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Empirical research on polycentric governance: Critical gaps and a framework for studying long-term change

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Abstract

Polycentric governance (PG) describes governance systems characterized by multiple, interdependent centers of decision-making, offering an alternative to centralized governance models. PG is often assumed to be effective at helping policy actors address complex collective action problems, but burgeoning empirical literature on PG shows that it is not a panacea – PG is associated with both positive and negative governance outcomes. In this article, we ask: what do we know about why PG performs well in some cases but not in others? We start with a systematic review, synthesizing findings that provide empirical support for positive and negative features that are theorized to accompany PG. Our review reveals a critical gap in relation to our understanding of PG: the existing empirical literature largely fails to address change and evolution over time in PG systems, undermining our understanding of why PG works – or does not– across different contexts and over time. To fill this gap, we propose a "Context – Operations – Outcomes – Feedbacks" (COOF) framework that draws explicit attention to the interplay between context, operational arrangements, outcomes and identifies feedback pathways and adjustment mechanisms that drive dynamic change and evolution over time.

KEYWORDS

environmental governance, institutional analysis, long-term change, policy feedbacks, polycentric governance

INTRODUCTION

All policy landscapes are complex, and a better understanding of the ways that complex governance systems operate could be instrumental in helping communities and policymakers adapt to the socio-ecological challenges of the 21st century. In recent years, there has been an explosion of interest in polycentric governance (PG), a term that connotes multiple, interdependent centers of decision-making, and that many scholars see as an alternative to more centralized governance models. But despite this explosion of interest, there has been limited cumulation of knowledge about how PG affects policy actors' ability to effectively address complex collective action problems.

A growing empirical literature has demonstrated that PG is sometimes effective (e.g., Pahl-Wostl et al., 2012) and sometimes ineffective (e.g., Lieberman, 2011), but to date, there are few, if any, efforts to synthesize across these cases and understand why PG works well in some cases and poorly in others. In this article, we ask: what do we know about why PG performs well in some cases but not in others? We start by taking stock of the existing empirical literature on PG, identifying trends in the literature and synthesizing findings across studies. Our review shows that most studies to date have focused on "operational" aspects of PG (e.g., structure, process, and the interplay between them), often assessing how polycentric structure and process affect the performance of the governance system. In doing so, many studies neglect the way PG is nested within a particular socio-ecological and institutional context. Moreover, most studies take a short-term view, providing only a brief snapshot of PG performance. The literature on PG has also paid limited attention to feedback that might prompt evolution and change to PG. As a result, we know little about whether, why, and how PG affects policy actors' *long-term* ability to resolve collective action problems.

To fill this gap, we propose a framework that builds on the existing Institutional Analysis and Development (IAD) framework, which is widely used to analyze actors, interactions, and outputs within "action situations" where decisions related to policy and collective action are made (Ostrom, 2011). While our framework includes many of the IAD's basic components and concepts, our framework scales up the level of analysis from the individual action situation to the more complex "operational arrangements" that comprise PG. In doing so, our framework draws explicit attention to feedback pathways and adjustment mechanisms by which PG changes and evolves over time, as well as contextual factors in which PG operates. We hope that this framework will lead to more longitudinal studies of PG, as well as more cross-case comparison and knowledge cumulation by means of a shared conceptual language within this diverse research community.

The abstract concept of "polycentricity" dates back at least to Polanyi (1951), but was first applied to political systems in 1961, when Vincent Ostrom, Charles Tiebout, and Robert Warren used the phrase "polycentric political system" to denote a mode of metropolitan governance involving multiple, overlapping, autonomous, yet interdependent centers of decision making (Ostrom et al., 1961, henceforth OTW). The term remained relatively obscure until the 2000s, although it has always been a theme within the Bloomington School of Political Economy (Aligica & Boettke, 2009; Aligică et al., 2019; Cole & McGinnis, 2015a, 2015b, 2017; McGinnis, 1999; McGinnis, 2011; Mitchell, 1988; Ostrom, 1990). Indeed, one of Elinor Ostrom's "design principles" for the sustainable, community–based management of common pool resource systems evokes PG by specifying that governance should comprise a system of nested tiers, in which decision-makers from the lowest to highest governance levels can coordinate within a shared overarching system of rules (Ostrom, 1990, 2010). Although she received a Nobel Memorial Prize for her "research on governance, especially the commons," Ostrom made the connection to PG explicit by subtitling her Nobel Memorial Lecture "Polycentric Governance of Complex Economic Systems" (Ostrom, 2010).

