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Collaborative Governance of Climate Change Adaptation Across Spatial and Institutional Scales

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We examine two related questions that are key for understanding collaborative outcomes in complex governance systems. The first is the extent to which collaboration among policy actors depends upon their joint participation in policy forums. The second is how the scales at which these forums operate conditionally affect the likelihood of collaboration. We address these questions using data from a recent survey on actors' collaborative interactions as well as their participation in climate change adaptation policy forums in the Lake Victoria region in East Africa. Exponential random graph models show that actors are more likely to collaborate if they jointly participate in policy forums. However, this effect weakens at progressively higher spatial levels at which forums operate. Similarly, collaboration is less likely among actors jointly participating in forums that sponsor decision making at the higher collective choice level rather than lower operational choice level. While policy forums may catalyze collaboration, our findings suggest that their capacity to do so may be subject to scale-dependent transaction costs of political contracting.

KEY WORDS: climate change adaptation governance, spatial and institutional scales, East Africa

我们分析了有关理解复杂治理体系的合作结果的两个关键性问题。 首先是政策行为者间的合作程度取决于多个政策论坛中他们的共同参与。其二是这些论坛的运行规模如何有条件地影响了合作的可能性。我们通过使用对东非维多利亚湖地区行为者的调查问卷回答了以上问题。这一问卷针对的是这一地区行为者的合作互动和他们对适应气候变化政策论坛的参与。指数随机图模型表明共同参加政策论坛的行为者更容易合作。然而， 这个效果随着论坛运行的空间范围的扩大而逐步减弱。相似地， 当一个论坛主办方的决策在更高的集体选择层面而非在更低的操作选择层面时, 参加同一政策论坛的行为者更不易合作。尽管政策论坛可能催化合作, 我们的结论表明它们实现这一催化作用的能力可能会受制于由规模影响的政治合同的交易成本。

Introduction

This paper explores two core questions on how policy actors collaborate to address collective action problems in complex governance systems. First, do institutions facilitate collaboration? We hypothesize that policy actors are more likely to collaborate with one another when they jointly participate in formal and informal

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institutions, which we term "policy forums." Second, how do different notions of scale influence the transaction costs of collaboration? Here, we argue that the likelihood of collaboration between two actors is partly a function of the geographic scope and level of decision making of the policy forums in which they jointly participate. We empirically examine these questions in the context of climate change adaptation governance in the Lake Victoria region, in East Africa, in which diverse sets of policy actors participate in numerous policy forums to address climate change issues such as the adaptive capacity of cropping and pastoral systems, as well as small-scale fisheries.

The relationship among institutions, networks, and collaboration is one of the most enduring questions in political science (E. Ostrom, 1998, 2010a), and has fueled a literature spanning many subfields. Public policy and public administration scholars focus on the concept of collaborative governance, where institutions facilitate the formation of policy networks among diverse types of political actors (Ansell & Gash, 2008; Calanni, Siddiki, Weible, & Leach, 2014; Provan & Milward, 2001). The structure of collaborative policy networks is influenced by institutional and network-level variables (Bodin & Crona, 2009; Lubell, Schneider, Scholz, & Mete, 2002), along with individual-level variables and actor strategies (Carlsson, 2000; Carpenter, Esterling, & Lazer, 1998; Knoke, 1998). Scholarship on the dynamics of urban and local politics has highlighted the role of collaborative policy networks in conflict resolution and the coordination of service delivery (Feiock, 2007, 2009). In international relations, analyses of institutional structures have shed light on the emergence of boundary-spanning collaborative networks as well as the determinants of actor behavior (Haas, 1992; Young, 2005). For example, Keohane (2005) argues that despite the decentralized nature of international governance systems, institutions can promote cooperation among state actors by lowering the transaction costs associated with uncertainty and monitoring. Much of this research has focused on environmental policy and politics because of the many collective action problems involved with environmental issues.

Our analysis extends this field of research in two crucial ways. First, we grapple with the structure of collaborative interactions among actors in complex governance systems, in which numerous policy forums contribute to the design and implementation of policy (Berardo & Scholz, 2010; Calanni et al., 2014; O'Toole, 1997). The degree to which multistakeholder decision-making processes foster collaborative problem solving is a core question in environmental governance research. This present paper is one of the first to empirically test whether actors who jointly participate in policy forums are more likely to have collaborative relationships (see Fischer and Sciarini [2016] for another recent test), which are a necessary condition for solving collective action problems in regional environmental governance settings.

We then open a new vein of scholarship on the relationship between institutions, networks, and collaboration by assessing the degree to which collaboration depends upon the scale at which policy forums operate. In so doing, we address the long-standing question raised by E. Ostrom (1998, p. 9) about which features of institutions facilitate cooperative outcomes when actors confront collective action problems.

We argue that two different types of scale influence the transaction costs of collaboration when actors jointly participate in policy forums. Geographic scale refers to the size of the policy forum's jurisdiction (e.g., national vs. regional), while institutional scale refers to whether actors collectively contribute to decisions about policy implementation (guided by lower-level operational choice rules) versus policy design (guided by higher-level collective choice rules). New institutional economics argues that collaboration occurs when the benefits of solving collective-action problems outweigh the transaction costs of discovering, negotiating, monitoring, and enforcing political or economic agreements (Coase, 1960; Eggertsson, 1990; North, 1990; Williamson, 1981, 1988). Policy forums that reduce the transaction costs of collaboration are expected to be more efficient and preferred by the actors involved. As we argue in detail below, the transaction costs of collaboration vary across spatial and institutional levels. Our analysis thus provides a strong theoretical basis for understanding multilevel institutional arrangements, which is a core theme in the literature on governance and polycentric systems (Berardo & Lubell, 2016; Galaz, Crona, Österblom, Olsson, & Folke, 2012; E. Ostrom, 2010a, 2010b; V. Ostrom, Tiebout, & Warren, 1961).

Second, we bring political economic theory to bear on one of the most global collective-action problems—climate change adaptation—which has not received enough attention in political science (Javeline, 2014; Keohane, 2015; Keohane & Victor, 2011). Because climate change has heterogeneous local impacts, it is important to analyze regional governance. We focus on the Lake Victoria region of East Africa, which like most regions of the world features a complex governance system in which actors participate in many different policy forums ranging across spatial levels from international to local, as well as institutional levels that span collective choice and operational choice decision-making processes. At the same time, Lake Victoria provides a useful comparative perspective on the structure of climate change adaptation policy networks in regions of the world where a lack of political capacity among national governments fosters a heavy reliance on international nongovernmental actors and transnational advocacy coalitions. Over the past several years, heightened attention to climate change has significantly restructured the policy landscape within the Lake Victoria region, resulting in the creation of new policy forums, the expansion of some actors' mandates, and the growing need for policy-relevant information on likely effects of climate change. In this context, research can provide insight into the emergence of international governance regimes, where multiple international agreements affect the transaction costs of cooperation among countries (Keohane & Victor, 2011).

