less systematic. For example, by mapping the formal resources and informal social resources in the aftermath of a hurricane, it can help to explain the evolution of cooperative networks in a village, development of social capital, diffusion of knowledge, or the ability to recover from a disaster (141). It has the potential to be used by GEG researchers in conjunction with spatial analysis using geographic information system (GIS) techniques (142).

Fisher and colleagues (143) have used network analysis to analyze hearings on climate change within the US Congress: They mapped out the ideological relationship among different types of speakers providing Congressional testimony on the topic. In contrast to studies that examined the relationship between subnational and national policy making (e.g., on federalism, see 144) in the United States, network analysis allowed these researchers to focus on the specific role and coalitions of actors involved in the policy-making process. In addition, they used a tool developed by Leifeld and colleagues (143)—which has some similarity to NVivo, a popular tool for qualitative data analysis—to code the content of testimonies from Congressional hearings and then analyze it to assess relationships quantitatively between types of actors, the discourses they supported or promoted around climate change policy, and the strength of the common discourse ties among them. Network analysis of this type allows a more systemic treatment of discourse than could be accomplished using only qual-

itative analysis of congressional testimony. It also creates a way to visualize polarization and coalitions of types of actors at different times. However, to code the discourses correctly, researchers must make qualitative judgments about what speakers meant, making this process quite labor intensive.

Network analysis has also been used to understand the complex institutional landscape governing climate change with the rise of a large number of competing as well as overlapping institutions at the global, national, and local levels for dealing with climate change. Green (145) used network analysis to examine a new data set of private standards for managing greenhouse gas emissions to demonstrate the compatibility among those standards and the order that exists within such an institutionally complex landscape. Although network analysis is useful for mapping these relationships, Green's study also underscores the importance of other conventional qualitative methods, such as semistructured interviews, to explicate the motivations of the standard setters.

Some scholars are expanding network analysis so that it integrates qualitative data with inferential statistics to make causal inferences about the impact of network membership. For example, Cao (146) has used network analysis to look at the relationship between participation in intergovernmental organization (IGO) networks—that is, countries sharing participation in particular IGOs—and the particular type of IGO to explain policy diffusion and convergence. Simplifying a complex methodology, Cao argued that different IGOs depend on different mechanisms (some are more coercive, others reflect learning environments) and then used network analysis to see if network linkages among states and the IGOs led to convergent policies and what type of diffusion mechanisms were most likely at work (coercion as opposed to learning, for example).

Although all these examples show the power of network analysis to establish patterns and, when combined with statistical tools, to make inferences about network effects on outcomes, care is required in research design owing to the

characteristics of environmental governance noted above. For example, studies of diffusion (e.g., 146) assume states are the repositories of environmental policy. By contrast, other studies (e.g., 145) more self-consciously turn the lens on standard setting bodies for which governance is increasingly occurring, thereby providing data that would not be captured by a network analysis of states and IGOs. Similarly, Paterson et al. (147) used network analysis to examine policy diffusion regarding the idea of carbon markets, but they looked at networks of individuals who interacted with various “venues” where carbon markets were promoted or developed, almost none of which were states in the initial adoption period. Instead, the main venues were in an international agreement (the Kyoto Protocol, though that did not develop as an operational system), a supranational body (the EU Emission Trading System), and subregional systems in US states and Canadian provinces. Network analysis of all the individuals involved in these policy processes revealed, among other things, different clusters of actors who largely independently developed emission trading in the United States and Europe. To trace accurately the flow of ideas under conditions of complex or polycentric global governance, researchers also had to combine that work with qualitative analysis. Such analysis revealed a picture of diffusion different from the one that would have developed from a study focused on states that adopted emission trading or a study that looked only at qualitative data about which states pushed the idea in international gatherings. The latter approach would have erroneously led to the view that emission trading was largely a story of US coercion.

The above sections identify the benefits of methods within qualitative and quantitative techniques as well as the key gaps each family of methods displays in addressing the four challenges relevant to GEG scholarship reviewed at the beginning of this article: unpredictability, multilevel governance, ongoing evolutionary change, and dueling objectives. Partly as a result, recent innovations in the methodological area of MSB are relevant for addressing the

problem of change in open systems, where contingency, complexity, and possible nonlinearities and system shocks mitigate against prediction in the positivist sense.