Since then, diverse research teams have pursued empirical research programs related to PG. PG is often studied within water and marine governance systems, where multiple decision centers are often nested within a water basin or marine ecosystem (e.g., Dennis & Brondizio, 2020; Gruby & Basurto, 2013). PG has also been used in contexts like climate change (Cole, 2015; Dorsch & Flachsland, 2017; Huitema et al., 2019; Jordan et al., 2015; Jordan et al., 2018), as well as in other settings where traditional "top-down" policy models bear little relationship to a far more complex, multi-sectoral, multi-level, and

multi-jurisdictional reality (Feiock & Scholz, 2009; Lubell et al., 2010). Many scholars also see PG as normatively desirable, an antidote to governance systems that give local communities too little say in matters that affect them (Aligica & Boettke, 2009; Andersson & Ostrom, 2008; Gibson et al., 2005; Marshall, 2009; Ostrom, 1993), while others aim at deeper understanding of the conceptual elements underpinning PG for the purpose of spelling it out for positive analysis (Thiel, Pacheco-Vega, & Baldwin, 2019). PG's normative desirability makes it appealing to a wide range of researchers but has also contributed to a number of case studies that assume, rather than empirically examine, that PG will produce desirable outcomes like sustainable resource use or local self-governance. Conversely, a number of scholars identify negative features associated with PG, where complexity can stymie, rather than help, actors' ability to solve collective action problems. In the following section, we summarize the main positive and negative features that are theoretically associated with PG.

Our systematic review of empirical PG studies, presented in the third Section, shows that even as research on PG[i] has increased dramatically, knowledge cumulation has been limited. We synthesize PG study findings to find empirical support for the positive and negative features that are theorized to accompany PG. The literature provides ample empirical support for both positive and negative features but tells us little about *why* PG works well in some cases and not in others. While the IAD and related research frameworks emphasize that contextual factors shape governance outcomes and point to the need for cross-case comparison (Anderies et al., 2016; Ostrom, 2011; Schlager & Cox, 2018), few of the empirical studies we reviewed used these frameworks to guide their analyses, and many studies provided insufficient contextual information to support systematic comparison across cases. The result is a large volume of PG studies that have high internal validity, but that provide limited generalizable knowledge about why PG works well in some cases and poorly in others.

Perhaps more importantly, our review also shows that most PG studies cover a short time period of 2 years or less, providing only a brief snapshot of how a given PG arrangement performs at a particular moment in time, and telling us little about whether that performance is sustained over time as conditions change. Analysts often expect that PG should support policy learning and adaptive capacity to exogenous shocks (da Silveira & Richards, 2013; Villamayor-Tomas, 2018), but few studies in our sample took the longer-term perspective needed to test these claims. Those few longer-term studies suggest that actors' satisfaction (or dissatisfaction) with outcomes can prompt dynamic change to PG over time (Baldwin et al., 2016; Biddle & Baehler, 2019; Carlisle & Gruby, 2018; Morrison, 2017). These changes are driven by feedback pathways and adjustment mechanisms that are often studied in political science (Béland et al., 2022; Moynihan & Soss, 2014) but are rarely recognized explicitly in PG studies (e.g., Meckling, 2019). The framework we present in the fourth Section is designed to draw attention to these gaps and to facilitate cumulation of knowledge about PG.

A BRIEF CONCEPTUAL HISTORY OF PG

Defining PG

We start with an introduction to PG as it was originally described by V. Ostrom et al. (1961) (hereafter "OTW 1961") in their seminal article on metropolitan governance:

> The traditional pattern of government in a metropolitan area with its multiplicity of political jurisdictions may […] be conceived as a 'polycentric political system'. 'Polycentric' connotes many centers of decision-making which are formally independent of each other. Whether they actually function independently or instead constitute an interdependent system of relations, is an empirical question in particular cases. To the extent that they take each other into account in competitive relationships, enter into various contractual and cooperative undertakings or have recourse to central mechanisms to resolve conflicts, [they] may function in a coherent manner with consistent and

predictable patterns of interacting behavior. To the extent that is so, they may be said to function as a "system." (OTW 1961, 831).