We draw upon data from a survey that simultaneously measures whether actors jointly participate in policy forums and whether those actors have bilateral collaborative relationships in policy networks. By measuring joint forum participation separately from collaboration, we avoid making the assumption that the two are synonymous. In reality, actors may sit across the table from one another in a policy forum but never interact or engage in collaborative efforts to address adaptation challenges. Similarly, actors that do not jointly participate in policy forums may collaborate. Our findings suggest that on average joint participation is correlated with a

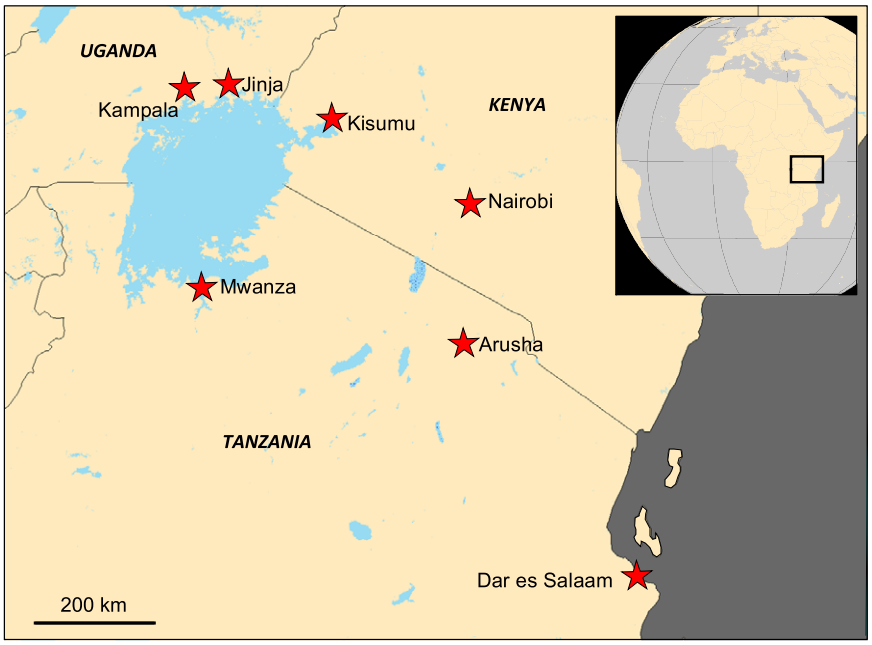

Figure 1. Map of the Lake Victoria Region in East Africa, with Fieldwork Locations Indicated.

collaborative policy relationship, but that collaboration is significantly less likely among actors participating in forums that operate at higher spatial or institutional levels.

The Ecology of Policy Games for Climate Change Adaptation in the Lake Victoria Region

We study how policy actors collaborate to address climate change adaptation challenges in the Lake Victoria region in East Africa. The study system, defined by a mix of ecological and political boundaries, spans territories of Uganda, Kenya, and Tanzania that lie within the Lake Victoria basin, as well as the administrative centers responsible for decision making within the basin (Figure 1). Nearly all climate models agree that over the next several decades the Lake Victoria region will experience warming and more intense precipitation events (Bindoff et al., 2013; Emori & Brown, 2005; Tebaldi, Hayhoe, Arblaster, & Meehl, 2006; Van Oldenborgh et al., 2013). These changes will affect small-scale agriculture (Schmidhuber & Tubiello, 2007; Thornton, Jones, Alagarswamy, & Andresen, 2009), pastoralism (Bond & Midgley, 2012; Kulmatiski & Beard, 2013; Thornton, van de Steeg, Notenbaert, & Herrero, 2009), and fishing (Balirwa, 1995; Ficke, Myrick, & Hansen, 2007; Hecky, Mugidde, Ramlal, Talbot, & Kling, 2010), among other economic sectors. Endemic poverty, poor infrastructure, and dependence on rainfed agriculture (Adger, Huq, Brown, Conway, & Hulme, 2003; Conway, Allison, Felstead, & Goulden, 2005) further increase the vulnerability of these climate-sensitive livelihoods to the effects of climate change.

The scale of these challenges has spurred the development of a climate change adaptation policy process, in which a large and diverse set of actors participate. These actors include civil society organizations (CSOs) such as the Uganda Coalition for Sustainable Development, governmental organizations such as Kenya's Ministry of Environment and Natural Resources, academic/research organizations such as the University of Dar es Salaam, intergovernmental organizations such as the Lake Victoria Basin Commission, development partners such as the U.S. Agency for International Development, and international nongovernmental organizations such as CARE.

The climate change adaptation policy process itself features numerous projects, programs, task forces, steering committees, planning groups, and other forums in which actors jointly contribute to decision making about the design and implementation of policy. The scope of these decisions varies broadly. In forums such as the Climate Change, Agriculture and Poverty Alleviation Project, representatives of Tanzanian CSOs jointly develop strategies for promoting climate-smart agricultural practices at the community level and conducting outreach to local elected officials. Other forums active in the Lake Victoria region focus on policy implementation at higher spatial levels. For example, in the Monitoring of the Environment for Security in Africa Programme, representatives of public research institutes, university centers, and intergovernmental organizations from across the continent plan the development and dissemination of climate assessments and outlooks. Among forums in which decisions focus less on implementation of policy and more on its design, some are mandated with the development of specific governmental policies, such as the Environment Management and Coordination Act (Kenya) or the East African Community Climate Change Policy. In other forums, participants provide input to representatives of organizations with jurisdiction over specific policies. For example, the Tanzania Development Partners Group on Environment, Natural Resources and Climate Change features interactions among representatives of donor organizations such as the U.S. Agency for International Development and officials from the Government of Tanzania, with an aim to improve alignment of donor goals and government policy.

Because forums vary in their accessibility, both generally and differentially across different types of actors, they can reflect or amplify power dynamics. For example, participation in the Tanzania Development Partners Group on Environment, Natural Resources and Climate Change is considerably more limited than the Africa Adaptation Knowledge Network, which engages a wider community of policymakers, researchers, and representatives of nongovernmental organizations. Additionally, in forums such as the United Nations Framework Convention on Climate Change conferences, a relatively small number of actors engage in formal negotiations, while a large number of nongovernmental actors attend as "non-Party stakeholders" and seek to influence outcomes though other channels, such as side events.