4.3. Modeling and Scenarios

MSB has become a widely employed method for examining GEG, but scholars of global environmental politics have not always joined in these efforts, with the exception of a small body of work on game theory and GEG (148, 149). In this section, we begin by defining models and scenarios and noting the limited, but emerging, role of GEG scholarship in MSB through examples from climate policy modeling and the development of climate scenarios. We use a recent set of articles on the sensitivity of climate outcomes to geopolitics to highlight both the potential and the challenges of a more robust role for GEG in global modeling. Finally we address the potential of MSB to address uncertainty and complexity in GEG evolution. MSB exercises are fertile terrain for the sort of scholarly exchange essential to support GEG. Such interactions may be marked by debate, but ultimately, and in the right hands, the exactitudes and uncertainties that MSB activities and outcomes elicit can help researchers to reconcile disparate ideas, theories, and bodies of evidence.

4.3.1. What are models? Models are simplified or idealized representations of structures, systems, and agents. They can be made of clay, binary code, mathematical equations, collections of ideas, or any other medium. They are not necessarily mathematical and can be qualitative (150). A novel, for example, is a model representing social relations, just as an integrated assessment model represents global environmental processes (151). Modeling activities may be fully inductive, fully deductive, and anywhere in between (152). Models may be used to develop stories and representations about any moment in time (both future and past periods) and to articulate how periods relate to each other.

Experiments and theories are also models. The aim of experimentation is to create

constrained, idealized model worlds. Experimentalists tell special, often falsifiable, stories—theories—to argue how experimental worlds represent elements of the “real” world. Thought experiments are models constructed of prose and integrally intertwined with theories explaining their implications. Thus, theories, by definition, at minimum have models as their foundation. Sometimes, the boundary between theories and models can be undetectably vague.

Models further contribute to the production of knowledge both through their construction and their use (153). The act of model making may prompt model builders to describe and explore more formally the relationships and contingencies of the systems that they study. Although such modeling can and does generate surprises, it cannot elucidate factors unknown to model makers unless it contains autonomous agents, as are found in experiments (154).

4.3.2. What are scenarios? Scenarios are collections of two or more stories assembled to elicit attention about processes of change (155). Scenarios overtly and covertly reflect the priorities, assumptions, and goals of those who develop them. For example, any one scenario or collection of scenarios may be designed to be plausible, may be designed to be controversial, or may be designed to be a hybrid of controversy and plausibility (156). We use the term scenarios to refer to both the process of assembling scenarios and the outputs of these processes. These products are individual stories and story collections; the processes can comprise the development and/or the use of story collections.

The evolution of the Intergovernmental Panel on Climate Change (IPCC) scenarios gives a sense of the breadth and varying depth of GEG-relevant scenario-making activities with respect to GEG themes. The first set of IPCC scenarios, the IS92 scenarios, were basically stories of “how future greenhouse gas emissions might evolve in the absence of climate policies beyond those already adopted” (157, p. 73). The IPCC’s characterization of these worlds as varying widely meant strictly that “the resulting

range of possible greenhouse gas futures spans almost an order of magnitude” (157, p. 73).

Another IPCC scenario set, the Special Report on Emissions Scenarios (SRES), more explicitly narrates a socioeconomic context for emissions pathways. Split into storylines A1, A2, B1, and B2, the SRES tells stories of four different groups of mid-twenty-first century worlds—A1, a world of rapid growth and technology development; A2, a heterogeneous, fragmented world of slower economic growth; B1, a dematerializing world with economic growth to rival A1; and B2, a world with effective local sustainability efforts.

The latest effort, the Shared Socioeconomic Pathways (SSPs), provides further detail about institutional and political elements of potential future worlds. The pathways are “Sustainability,” “Middle of the Road,” “Fragmentation,” “Inequality,” and “Conventional Development.” Within SSPs, there is greater GEG-salient nuance such as the representation of inequality within nations in addition to inequality between nations. Indeed, a number of GEG scholars have contributed to the development of the SSPs.

In MSB-based assessments of the global costs and impacts of climate change, the boundaries between scenarios and models sometimes blur. Some assessments start with scenario building, others with model making. Construction of the SSPs began with premodeling. The outcomes of these efforts form the grist for the formation of the narrative SSP scenarios. The SSPs determine how modelers prepare their models for simulations. Ex post, there are consistency checks between the assumptions and stories as well as across models.