This original description continues to provide a foundation for scholars' understanding of polycentricity as a concept, even as considerable subsequent work has unpacked and extended the basic set of ideas. Carlisle and Gruby (2019), for example, draw on OTW to define a theoretical model of PG including the following core attributes of PG: "(1) many autonomous units formally independent of one another, (2) choosing to act in ways that take account of others, (3) through processes of cooperation, competition, conflict, and conflict resolution." They go on to theorize about the enabling conditions under which these attributes might produce benefits like adaptive capacity and risk reduction. Stephan et al. (2019) offer a more detailed conceptualization of PG that adds several elements from the literature to OTW's original definition, identifying eight dimensions of PG, summarized in Table 1.

In Table 1, we re-organize Stephan et al.'s dimensions into three categories that are commonly used in policy process research: structural characteristics, dynamic processes, and outcomes (Giddens, 1979; McCubbins et al., 1989). (When we present our framework in the fourth section, we delineate a separate set of contextual variables that are independent of but influential on the particular PG setting and operational arrangements.) Structural characteristics denote the formal and informal authority given to or assumed by decision centers within the system, as well as constitutional-level (or overarching) institutions. As the black arrows in Table 1 suggest, these structural characteristics shape the dynamic processes by which decision centers engage in mutual adjustment, because they influence which decision centers can participate and the range of processes of mutual adjustment available in a particular setting. These dynamic processes in turn produce particular outcomes, and as processes recur over time, it may be possible to observe patterns that emerge from the interactions themselves, produced by many decision centers over time rather than directed by a single decision center.

Most definitions of PG (including the definition we provide here) focus on structural and process-based elements. But PG systems are also deeply embedded within their contexts, with implications for PG form and performance. Implicit in PG theory is the idea that there is no single "optimal" approach to PG that will work in all contexts; instead, the functional form of PG will depend on the underlying socio-ecological problem, as well as the social and institutional context in which that problem occurs. Context may also shape the way that analysts define "performance," since the performance of PG systems is often conceived in terms of the collective ability to resolve complex collective action problems (Thiel & Moser, 2018; Thiel & Moser-Preiwich, 2019). Because the interplay between context and PG form is critical, important questions for this research community include identifying forms of PG that are well-suited to addressing particular collective action problems in particular contexts, as well as understanding whether certain underlying constitutional conditions[ii] are necessary for proper functioning of PG systems (Ostrom, 1999b; Thiel & Moser-Preiwich, 2019).

TABLE 1 Eight dimensions of PG are grouped into three categories.

Structural characteristics	*Dynamic processes*	*Outcomes*[a]
• Multiple decision centers • That are autonomous • With overlapping authority • Operating within a set of overarching institutions	• Multiple processes of mutual adjustment between decision centers • Low entry and exit costs for decision centers	• Emergent patterns of behavior, interactions, and outcomes • Emergent and effective coordination throughout the system as a whole.

Note: Source: Adapted from Stephen et al. (2019: 41).

[a]Scholars differ on whether to include emergent outcomes, such as effective coordination, as part of the definition of PG. For some, a "true" PG should be capable of producing these outcomes; for others, this is an empirical question.

Structure, process, and institutional diversity in PG

Many empirical studies of PG emphasize structural characteristics, such as the presence of multiple, independent decision centers with overlapping authority (OTW, 1961). Structural characteristics of PG are relatively easy to observe, and analysts often use structural characteristics to identify cases or use them as a focal point of empirical analysis. Structural characteristics also describe the degree to which PG gives *local* decision centers the authority and autonomy to self-govern, as well as whether and how local self-governance is supported, undermined, or otherwise affected by decision centers at higher levels of governance (Andersson & Ostrom, 2008).