Actors commonly participate in a variety of adaptation policy forums, and in this way may contribute to policy design in one forum and policy implementation in another. Similarly, they may participate in forums that address adaptive capacity challenges at spatial levels ranging from subnational to global. As such, the overall

Lake Victoria region climate change adaptation policy process may be conceptualized as a network of policy actors interacting with one another and jointly contributing to decision-making processes sponsored by policy forums. Theories of political economy argue that the distribution of power among actors shapes the outcomes of these policy forums, particularly in institutional settings that feature substantial asymmetries of political influence and capacity (Adger, Brown, & Tompkins, 2005). For example, the network of climate change policy actors operating in the Lake Victoria region includes numerous CSOs with small staffs and limited budgets, and which depend upon financial resources from donors and nongovernmental organizations based outside the region. As in other regions of sub-Saharan Africa, these CSOs have historically been excluded from meaningful participation in decision-making processes (Amutabi, 2013; Sovacool & Linnér, 2016). In cases where centralized bureaucratic structures have replaced traditional institutions, often with disastrous social and ecological results (Mwangi & Ostrom, 2009), CSOs have the potential to inform other policy actors of how small-scale agricultural, pastoral, and fishing communities experience the effects of climate change. Their marginalization in policy forums has consequences for the efficacy of decisions.

Theories of political economy also highlight the implications of large-scale reconfiguration of authority that accompanies the emergence and expansion of policy issues such as climate change adaptation in institutional settings such as the Lake Victoria region. In particular, climate change adaptation policy initiatives have resulted in new institutional structures. For example, the Uganda Climate Change Unit, established in 2008 as the national focal point for coordination of climate change policy, was elevated in 2014 to become the Climate Change Department, gaining in the process considerable authority as one of four autonomous agencies of the Ministry of Water and Environment. As actors representing new climate change adaptation institutional structures seek to exercise their mandates across diverse issue arenas, each with established coalitions and factions, they must navigate entrenched power dynamics. Mainstreaming climate change adaptation presents a particular challenge, because agriculture, livestock production, fisheries, and other climate-sensitive productive sectors are especially prone to fragmentation and competition in East Africa due to "decentralized rent management," in which factions coalesce around the allocation of patronage and consequently resist reforms (Kjaer, 2015). In these settings, the degree to which a new policy issue reconfigures a governance system may hinge upon regional political processes such as election cycles or global dynamics such as donor priorities, rather than the importance of the policy issue itself (Kjaer, 2004).

Against the backdrop of the political economy of interactions among powerful and marginalized actors with wide-ranging preferences for adaptation policy in the Lake Victoria region, the ecology of games framework (EGF) offers a set of assumptions to guide investigation of factors that shape those interactions. The EGF conceptualizes a policy process as a set of "games"—opportunities for decision making, subject to formal and informal rules—in which actors strategically interact to advance policy preferences, extend their influence, and access resources (Lubell, 2013). A defining feature of the EGF is its focus on the potentially large number of

forums that collectively contribute to the design and implementation of policies within a governance system. For this reason, the EGF is particularly appropriate for investigating polycentric institutional settings characterized by numerous and overlapping decision-making processes. In the Lake Victoria region, this interdependence stems from the scale and scope of climate change adaptation collective action problems. For example, considering likely increases in the frequency and severity of drought and flood events in the region (Tebaldi et al., 2006; Thornton, Jones, et al., 2009; Thornton, van de Steeg, et al., 2009), outcomes of initiatives designed to increase the adaptive capacity of small-scale agricultural and pastoral communities depend in large part on how successfully policy actors coordinate decisions across numerous policy forums engaged in disaster preparedness, capacity building, and local planning. Higher institutional levels of the climate change adaptation policy process feature numerous forums in which actors seek to integrate adaptation planning into existing arenas such as agricultural or water policy. The effectiveness of these efforts hinges upon the cooperation among diverse actor groups, given the inevitable redistribution of political authority and resources that accompanies reconfiguration of the mandates of actors and institutions (Few, Brown, & Tompkins, 2007; Huq et al., 2004).

Policy Forums and the Transaction Costs of Collaboration

We operationalize collaboration in terms of relationships among actors in policy networks. Collaboration may involve activities such as exchanging data, sharing personnel, or jointly carrying out projects at the community level. According to new institutional economics theory, actors are more likely to form collaborative relationships when the benefits of working together outweigh the transaction costs of searching for mutually beneficial agreements, negotiating various options, and monitoring and enforcing implemented activities (Feiock, 2013; North, 1990; Sabatier et al., 2005; Thomas, 1999).

Policy forums can reduce the transaction costs of political contracting among prospective collaborators in a number of ways. Forums typically provide opportunities for actors to exchange information relevant for decision making, such as the status of drought preparedness within a particular region, or potential outcomes of a policy intervention under consideration. In this way, forums can mitigate uncertainty about the effectiveness of joint action to address an issue. Through joint participation in a forum, policy actors also learn about each other's capabilities and goals, which makes it easier to bargain over policy solutions. Finally, forums may incentivize collaboration by attracting prospective partners with similar policy preferences (Berardo & Scholz, 2010), and by providing opportunities for prospective collaborators to build trust and norms of reciprocity through repeated interaction (Axelrod, 1984; Leifeld & Schneider, 2012). Our baseline hypothesis focuses on collaboration as a function of joint participation:

Hypothesis 1: Actors are more likely to collaborate if they jointly participate in policy forums.

Although this hypothesis has been stated many times in the literature on polycentric governance, it is only recently that empirical studies have provided any evidence that institutions may indeed foster collaboration among participating policy actors. In their study of collaborative interactions among individual policy actors operating across diverse Swiss policy sectors, Fischer and Sciarini (2016) find that the odds of collaboration increase when actors jointly participate in the same decision-making processes. Focusing on government-sponsored collaborative groups similar in scope to the Lake Victoria region policy forums we study, Scott and Thomas (2015) show that organizations jointly participating in groups are more likely to engage in informal consultation, coordinated planning, and joint policy implementation.

The Spatial and Institutional Scales at which Policy Forums Operate

We extend this baseline hypothesis by analyzing how institutional and spatial scales may influence the transaction costs of collaboration, focusing specifically on costs associated with searching for information, bargaining, monitoring, and enforcement. In the context of regional climate change adaptation and other regional governance issues, the various policy forums operate along two different scalar dimensions.[1] Spatial scale refers to the geographic scope at which forums address climate change adaptation challenges. In forums that operate at lower spatial levels, actors focus on issues salient to relatively smaller areas, such as the need to improve resilience to extreme weather in the arid and semi-arid lands of Kenya. By contrast, forums at higher spatial levels sponsor decision-making processes that affect larger regions, for example, the establishment of funding mechanisms for transboundary adaptation projects.