As the evolution of GEG depth within IPCC scenarios indicates, the climate modeling community has begun to place a heightened emphasis on politics and institutions. To underscore the importance of GEG themes to climate outcomes, Rogelj et al. (158) showed that politics are the single most important determinant of how much the Earth may warm in the coming decades. A 5- or 10-year delay in the development of a climate treaty could create irreversible

INTEGRATED ASSESSMENT MODELS

Integrated assessment models (IAMs) aim to represent complex environmental problems, to identify potential solutions to these problems, and to orient future research. IAMs are so termed because they are used to integrate information, theories, and laws from multiple disciplines. Compared with climate and other Earth system models, IAMs tend to include some social, economic, and political variables in addition to biophysical variables. Some IAMs contain enormous complexity, run on supercomputers, and are primarily the domain of IAM experts. Other IAMs are built parsimoniously with the goal of encouraging broad literacy and usage. One example of an IAM built to incorporate social science—albeit largely economic—variables is the DICE (dynamic integrated climate economy) model, whose development was led by Dr. William Nordhaus. Used by the US Environmental Protection Agency, among others, such models are important—although it is not entirely clear how far they are able to incorporate the sorts of issues that concern other social scientists and humanities scholars. As we argue, there is much room for scholars of global environmental governance to engage in IAM building and development.

damage to the Earth system. That the comparison of magnitude of political uncertainty with other sources of uncertainty was the primary innovation of the paper is an indicator of the newness of the theme.

GEG scholarship can help the climate MSB community to develop scenarios that treat political and institutional themes with more sophistication. Its insights into the causes, dynamics, and consequences of fragmented and networked climate governance could be a rich addition to climate modeling (99). In fact, the fragmentation literature is the basis for a new class of climate modeling exercises that seek to explore the implication of uneven and unilateral climate policies (but see, for example, 159, 160). These analyses may be messy, but they are a more plausible representation of climate institutions than analyses that represent government restrictions on greenhouse gas emissions as global and monolithic (see, for example, 158, 161).

GEG themes and theories can be more than just scenarios—they can be components of climate models that interact with other elements of the modeled Earth system. Several recent articles use different MSB approaches to demonstrate how scientific uncertainty about the impacts of GHG emissions may have a chilling effect on international collective action to fight climate change or may warp the impacts of climate interventions (148, 162).

However, in circumstances of great complexity and deep uncertainty, efforts to establish bounding ranges around problems can also be inaccurate (163). A grand challenge for MSB is to communicate contingencies and uncertainties. Communicated poorly or taken out of context, model results can be interpreted as predictions and/or explanations when they are instead representations of unknown elements and interactions. In this way, GEG-focused MSB practitioners share several aims and challenges with those engaged in the broader scholarship in the area of global environmental politics. Both groups seek out the unpredictable, evolving, complex, and uncertain nature of GEG, and both are concerned with interactions that cross multiple scales and that are horizontally linked (164).

The shared challenge presents an opportunity for a transdisciplinary conversation about doing and about how to communicate research on complex systems. We see potential for part of this conversation to happen within modeling exercises that involve GEG scholars. Models can provide a space for scholars to convene to pool resources and expertise. From regime databases to integrated assessment models, this pooling can make the whole greater than the sum of its parts (see sidebar Integrated Assessment Models). The standards and exactitudes of models can also promote discursive clarity. Clear communication within model groups and clear documentation of model approaches are imperative, however, to avoid models that carry an imprimatur of harmony even when they are internally inconsistent.

Furthermore, MSB of GEG has tended to focus on the “easy problems” that “God gave physicists” (to paraphrase an article that argues evolutionary biology is a more productive analogy than classical physics for social sciences) as opposed to the complex, messy problems that GEG scholars tackle (34). Biophysical Earth models represent physical processes according to the laws of classical physics and the equilibriums that these laws predict. Likewise, models of the world economy often assume an overarching set of governing principles that suggest the possibility for steady states and equilibriums. The problems of physics and economics are not actually easy. Rather, fairly universal theories provide these simplified representations.

Meanwhile, scholars in the broader GEG field focus on norms, values, politics, and cultural proclivities. Few see these elements of GEG as having equilibrium characteristics or even the stability to be represented with straightforward functional forms. These are the elements of the Earth system that create fat tails, uniform distributions, and black swans: in other words, highly unexpected outcomes that are not predictable, no matter how many data points on previous similar events have been collected. GEG themes are the elements that generate the most climate uncertainty (158). Because GEG scholars tend to be suspicious of approaches that lead to narrow conclusions about complex environmental systems, they can help to enrich MSB. In turn, by participating in MSB, GEG scholars can benefit from rich and meaningful interactions with other researchers seeking to understand and inform GEG.

5. STRATEGIES FOR PROBLEM-DRIVEN GLOBAL ENVIRONMENTAL GOVERNANCE RESEARCH

We argue that contemporary GEG researchers face four challenges identified at the outset of this article—unpredictability, complexity, linkages, and scale. As Miller et al. (165, p. 4) point out, “[n]ormal science has become less capable of addressing complex social-

ecological interactions in particular, and less resilient to dramatic changes in the societal demands for knowledge and to revelations from ongoing research that demand reconsideration of accepted theories” (166, 167). Or, as Andonova & Mitchell suggest (30, p. 258), “rescaling of environmental politics reflects both an ontological shift driven by increasingly interdependent countries facing increasingly complex and interconnected environmental problems and an epistemological shift driven by scholars studying global environmental politics with increasingly interdisciplinary and diverse theoretical frameworks.”