But PG cannot be defined by structural relationships alone. For OTW (1961), a functioning polycentric system also requires that decision centers "take each other into account" through competitive, cooperative, conflictual, and hierarchical interrelations, thus enabling participants to solve complex collective action problems around how to best provide a complex array of public goods.[iii] One argument offered by OTW (1961) was that in metropolitan areas, PG would allow towns, cities, suburbs, and neighborhoods not only to compete to offer desirable services to citizens but also to collaborate or consolidate when doing so would improve the delivery of local public goods and services. This idea that effective PG requires multiple, diverse coordination processes ordered through markets, hierarchies, or cooperation has become resonant in the literature on PG (Carlisle & Gruby, 2018; Kellner et al., 2019; Thiel & Moser, 2018).

In theory, institutional diversity within PG should give participants a wide array of possible coordination mechanisms to structure their interactions. In addition to OTW's original focus on cooperation, competition, and conflict as primary coordination mechanisms, scholars also point to negotiating and learning over time as ways that actors coordinate within systems (Koontz et al., 2019; Lubell, 2013). And Vincent and Elinor Ostrom themselves define agents in their work as boundedly rational, fallible learners, some of whom become artisans of institutional crafting (Ostrom et al., 1994; Ostrom, 1980). Theoretically, as actors learn over time, they should be able to devise new policy venues to engage with one another and develop new coordination processes to improve shared capacity for collective action (Ostrom, 2005). But effective coordination is not automatic in PG, and the empirical literature offers examples of ineffective or insufficient coordination within PG (Lieberman, 2011; Morrison, 2017).

Outcomes of PG

Finally, the interplay between structure and process gives rise to outputs and outcomes. Any case of PG will produce a great many outputs and outcomes, and it can be challenging to identify which outputs and outcomes are most important to study. Not surprisingly, scholars have taken a wide range of approaches to the way that they conceive of "outcomes" in PG. Many of the first PG studies focused on PG's potential to improve citizens' satisfaction with service delivery (McGinnis, 1999; Ostrom, 2010; Ostrom et al., 1961). As the PG concept was developed further by scholars of natural resource governance, PG was theorized to lead to long-term sustainable resource use (e.g., Andersson & Ostrom, 2008), or adaptive capacity (e.g., Pahl-Wostl et al., 2012). These kinds of socio-ecological outcomes are straightforward to conceptualize, if sometimes more difficult to observe and measure.

But socio-ecological outcomes alone may not fully describe all of the potentially relevant outcomes of PG. PG is theorized to improve actors' ability over time to learn, solve problems, resolve complex collective action dilemmas, and develop the capacity to respond effectively to exogenous shocks (Béland et al., 2022; Béland & Schlager, 2019). Table 1 reflects this idea by conceiving of outcomes of PG not solely in terms of socio-ecological outcomes at a given moment in time but also as emergent patterns of behavior and coordination. These longer-term governance outcomes are theoretically important, but far less straightforward to define, observe, and measure empirically.

The question of whether and why PG gives rise to desirable outcomes at all is a pressing one. One of the major benefits of a polycentric system is that participants are free to set up new decision centers, and

these new decision centers may well have jurisdictions that overlap, at least in part, with the previous set of decision centers, or with decision centers at higher levels of governance, or in adjacent jurisdictions. But these diverse decision centers may produce externalities that affect others (Mewhirter et al., 2018), have different preferences about what substantive outcomes the system should seek to achieve, or have different ideas about what procedures should be used to balance conflicting interests. PG may change dynamically in response, as decision centers periodically or continually (re)negotiate and reconfigure their overlap and authority.

Positive and negative features of PG

While some studies tend to assume PG will generally produce normatively desirable outcomes (Tormos-Aponte & García-López, 2018), this was an empirical question for OTW (1961), and it remains a critical question for empirical research. Moreover, as research on PG has accumulated, the literature has identified cases where PG failed to result in emergent order or to adapt well to changing conditions (e.g., Lieberman, 2011; Morrison, 2017). Below, we briefly describe some of the positive and negative features that have been theoretically associated with PG (as compared to more centralized governance approaches) in prominent recent work on PG. We summarize these in Table 2.