Turning to institutional scale, we draw upon the Institutional Analysis and Development framework, which recognizes tiered levels of decision-making processes (Kiser & Ostrom, 1982; E. Ostrom, 2007). At the lower end of the institutional scale, operational choice-level forums typically focus on policy implementation, such as how to deploy a flood early warning system within a transboundary river system. At a higher institutional level, collective choice forums sponsor decisions about policy design and agenda-setting, such as whether to prioritize flood early warning initiatives over alternative measures to reduce disaster risk.

Our basic argument is that actors incur higher transaction costs of collaboration when jointly participating in policy forums operating at higher institutional and spatial levels. However, each type of scale features different mechanisms that affect transaction costs, as summarized in Table 1.

Spatial Scale. The upper-left quadrant of Table 1 describes how search and bargaining costs associated with collaboration between actors may be greater in forums that operate at higher rather than lower spatial levels. We argue that actors who

Table 1. Scale-Dependent Transaction Costs

		Types of Scale	
		Spatial	Institutional
Types of Transaction Costs	Search and Bargaining	*Scientific/technical uncertainty*: At higher spatial levels, a smaller subset of actors have a degree of place-based knowledge about systems and people pertinent to decision-making processes that involve the entire pool of actors. Prospective payoffs that result from collaboration are less certain. *Political/administrative uncertainty*: At higher spatial levels, actors' preferences are less homogeneous and therefore less well-known to all actors. As a result, actors are less certain of the value of prospective collaborators.	*Stakes of decisions*: Collective choice-level decisions reconfigure the scope of lower level (i.e., operational choice) decision-making processes. The magnitude of redistribution of political authority (and prospective payoffs that accrue to actors) that accompanies these higher-level decisions decreases actors' willingness to negotiate to reach bargained solutions.
	Monitoring and Enforcement	*Infrequency of interactions*: At higher spatial levels, actors' geographic spheres of operation overlap to a lesser degree, decreasing the likelihood of prior interaction among prospective collaborators (or even their familiarity with one another's reputation or capabilities).	*Outcome/compliance uncertainty*: While lower-level (operational choice) decision-making processes lead to observable results in relatively short time spans, the linkages between collective choice decisions and outcomes are less direct and therefore more difficult to assess. As a result, actors collaborating in the context of these higher-level decision-making processes have less assurance that rules will be followed as agreed.

participate in higher-level forums tend to confront greater scientific/technical uncertainty, which relates to the inadequacy of information necessary for predicting policy outcomes. At higher spatial levels, actors lack place-based knowledge about specific social, economic, and environmental processes that span large and heterogeneous jurisdictions and have important implications for decisions about the design and implementation of policy. Consequently, compared to more local forums, actors participating in higher-level policy forums may have less confidence in their abilities to identify mutually beneficial policy solutions. Without making costly investments to improve their scientific or technical understanding of the issue at hand, actors risk entering into agreements that may result in poor outcomes.

Another source of transaction costs is political uncertainty, which relates to a lack of awareness of the policy beliefs and preferences of other actors (Lubell, Mewhirter, Berardo, & Scholz, 2017). Actors confront greater political uncertainty in forums at higher spatial levels, which encompass larger and more heterogeneous jurisdictions and attract participants with more diverse preferences (Mazmanian & Sabatier, 1983). Variance in preferences (and intensity of preferences) does not

necessarily inhibit collaboration and may actually provide opportunities for actors to reach mutually advantageous bargained agreements (Martin, 1994). However, if actors are less aware of other actors' preferences, they must expend greater resources in learning about one another before initiating or reaching agreements. In a study of lawmaking in the European Union, Hertz and Leuffen (2011) find a positive association between the diversity of partisan preferences and the amount of time legislative groups needed to reach decisions.

Compared to actors in more local forums, actors in forums operating at higher spatial levels experience greater costs associated with monitoring and enforcing each other's commitment to collaborative goals, obligations, and actions, due to less familiarity with one another (lower-left quadrant of Table 1). A large literature on collective action and social capital argues that cooperation requires trust and norms of reciprocity, which develop through repeated interactions (Adger, 2003; E. Ostrom, 1994; Putnam, 2000). Actors participating in forums at more local levels will be more familiar with one another because they tend to design and/or implement policies within the same geographic areas (Wyborn & Bixler, 2013). Prior observation helps actors to more confidently predict prospective partners' capacity to reciprocate or faithfully execute agreements (Ahn, Ostrom, Schmidt, Shupp, & Walker, 2001; Gulati, 1995). Correspondingly, in forums that operate at higher spatial levels, a greater degree of unfamiliarity among actors may increase the need for costly monitoring and enforcement of how collaborators follow through on pledges, contractual commitments, and other responsibilities. Given our expectation that scale-dependent transaction costs will reduce the net benefits of collaborative interactions in policy forums that operate at higher spatial levels, we hypothesize:

> *Hypothesis 2: Collaboration is less likely between actors jointly participating in policy forums operating at higher spatial levels relative to lower spatial levels.*

Institutional Scale. Turning from spatial to institutional scale, the upper-right quadrant of Table 1 indicates that search and bargaining costs may increase in forums that sponsor higher-level decision-making processes because these decisions are more consequential. Although lower-level (e.g., operational choice) decisions do not affect higher-level (e.g., collective choice) processes, higher-level decisions reconfigure the scope of choices available to actors at lower-level forums (Kiser & Ostrom, 1982). Because agreements reached at higher-level forums may significantly alter the distribution of resources and political authority within a policy system, actors may be unwilling to abandon the *status quo* in favor of systemic change, especially if outcomes are difficult to predict. As a result, actors who seek to participate in such agreements in higher-level forums may face protracted negotiation processes, which reduce the net benefits of collaboration.

In the lower-right quadrant of Table 1, we argue that in higher-level forums, actors face greater difficulty in monitoring and enforcing each other's commitments to agreements and other collaborative outputs, which decreases the potential net benefits of collaboration. An important characteristic of higher-level collective choice

processes is that decisions do not directly produce outcomes observable in the real world, as is more likely with operational choice decisions (Kiser & Ostrom, 1982). In higher-level institutional settings, indicators of cooperative behavior may be more subjective or abstract, thus increasing the difficulty of detecting defection as well as promoting compliance. Additionally, the set of actors that participate in the design of a policy at the collective choice level is entirely distinct from the set of actors responsible for its implementation at the operational choice level (Margerum, 2008). For this reason, assessing the outcomes of collective choice decisions is considerably more difficult and actors have less assurances that agreements will be implemented as intended, which reduces actors' expectations about the prospective net benefits they may receive through collaborative interactions in higher-level institutional settings. Given our expectation that higher-level (collective choice) decision-making processes feature higher transaction costs, we hypothesize:

Hypothesis 3: Collaboration is less likely between actors jointly participating in policy forums operating at higher institutional levels relative to lower institutional levels.