Designing the rigorous, applied research projects that are needed to address global environmental problems in the context of these challenges and in broader research contexts that downplay or do not create incentives for applied work may pose significant obstacles for the individual researcher. In the above sections, we identify some tools and approaches as well as debates around specific techniques. This section pulls together some of the common themes of these debates and discusses possible strategies researchers can adopt. We examine the potential of multiple methods and collaborative research. Although these are not necessary for successful applied research, many and various forms of collaboration and methodological pluralism exist, making it possible for even the most individualist researcher to draw on different analytical traditions and data sources. Undergirding these strategies is a need for researchers to be more reflective about their methodological choices, especially when researchers face the dilemma of choosing among a wide range of possible methods and research designs (also see 27). We likewise echo a need for pragmatism in real-world applied research design. Among other implications, this means that researchers do not always need to reinvent the wheel: The above analysis shows that GEG researchers across disciplinary traditions still use many long-extant tools for data collection and analysis, albeit in different ways and in different sorts of contexts.

5.1. Multiple Methods

A small but thriving body of literature has begun to examine how to incorporate both multiple methods and plural epistemologies (165, 168) into reflective research designs and how to bridge disciplinary divides; this approach has already taken hold in literature on the commons at the local level (101, 102, 169), which goes beyond similar attempts that have not yet managed to break out of the constraints of political science (e.g., 170). Miller et al. (165), for example, call for “epistemological pluralism,” which “recognizes that, in any given research context, there may be several valuable ways of knowing and that accommodating this plurality can lead to more successful integrated study” (p. 1).

Multiple methods or what have also been referred to as mixed methods within the political science canon can take many forms, but they have often brought together qualitative and quantitative methods to answer a research question. In Section 4.1, we discuss the significance of triangulation, i.e., the use of multiple methods to get a firmer fix on a complex research question. Betsill & Corell (12), in particular, have demonstrated that multiple data types and methods are essential for understanding the different ways through which NGOs exert influence on international environmental negotiations. However, the use of triangulation is not confined to qualitative research. It is helpful in establishing causal relationships by applying both qualitative and quantitative insights that add up to a more complete picture. Snow’s identification of cholera as an infectious disease provides a classical depiction of this approach: He performed a qualitative study to identify victims, then a statistical analysis to identify contaminated drinking water as the source (171). This study advanced the field of epidemiology, and utilizing both qualitative and quantitative data, statisticians and political scientists have championed it as a methodological breakthrough for showing the importance of causal inference (172).

Within the study of regime effectiveness, Young (10) has called for scholars to use multi-

ple methods whenever possible to tackle many of the same challenges we describe above and, in doing so, “to think in terms of a methodological portfolio or toolkit containing a range of distinct but complementary modes of analysis” (p. 19858). Mitchell & Bernauer (173) suggest that more large-*N* studies can complement qualitative studies and ultimately facilitate triangulation. Studies of regime effectiveness concur that, to grasp fully patterns of regime effectiveness and causal mechanisms (including the role of power), qualitative methods must be combined with quantitative methods (72).

As an example of the effective use of multiple methods, Cashore et al. (70), in their comparative study of forest certification, first applied survey data and analysis to map out the broad terrain and assess support and interest in the targets of this innovative market mechanism. Drawing on these quantitative data, they then developed questions and concepts with which to undertake careful casual historical process tracing and structured focused comparisons to get at questions of why some countries adopted certain forest certification programs and others did not. Their work shows how such an approach can generate exploratory, descriptive, and explanatory research that would not have been possible by applying only a single method or bringing a single researcher’s perspective to bear. Another area where there may be a growing desire for multiple methods with GEG research is with the use of spatial analysis (GIS) (27), especially to deal with issues of multiscale and the interface between human and ecological systems. GIS technology can help researchers to visualize boundaries and relations among people and their environment as well as to bring policy and science together so as to better address environmental problems (174).