Starting with the positive features of PG, many scholars suggest that the presence of multiple autonomous decision centers will give local decision centers the flexibility to govern in ways that match local conditions, rather than follow a centralized blueprint (e.g., Carlisle & Gruby, 2019). Over time, this should facilitate actors' ability to experiment in an effort to improve governance outcomes – for example, by creating new venues for coordination across decision centers or changing the rules in use within existing venues. Other decision centers may observe and learn from this kind of experimentation, leading to widespread adoption of new governance approaches that improve actors' ability to act collectively (ibid.). This kind of experimentation and adaptation is thought to make PG more adaptive and resilient to exogenous shocks, since individual decision centers can respond to changing conditions and share successful innovations with other decision centers, and redundancy across decision centers may protect against the risk of widespread governance failures (Anderies & Janssen, 2013). Underlying these dynamics is the idea that respectful and accessible contestation processes can lead to change and evolution in the institutional landscape of PG.

The public, in turn, may see outcomes from PG as more legitimate than outcomes produced by more centralized governance arrangements, since local decision centers may be more likely to include local actors or address local needs and preferences, which increases perceived legitimacy (Bryson et al., 2006;

TABLE 2 Examples of potential positive and negative process-related features of PG.

Positive features	Negative features
Flexibility to match local circumstances	High transaction costs required to coordinate a coherent response to major challenges
Encourages opportunities for experimentation and learning	Weakens democratic accountability: "who's in charge?"
More resilient to exogenous shocks	Powerful actors may easily manipulate the system for personal/private interest
The public sees outcomes as more legitimate	Non-institutionalized, marginalized groups may be excluded if they are not proactively and structurally included
Facilitates identification of trustworthy collaborators	Too many veto points, holdouts, or intractable conflicts may prevent any coordinated response to problems
Long-term accumulation of successful adjustments provides lots of options	Complexity may become overwhelming and may reinforce status quo conditions
	Externalities and conflicts may spread across forums

Note: Source: Synthesized from Jordan et al. (2018) (citing Galaz et al., 2012; Lieberman, 2011; Morrison, 2017; Ostrom, 2010; Sovacool, 2011; Thiel & Swyngedouw, 2019).

Emerson & Nabatchi, 2015). As policy actors participate in PG arrangements over time, they can identify trustworthy collaborators to work with (Ostrom, 1998, 2010), and accumulate a range of coordination mechanisms that can be applied as new problems emerge or conditions change.

But not all features of PG are positive. With multiple decision centers and means of coordination, transaction costs tend to be high in PG, suggesting that PG may be an effective solution only in cases where the potential gains from collective action outweigh the costs of coordination (McGinnis, 2005). The complexity inherent in PG can also raise concerns about democratic accountability, as it may be difficult to assess who is in charge – and who should be held accountable if problems arise (Lieberman, 2011). PG may be dominated by powerful actors with the capability or the financial resources to participate, creating the opportunity for those powerful actors to create new rules, procedures, or policy venues that serve their own individual interests, even if those interests run counter to the collective interests of the group (McGinnis, 2005). Similarly, marginalized groups may be deliberately excluded, or may lack the resources and capability to navigate complex governance arrangements. Even where transaction costs and power asymmetries are not present, complex PG arrangements may create multiple veto points, or suffer from intractable conflicts, such that a few holdouts can stymie progress for everyone (ibid.). And if complexity is too overwhelming, it may be difficult for actors to actually engage in experimentation and learning, reinforcing status quo conditions that may turn out to be maladaptive over time (Morrison, 2017).

As Table 2 suggests, PG can take multiple forms, and can have both positive and negative implications, and no particular form is a blueprint solution for all contexts. While there is burgeoning empirical literature on polycentricity, to date much of this work has focused on answering questions about whether PG has been effective in the areas where it has been observed, rather than asking why or under what circumstances PG is likely to work well. And scholars are just beginning to develop theoretical models that might guide this kind of inquiry. In one of the more comprehensive theoretical models offered to date, Carlisle and Gruby (2019) build on Ostrom (1999a) to propose that particular *enabling conditions* (e.g., contextual characteristics shaping PG) are required for PG to produce corresponding positive benefits. They theorize, for example, that benefits of PG such as adaptive capacity require institutional diversity, decision centers at multiple levels, and cross-scale linkages that allow these decision centers to deliberate and learn from one another, as well as mechanisms for accountability and conflict resolution (ibid.). Testing these propositions will require framework-guided, systematic cross-case comparative institutional analysis (Cole, 2013; Greif, 1998) which remains rare in the literature.