Methods

Data Collection

We surveyed representatives of organizations active in the design and/or implementation of climate adaptation policy in the Lake Victoria region. Organizations were identified through Internet search and document review, on the basis of their participation in climate change adaptation initiatives within the region. The list of organizations was reviewed and slightly expanded by a research steering group composed of faculty members from Makerere University (Uganda), the University of Dar es Salaam (Tanzania), and Dedan Kimathi University of Technology (Kenya), who had themselves conducted research on climate change adaptation in the region. A total of 245 organizations were identified. For each of these organizations, we identified at least one representative through a second wave of Internet search, document review, and consultation with steering group members. For larger organizations, these individuals were usually climate change adaptation point persons. For smaller organizations, particularly those without personnel working entirely on climate change adaptation issues, we sought representatives with programmatic leadership or administrative positions (e.g., executive directors) who were broadly knowledgeable of their organizations' interactions with other organizations and participation in the Lake Victoria region climate adaptation policy process. A small number of representatives were identified by survey respondents.

We administered the survey February–July 2014. The primary survey format was a paper instrument, which we administered through in-person meetings at respondents' places of work. Visits to cities where respondents' organizations were

based ranged from one to six weeks.[2] The in-person format provided several advantages: it afforded us the opportunity to confirm that respondents understood questions as we had intended, we gained extensive qualitative knowledge through dialog with respondents while completing the survey, and our interest in visiting respondents likely resulted in a higher response rate. We surveyed representatives of 125 organizations in this way.[3] A number of respondents indicated willingness to participate in the survey but were not available during our visit to their cities. These individuals received a web-based version of the survey. Representatives of an additional 19 organizations completed the web-based survey. In total, we received responses from representatives of 144 organizations, for an American Association for Public Opinion Research estimated response rate of 59 percent.[4]

Analytical Approaches: Estimating Conditional Log-Odds and Probabilities of Collaboration

We fit an exponential random graph (ERG) model to test our hypotheses. For cross-sectional network data such as ours, ERG models provide a means of statistical inference that accounts for issues of interdependence among observations (Cranmer & Desmarais, 2011; Robins, Pattison, Kalish, & Lusher, 2007). The technique recognizes the observed network as one potential realization of a set of social processes believed to influence the structure of interactions among actors. These processes may be operationalized as model parameters that may be exogenous (e.g., spatial level of a policy forum) or endogenous (e.g., tendency for actors to cluster) to the network. For each parameter included in the model, estimates and standard errors are calculated by comparing the distributions of parameter values drawn from large numbers of simulated networks to values in the observed network. Use of this modeling approach has been spurred in recent years by improvements in model specification to avoid degeneracy (Goodreau, 2007; Robins et al., 2007; Snijders, Pattison, Robins, & Handcock, 2006), as well as the availability of software that allows for inclusion of a wide variety of theoretically relevant parameters and tools to evaluate model fit. We used the "statnet" suite of packages (Handcock, Hunter, Butts, Goodreau, & Morris, 2008) in R (R Core Team, 2015) to process network data, estimate the ERG model, and evaluate model fit.

Network and Model Parameters

Our primary dataset was a network of collaborative relationships among actors involved in the design and implementation of climate change adaptation policy in the Lake Victoria region. Specifically, we created an adjacency matrix in which each cell corresponded to a pair of actors, and took the value of 1 if either actor identified the other actor in response to the question: "Please list the organizations your organization has collaborated with in the context of climate change adaptation in the past year" and 0 otherwise.[5]

We used three parameters to directly test our hypotheses. The *Shared forum* parameter is measured at the dyad level and indicates whether actors jointly participate in at least one forum. The survey defined forums using the following language: "Climate change adaptation can be addressed in different kinds of projects, programs, forums, or planning processes where multiple organizations collaborate to make decisions about the design and implementation of climate change adaptation activities." The survey then prompted respondents to list up to 12 forums. Of the 8,128 dyads in our network of actors, 891 (11.0 percent) jointly participated in at least one forum.

The remaining two hypothesis-driven parameters refer to characteristics of the forums in which actors jointly participate. The dyadic parameter *Spatial level of shared forum* indicates the geographic level at which forums operate. This ordinal variable takes the value of 1 when actors jointly participate in forums at the national/subnational level, 2 for forums at the Lake Victoria regional level, 3 for forums at the level of the African continent, and 4 for global-level forums. The *Institutional level of shared forum* parameter, also measured at the dyad level, is binary and equals 0 for operational choice forums and 1 for collective choice forums. Because many of the forums elicited through the survey were informal and/or had little descriptive documentation (e.g., a mandate or mission statement), we could not directly classify them according to institutional level. Instead, we conducted a classification analysis based on the profile of adaptation-related activities carried out by each forum. We regarded each forum's set of activities as indication of its mandate, and we used these profiles to classify forums in terms of the level of the policy process in which they primarily operate. Specifically, we drew upon a typology of climate change adaptation activities developed by Biagini, Bierbaum, Stults, Dobardzic, and McNeeley (2014), noting for each forum whether or not it carries out each activity. These activities included management and planning, capacity building, implementation of climate-resilient biophysical or "green" infrastructure, and the development of adaptation-related financial mechanisms, among others.[6] We used the package "mclust" (Fraley, Raftery, Murphy, & Scrucca, 2012) in R (R Core Team, 2015) to identify and implement a classification model, which resulted in two classes of forums. The first class was characterized primarily by forums in which stakeholders make operational choice decisions, while collective choice decision-making processes better characterized forums in the second class. An even higher "constitutional" level describes decision-making processes that structure collective choice-level processes, but none of the forums identified by our survey represented this level. Table 2 provides examples of the types of forums that were grouped in each class, cross-tabulated by spatial and institutional levels.

We included several parameters to control for actor attributes, including the binary variable *Large staff*, which equals 1 for actors with more than 25 staff and 0 otherwise. The categorical parameter *Spatial scope* indicates whether actors address climate change adaptation in Kenya, Tanzania, Uganda, or at the Lake Victoria regional level. Table 3 provides the distribution of actors for these two variables, along with the locations of actors' offices in the region as well as the sector in which they operate. Although these latter two attributes are not included in the models,

Table 2. Cross Tabulation of Forums by Spatial and Institutional Levels

		Institutional Level of Forum	
		Operational Choice	Collective Choice
Spatial level of forum	National/ subnational	N = 7 e.g., *Climate Change, Agriculture and Poverty Alleviation Project (CCAP)*	N = 40 e.g., *Tanzania Development Partners Group on Environment*
	Lake Victoria Regional	N=9 e.g., *Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa (CHIESA)*	N=7 e.g., *East African Community Climate Change Policy*
	Continental	N = 1 e.g., *African Monitoring for Environment and Sustainable Development (AMESD)/Monitoring for Environment and Security in Africa (MESA)*	N = 6 e.g., *Africa Regional Platform on Disaster Risk Reduction*
	Global	N = 7 e.g., *Partners for Resilience (PfR)*	N = 9 e.g., *Adaptation Fund Board Meetings*