One of the debates around multiple methods, especially mixed methods, has to do with their commensurability (168): Do they add up to more than the sum of their parts, or can they reflect yet another form of methodologically driven research? Can methods that reflect very different epistemologies be brought together effectively? And how can research design take

into account multiple epistemologies or ways of knowing? Miller et al. (165, p. 4) argued that “ignoring the role of multiple ways of knowing, process, etc., in interdisciplinary research can torpedo efforts from the beginning.” Poteete et al. (102, p. 13) further pointed out that the “use of multiple methods, however, does not guarantee methodologically superior social science research.” Seen in this light, we argue that methods must be justified in their ability to address an environmental challenge that initially motivated the research as well as the implications and challenges of the range of methodological choices scholars will necessarily have to make. Many mixed-method theorists explicitly call for a pragmatic approach to social science research: Small (168, p. 60; paraphrasing 175, p. 8) noted that “pragmatism encourages researchers to set aside considerations about what is ultimately true in favor of what is ultimately useful and to remain comfortable with uncertainty and that it orients itself toward solving practical problems in the ‘real world.’”

5.2. Collaboration

One of the challenges of multiple methods concerns whether individual scholars need to be well versed in a suite of methods, often ranging from quantitative to qualitative methods, or whether the use of multiple methods also calls for collaborative and interdisciplinary undertakings. Increasingly, collaborative research is viewed not only as central to fostering interdisciplinary research, but also as the foundation upon which multiple methodological approaches can be applied to solve problems (e.g., 102). One of the desirable aspects of collaboration and the use of multiple methods fosters greater generalizability and breadth of studies: Investigators are able to work at multiple field sites and across scale simultaneously, and they can foster greater comparability.

Within the study of GEG, encouraging signs indicate that collaboration is becoming more widespread. Research on GEG has resulted in collaborative endeavors, such as the Global Governance Project carried out by 13

European research institutions, that have examined different components of GEG, ranging from public-private partnerships to regional governance arrangements. Research on international regime effectiveness has led to the development of collaborative research teams as well as looser networks of researchers (10). In particular, collaboration was instrumental in creating the International Regimes Database (72).

Collaboration can be organized in a number of different ways. Scholars—faculty, postdoctoral researchers, and graduate students—may work and publish in groups. Others (as with the CEE approach discussed above) may work jointly to collect data that are then used in individual or joint projects and increasingly made publicly available. Yet others may be far more loosely organized around a single theme, for instance, or source of funding, thus enabling more individual outputs.

The main constraints, however, to encouraging collaboration outside of interdisciplinary programs are the traditional means by which junior scholars are evaluated within disciplinary departments. For collaboration to be more commonplace, universities will need to make a firm commitment to junior scholars that their efforts to work outside of the conventional mores will be given equal weight. In addition, although collaboration (for example, in lab groups) is a common feature in the natural sciences, it is far less prevalent in the social sciences and humanities. As a result, researchers in the latter disciplines face more difficulties in their attempts to draw on established norms and practices over, for example, ownership of data or author accreditation. Notable exceptions include the humanities labs at the Franklin Humanities Institute at Duke University as well as those at Stanford University.

6. CONCLUSION

This review has surveyed appropriate methods for studying GEG and has connected this discussion to broader debates about methods and research design in the social sciences.

The above analysis demonstrates that great advances have been made in developing research methods relevant for GEG scholarship, especially for handling historically complex causal processes and meeting the challenges of developing theory that is critical for problem solving. Old tools are being applied in new ways, and traditional divides between quantitative and qualitative methods of data collection and analysis are breaking down. However, methods and their applications have often remained underexplored, and in published work, many researchers only implicitly connect their methodological choices to address effectively the problem at hand.

To advance these explorations, GEG research and methods must begin by being consistent with and incorporating the four unpredictable, multiscale, horizontal, and evolutionary challenges that frame this review. Accordingly, scholars must be reflective about the most appropriate methodological approaches for the question they are addressing, rather than limiting their choices to preexisting preferences or the techniques that their home institutions emphasized. Breaking out of these biases means consciously embracing methodological pluralism. This will not be easy,

however, because it means figuring out ways of moving beyond one's own disciplinary or interdisciplinary comfort zones. Studies that are too narrow in their approach and design lose sight of bigger questions and concepts. As a result, they forego the possibility of contributions to interdisciplinary collaborations about GEG in general and problem solving in particular. To help in this endeavor, our review has identified an expanding toolbox of methodological approaches available to scholars that is likely to generate innovations in data collection, collaboration, and new modeling tools. In addition, although canon may be too strong a word, there now exists a substantial range of published works that utilize these techniques and may be contributing to the expansion of GEG articles that are more explicit about methodological techniques employed, as we found over time in our survey of articles in *GEP*. Overall, our analysis suggests that many avenues are available for GEG scholars as they move forward and design problem-focused research that deals with pressing issues facing the global community. Some involve more collaboration or retraining than do others, but in all cases, reflection and methodological pluralism are required to generate rigorous and relevant research.

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