WHAT DO WE KNOW ABOUT WHY PG PERFORMS WELL IN SOME CASES BUT NOT IN OTHERS?

In this section, we return to our original research question: *what do we know about why PG works well in some cases but not in others*? In much of the literature and scholarly debates about PG, there is a normative assumption that PG is preferable to more centralized governance models. But as Table 2 suggests, complex governance arrangements could have both positive and negative features, and discerning whether and why PG arrangements lead to positive or negative outcomes is a pressing empirical question. Below, we systematically review the literature on PG.

Article sampling strategy

Using Web of Science, we searched for articles using the term "polycentric governance," finding 283 articles for our review published between 2006 and 2020.[iv] To ensure that we were not missing seminal articles that omitted the term "governance," we also searched for the term "polycentricity" within the five journals that had published the most policy-oriented empirical work on PG (Policy Studies Journal, Ecology and Society, Environmental Policy and Governance, Environmental Science and Policy, and the International Journal of the Commons), which brought our sample up to 302. After filtering this

initial sample to exclude book chapters, conference proceedings, non-empirical work, and predictive models, we had a final sample of 179 empirical, peer-reviewed articles. Undoubtedly, our sampling approach misses some important empirical articles, including those not indexed in Web of Science, or seminal works that use different terminology. Nonetheless, we believe that our sample of articles paints a sufficiently representative picture of the literature on PG.

Article coding and analysis

We iteratively developed a codebook to track article attributes, policy areas, and data and methodological approaches for our sample of 179 articles. Three co-authors each coded roughly one-third of the total sample. To ensure consistency in coding, we tested the coding form on an initial sample of eight articles, compared results, clarified any ambiguities, and updated the codebook. The results of this coding are presented below.

This initial coding process revealed a number of studies that referenced PG only as a framing device or a policy prescription and thus provided limited empirical evidence about PG performance or related dynamics. To continue our investigation into why PG performs well in some cases but not others, we narrowed our focus to 112 articles that either a) empirically examined PG as a key independent, dependent, or context variable, or b) explicitly sought to advance our understanding of the functioning, form, or performance of PG in some way. For these 112 articles, we used an open-ended coding process to summarize each paper's research questions, hypotheses, and findings.

We initially attempted to engage in systematic cross-case comparison by coding and comparing the independent and dependent variables used in each analysis, but found that many papers were not explicit about the way that they conceived of independent and dependent variables. Moreover, the literature has not yet defined the basic concepts and variables in a way that would enable comparison across studies of PG. We also found that many research questions were vague or inconsistent with the papers' actual empirical analyses, and few papers in our sample included explicit hypotheses. Since these challenges undermined our ability to engage in meaningful cross-case comparison, we chose instead to synthesize the findings that the authors themselves highlighted in their discussion and conclusion sections. We draw on these findings to provide evidence about PG performance, as well as the positive and negative features described in Table 2. The results of this qualitative analysis are presented below in two Sections: Synthesis of findings about PG performance and Remaining gaps.

Overview of how the field has developed over time

As Figure 1 shows, articles on PG have increased over time, with pronounced upticks in empirical articles around 2012, 2015, and 2017 and a slight drop-off in 2020, which may reflect pandemic-related publication delays rather than decreased interest in PG itself.

Studies cover all regions, but cases from Europe and North America are most prevalent, and the 2017 uptick is largely driven by cases from Europe (see Figure 2). Similarly, studies span all geographic scales, but studies that focus on the local or national level are less common than those that study subnational regions (see Figure 3).