Table 3. Attributes of Actors

Attribute	Value	Number of Actors
Staff size	25 or fewer	67
	Larger than 25	61
Geographic scope	Lake Victoria region	40
	Uganda	34
	Tanzania	28
	Kenya	26
Office location (city)	Nairobi, Kenya	50
	Kampala, Uganda	29
	Dar es Salaam, Tanzania	26
	Arusha, Tanzania	6
	Kisumu, Kenya	6
	Entebbe, Uganda	5
	Mwanza, Tanzania	4
	Bukoba, Tanzania	1
Type	International nongovernmental	40
	National/subnational nongovernmental	29
	Central government	28
	Development partner	19
	Intergovernmental	6
	University-based institute	4
	Private	2

they provide an additional overview of the characteristics of actors that comprise the network.[7] The *Spatial scope homophily* parameter controls for the tendency for similar actors to collaborate (Calanni et al., 2014; Gerber, Henry, & Lubell, 2013; Provan & Kenis, 2008). For each pair of actors, this parameter takes the value of 1 if both operate either in Kenya, Tanzania, Uganda, or at the Lake Victoria regional level, and 0 otherwise.

Our final set of parameters measure the effects of social processes that generate patterns of collaborative interactions among the broader network of climate change adaptation policy actors. The *Edges* parameter indicates whether actors collaborate and is analogous to the intercept of a logistic regression model. The parameter *GW Degree* measures the degree distribution of the network, where "degree" reflects the sum of each actor's collaborative relationships. The parameter indicates the extent to which each collaborative tie decreases the likelihood of an additional tie, and the strength of this effect itself decreases geometrically according to a decay parameter θ_S. The *GW Edgewise shared partners* measures the tendency for actors to cluster. Specifically, the parameter indicates the increase in the likelihood that two actors collaborate for each additional actor with which both actors independently collaborate. As with the *GW Degree* parameter, this strength of this effect decreases geometrically, as set by the decay parameter θ_T.

Results

Overall, the research identified 86 climate change adaptation forums operating at different spatial and institutional levels, in which at least two actors reported participation. A majority of forums were classified at the (higher) collective choice level (62, versus 24 at the operational choice level). Most forums operated at the national/subnational level (47, compared to 16 at the regional level, 7 at the continental level, and 16 at the global level). The cross-tabulation presented in Table 2 indicates relative independence of both dimensions of scale (i.e., forums at higher spatial levels do not tend to operate at the higher institutional level, and vice versa).

We turn to the results of our ERG models for insight into the effects of actor attributes and network structural characteristics on the likelihood of collaboration between actors. Model fit diagnostics (presented in Supporting Information Figure A1) reveal that observed network statistics indeed fall within the distribution of statistics from simulated networks, indicating good fit for each model.

Table 4 presents estimates of each parameter included in the series of nested ERG models. We confine our discussion to the top three variables, each of which corresponds to one of our hypotheses. Estimates of the remaining variables are discussed in the Supporting Information. Each parameter coefficient represents the log-odds ratios for a collaborative tie that fulfills the condition specified by the parameter. For example, the coefficient for the *Shared forum* parameter indicates that if adding a tie to the network results in one additional collaboration between two actors that jointly participate in at least one policy forum, the likelihood of that tie increases by 0.94 in log-odds in the Baseline model. Calculation of the probability of observing that particular tie (or all collaborative ties that also fulfill a certain condition) requires accounting for the model specification and all other parameter estimates, given the pattern of collaborative ties in the rest of the network (Desmarais & Cranmer, 2012). We turn to these probabilities following presentation of model coefficients.

The positive and significant estimate for the *Shared forum* parameter provides support for our first hypothesis: actors are more likely to collaborate if they jointly participate in the same policy forums. Estimates for the *Spatial level of shared forum*

Table 4. Exponential Random Graph Model Results

	Baseline Model	Spatial Model	Institutional Model	Full Model
Shared forum	0.94*	1.28*	1.35*	1.53*
	(0.09)	(0.12)	(0.13)	(0.15)
Spatial level of shared forum		–0.22*		–0.19*
		(0.05)		(0.06)
Institutional level of shared forum = higher[a]			–0.53*	–0.40*
			(0.14)	(0.15)
Large staff	0.29*	0.26*	0.26*	0.25*
	(0.05)	(0.05)	(0.05)	(0.05)
Spatial scope = Kenya[b]	0.04	0.03	0.07	0.05
	(0.05)	(0.05)	(0.05)	(0.05)
Spatial scope = Tanzania[b]	0.01	0.01	0.01	0.01
	(0.04)	(0.04)	(0.04)	(0.04)
Spatial scope = Uganda[b]	0.11*	0.08	0.12*	0.08
	(0.04)	(0.04)	(0.04)	(0.04)
Spatial scope homophily	1.01*	0.95*	1.03*	0.97*
	(0.06)	(0.06)	(0.06)	(0.06)
Edges	–5.91*	–5.81*	–5.89*	–5.81*
	(0.18)	(0.18)	(0.18)	(0.18)
GW degree ($\theta_S = 0.9$)	1.77*	1.69*	1.68*	1.65*
	(0.42)	(0.41)	(0.41)	(0.42)
GW edgewise shared partners ($\theta_T = 0.9$)	1.02*	1.02*	1.02*	1.02*
	(0.07)	(0.07)	(0.07)	(0.07)
AIC	3227.82	3212.07	3217.21	3207.75
BIC	3290.85	3282.10	3287.24	3284.78
Log likelihood	−1604.91	−1596.03	−1598.60	−1592.87

Notes: Standard errors in parentheses. *$p < 0.05$.
[a]Higher: collective choice level; reference category: operational choice level.
[b]Reference category: Spatial Scope = Regional.

and *Institutional level of shared forum* parameters were likewise significant and provide support for our second and third hypotheses. The Spatial model indicates that, conditional upon joint forum participation, the likelihood of collaboration between actors becomes less likely at increasingly higher spatial levels at which forums operate. Similarly, the Institutional model shows that collaboration is less likely between actors that jointly participate in higher-level collective choice forums compared to lower-level operational choice forums.

Drawing upon methods developed by Desmarais and Cranmer (2012), we also calculated the probability of collaboration for each pair of actors given their attributes and network position using the estimates obtained in the Full model. This approach, analogous to the calculation of predicted values using the results of a logistic regression model, allowed us to assess the overall probability of collaboration under various conditions (e.g., joint participation in policy forums), through aggregation of estimated probabilities over subsets of actor pairs characterized by each condition of interest. Specifically, we first calculated the statistics of all model parameters and then we compared these measures to statistics resulting from the establishment of a tie between each pair of actors that were not connected in the network. We then used these "change statistics," in combination with coefficients from the ERG model, to estimate the probability of a collaborative tie between each pair of actors according to the following equation from Desmarais and Cranmer (2012):

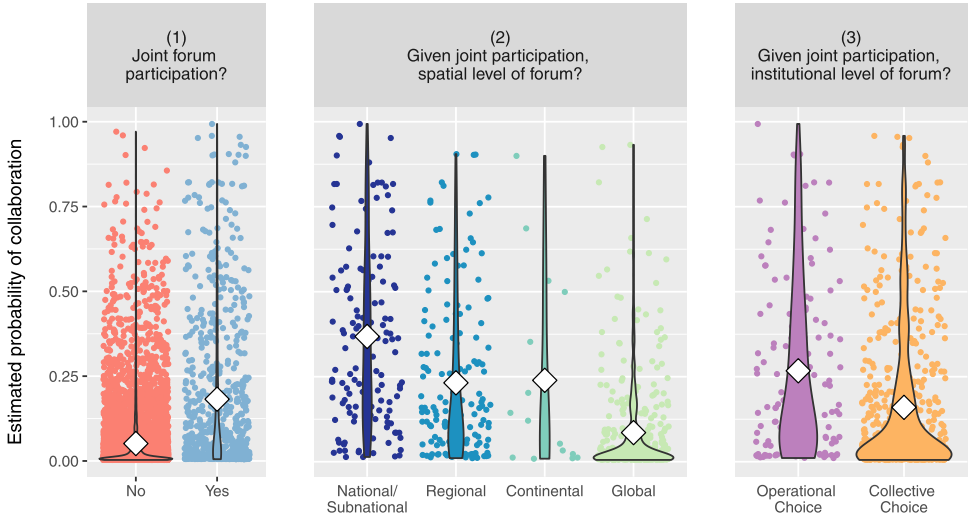

Figure 2. Predicted Probability of Collaboration for Each Dyad of Policy Actors.
Note: Each point represents the estimated probability of collaboration between a specific pair of actors. Points are randomly jittered horizontally. The shaded areas correspond to the density of actor pairs across the range of probability of collaboration for each condition, and the white diamonds indicate the mean probability. Plots created using the "gglot2" package (Wickham, 2009) in R (R Core Team, 2015).

$$P\left(\gamma_{ij}=1|\gamma_{-ij},\theta\right)=\text{logit}^{-1}\left(\sum_{h=1}^{k}\theta_h\delta_h^{(ij)}(\gamma)\right),$$

in which $\gamma_{ij}=1$ indicates a collaborative tie between actors i and j, γ_{-ij} is the network without actors i and j, θ is a vector of h parameters included in the ERG model, and $\delta_h^{(ij)}(\gamma)$ is the vector of change statistics generated by adding a collaborative tie between actors i and j.

Figure 2 presents predicted probabilities of collaboration. In each plot, every point represents a specific pair of actors, the shaded areas correspond to the density of actor pairs across the range of probability from 0 to 1, and the white diamonds indicate the mean probability of collaboration. Panel 1 shows that the probability of collaboration between actors that do not jointly participate in forums is 5.1 percent and rises to 18.2 percent for actors that do jointly participate in at least one forum. Panel 2 parses out the effects of different spatial levels and indicates that the probability of collaboration is 36.8 percent when actors jointly participate in forums that operate at the national/subnational level, 23.2 percent for regional forums, 23.9 percent for continental forums, and 8.6 percent for global forums.[8] Panel 3 shows that joint participation in operational choice forums corresponds to a 26.7 percent probability of collaboration, which falls to 16.0 percent for collective choice forums.

These plots tell a much more nuanced story than the ERG model coefficients alone. For example, a subset of actors that do not jointly participate in forums nevertheless have a relatively high estimated probability of collaboration, as indicated by the number of points in the upper region of the "No" joint forum participation plot

in Panel 1. This highlights the importance of factors such as geographic homophily (which may indicate cultural barriers to collaboration), staff size, and the tendency to collaborate with partners of collaborators. While joint forum participation and the characteristics of forums are strong predictors of collaboration, these and other factors are important as well (see Supporting Information for detailed descriptions).

Conclusion

Like most other governance systems throughout the world, climate adaptation in Lake Victoria features complex sets of linkages among actors and policy forums operating at multiple institutional and spatial levels. In these settings, actors contribute to the design and implementation of policy through their participation in forums as well as through collaborative activities with other actors. It is crucial for the political science, policy, and governance literatures to develop a solid theoretical understanding of these systems that is supported by empirical hypothesis tests. The overall literature on environmental governance rests on the largely untested hypotheses about a positive relationship between institutions and collaboration, and the importance of scale (Brondizio, Ostrom, & Young, 2009; Lubell, Henry, & McCoy, 2010). Our study addresses this gap by integrating transaction cost theory with the concepts of institutional and spatial scale. This theoretical linkage provides a better account of the specific mechanisms that might influence the differential capacity of institutions to support the formation of collaborative policy networks.

Consistent with other recent studies, our results demonstrate that, on average, joint participation in policy forums is associated with collaborative relationships between actors (Fischer & Sciarini, 2016; Scott, 2016; Scott & Thomas, 2015). However, collaboration between actors that jointly participate in the same policy forums is conditional on the spatial and institutional levels at which those forums operate. Actors are substantially more likely to collaborate if the forum in which they jointly participate operates at a more local level, even after controlling for geographic homophily. This finding is consistent with our argument that scale-dependent transaction costs shape the prospective payoffs of collaboration in complex institutional settings. In forums that operate at lower spatial levels, participants have greater place-based knowledge, which allows them to evaluate the prospective payoffs from entering into agreements without significant investment in searching for information. Similarly, actors in more local forums are more familiar with each other's preferences and capabilities, which decreases the need for costly bargaining, monitoring, and enforcement of partners and partnerships.

Another dimension of scale concerns the institutional level of decision making that forums sponsor. Results supported our hypothesis that actors would be more likely to collaborate if they jointly participate in lower-level operational choice forums compared with higher-level collective choice forums. Again, transaction cost theory provides the intuitive explanations for this finding: in lower-level forums, because agreements result in less substantial changes to the distribution of political authority, actors may be more willing to negotiate to reach bargained solutions; moreover, the outcomes of agreements reached in lower-level operational choice

forums tend to be more readily observable (Kiser & Ostrom, 1982), which decreases the need for costly monitoring and enforcement.[9]

Taken together, these findings advance understanding of the factors associated with cooperative outcomes in complex and multilevel institutional settings. New institutional economics argues that collaboration is more likely when prospective payoffs from solving collective action problems outweigh the transaction costs of collaboration activities (i.e., net benefits are positive). The EGF argues that actors seek to maximize their net benefits of contributing to the policy process through selection of collaborative partners across a potentially large set of policy forums. In this article, we have argued that the scalar dimensions at which these policy forums operate shape the transaction costs of political contracting. Patterns of collaboration reveal actor strategies and have implications for governance outcomes. In particular, if actors find it harder to collaborate with joint participants of higher level forums, they may prioritize lower level forums.