Water and climate are the two most commonly studied policy areas, suggesting that two main drivers of this body of literature are scholars' interest in nested water governance, on the one hand, and growing calls for polycentric approaches to climate governance on the other. Global level and transboundary studies were relatively rare before 2016, but have increased rapidly since then, reflecting increased interest in PG for global problems like climate change. As Figure 4 shows, many papers focus on policy areas that are outside traditional natural resource governance, suggesting considerable potential for the field to expand to other policy areas.

Our sample includes papers focused on policy areas as diverse as education (Ball & Exley, 2010), healthcare (Carter & Martin, 2016), global shipping (Monios, 2019), governance of global nitrogen and
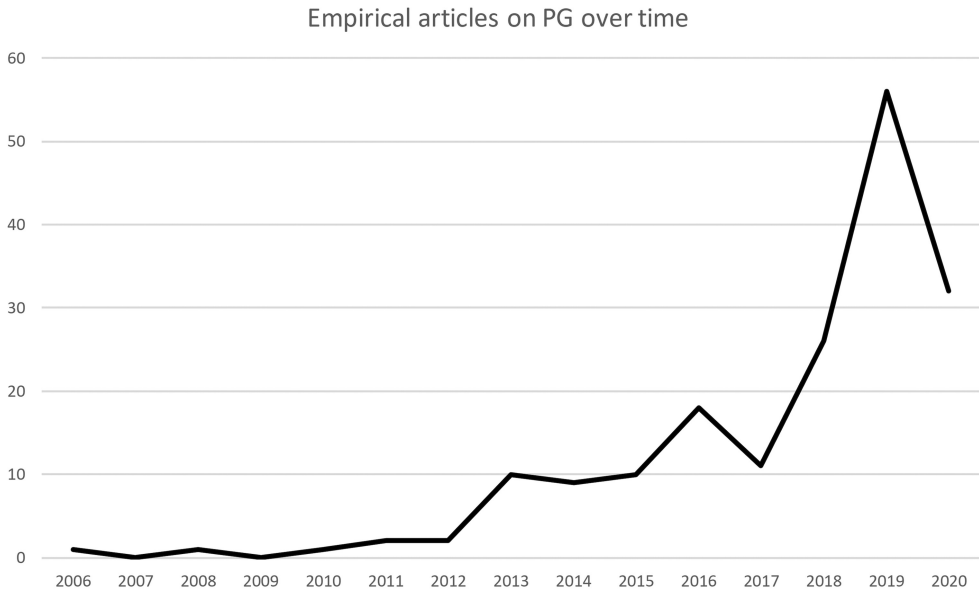
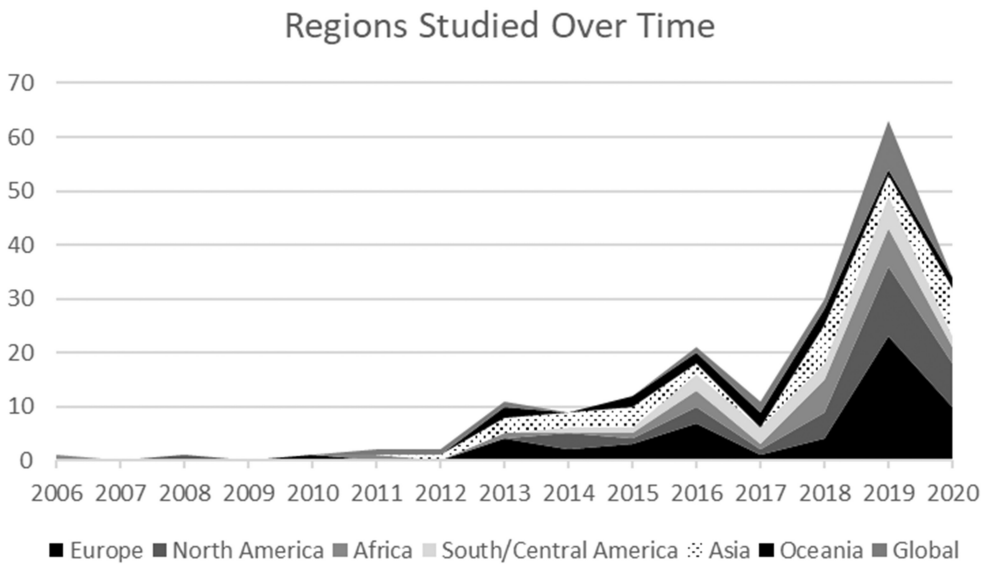**FIGURE 1**   Number of empirical articles on polycentric governance over time.