Substantively, these findings help explain weaknesses of adaptation policy processes and highlight opportunities to improve outcomes. The symbolic nature of many climate change adaptation forums at higher spatial as well as institutional levels may well reflect the high transaction costs facing policy actors who might otherwise succeed in building collaborative relationships necessary to effectively craft policy necessary to address large-scale adaptation challenges. Where this is the case, our research suggests that efforts to engender familiarity and build trust among actors (e.g., through more frequent interactions in a given forum) are worth the investment.

Meanwhile, the fragmentation and redundancy that sometimes characterizes lower-level policy forums may reflect the low barriers to the establishment and maintenance of collaborative networks tasked with implementation of policy over relatively small areas. Hence, from a multilevel governance perspective it is important to think about how forums operating at higher spatial and institutional levels can facilitate coordination among lower-level institutions to prevent fragmentation, for example, by strengthening linkages between geographic subregions (e.g., between arid regions of Uganda and Kenya) and/or networks implementing similar policies, which may improve local adaptation outcomes resulting from national and international interventions (Agrawal, Perrin, Chhatre, Benson, & Kononen, 2012). The ecology of climate adaptation games operates as a system, so from a policy analysis perspective it is important to focus on the structure of the overall network of policy actors and forums rather than analyze just one decision-making process at a time.

Although our finding that environmental policy actors in the Lake Victoria region are more likely to collaborate if they jointly participate in policy forums buttresses results from similar studies in the United States (Scott & Thomas, 2015) and Switzerland (Fischer & Sciarini, 2016), to our knowledge our study is the first to examine the relationship between collaboration and the scales at which forums operate, either in industrialized or developing regions, such as the system we study. Efforts to further increase understanding of scale-dependent transaction costs and collaboration will require comparison across study systems in industrialized regions, as well as governance systems throughout Latin America, Asia, Africa, and other developing regions. For example, in light of recent research on how transaction costs

"evolve" as governance systems institutionalize (Lubell et al., 2017), we speculate that both scientific/technical and policy uncertainty may vary less between lower- and higher-level forums in industrialized settings, resulting in a more even distribution of transaction costs across spatial levels.

Our finding that organizations with larger staff are more likely to enjoy the benefits of collaboration (Table A1) highlights the importance of further studying political power dynamics in complex institutional systems, particularly in developing regions such as East Africa. While transaction cost theory has been criticized for ignoring political power (Moe, 2005), it is not antithetical to political power in principle. Political actors with extensive resources and political capital, such as international NGOs and donors, may be advantaged in creating/destroying new forums, gaining or preventing access to existing forums, and bargaining for their preferred distribution of policy benefits and transaction costs (Gallemore, Di Gregorio, Moeliono, Brockhaus, & Prasti H, 2015). Less powerful actors such as CSOs thus have fewer opportunities to create or participate in forums and are less effective at bargaining (Leach, Mearns, & Scoones, 1997). The set of available policy forums thus does not offer a level playing field for diverse groups of actors to advance their policy goals and the resulting patterns of collaboration may amplify and reinforce disparities in political power (Leach, Mearns, & Scoones, 1999). A crucial research question going forward is how these political power dynamics coevolve with the structure of polycentric governance systems over time, and link to crucial environmental, economic, and social outcomes. From the perspective of political and environmental development, a normative hypothesis is that polycentric systems will be more effective if they are capable of building collaboration while limiting inequities in political power.

An important limitation of our current cross-sectional data is the inability to untangle the causal relationship between joint forum participation and the development of collaborative ties. For example, the collaborations observed between pairs of actors may have predated and predisposed their joint participation in forums. We believe the most likely case is a coevolution between joint forum participation and collaborative relationships, as has been depicted in some computational models (Smaldino & Lubell, 2011). Longitudinal data on collaboration and participation in forums will be necessary to better understand causal linkages, including how policy forums and actors enter and leave the system. Similarly, without longitudinal data, we cannot draw conclusions about how attributes of forums may result in certain social or ecological outcomes. However, characterization of the policy forum-level covariates of collaborative behavior, as we have done in the present study, lays the groundwork for more directed inquiry into the mechanisms at play when actors establish collaborative relationships, as well as the collective results of these collaborations at the level of the governance system.

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Notes

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1. Following Gibson, Ostrom, and Ahn (2000), we use *level* to refer to a particular position on a *scale*.
2. Fieldwork locations included Kampala, Entebbe, and Jinja in Uganda; Nairobi and Kisumu in Kenya; and Dar es Salaam, Arusha, and Mwanza in Tanzania.
3. For three large organizations, we surveyed two representatives.
4. A common reason for nonresponse was the difficulty of scheduling meetings with prospective respondents within the period of time we spent in each of the fieldwork locations. Our response rate was relatively strong compared to similar research evaluating ecology of games hypotheses using surveys of policy elites (e.g., Lubell, Robins, & Wang, 2014; Scott & Thomas, 2015).
5. While the survey allowed respondents to define collaborative relationships themselves, an earlier question (not included in this analysis) identified 14 "collaborative activities," including "Sharing data, advice, and information with another organization," "Training or receiving training from another organization (capacity building)," "Sharing personnel with another organization," and "Jointly implementing projects."
6. We modified Biagini et al.'s (2014) typology slightly, by splitting the original "information" category to distinguish between activities designed to generate/disseminate climate adaptation-relevant information and efforts to establish information-sharing platforms.
7. We did not include a variable for the locations of actors' offices due to strong collinearity with the geographic scope variable. Although our main models do not include a variable for actors' sectors because it does not improve the likelihood of the model, we show the effect of this variable in Table A1 of the Supporting Information.
8. The predicted value of collaboration in continental forums is higher than expected given the negative coefficient for the *Spatial level of shared forum* parameter in the ERG models. This result may reflect the small number of actor pairs jointly participating in forums at the continental-level (15, compared with 135 at the national/subnational level, 162 at the regional level, and 353 at the global level).
9. While our study focuses on spatial and institutional scales, other scalar dimensions of policy forums, such as the time frames decisions (Cash et al., 2006), may likewise shape the likelihood of collaboration among their participants.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article.

Figure A1. Goodness of Fit of the Exponential Random Graph Models.
Table A1. Exponential Random Graph Model Results.