FIGURE 2   Regions studied over time.

phosphorous cycles (Ahlström & Cornell, 2018), and wildfire (Kelly et al., 2019). PG thus applies in diverse settings well beyond traditional common pool resources, particularly those where policy problems and solutions span jurisdictional boundaries or levels of governance.

Methodologically, qualitative case studies have traditionally been – and remain – most common (see Figure 5). Single case studies continue to predominate, although comparative work has become more common. Over time, a growing number of studies have begun to use larger-n research designs and to employ statistical and social network analytical methods. For a small but significant number of studies, however, it was impossible to discern a clear research design or method (Figure 5).
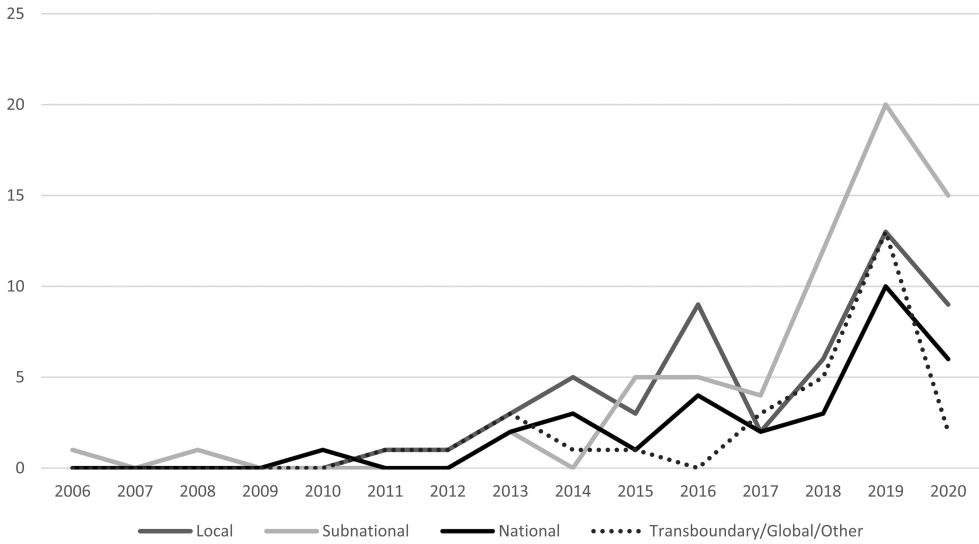
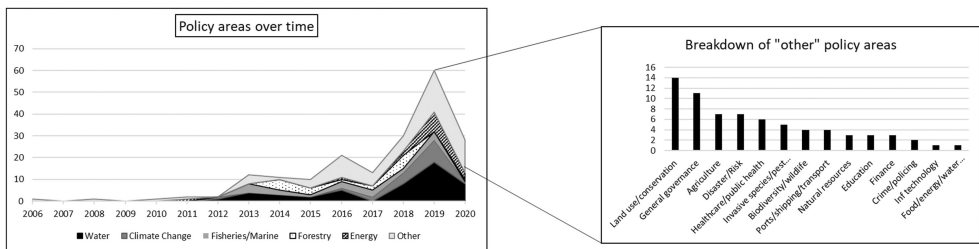**FIGURE 3**   Geographic scales studied over time.

FIGURE 4   Policy areas studied over time.

Somewhat surprisingly, while many studies referenced the IAD or SES frameworks, few of them made explicit use of either framework to guide their choice of variables, posited the IAD's "action situation" as the core unit of analysis, or otherwise used the IAD or SES framework to guide empirical description and analysis (exceptions include McCord et al., 2017; Müller & Chaliganti, 2016; Nyaupane et al., 2022). Our review thus suggests that empirical researchers continue to see the IAD as primarily useful for studying relatively bounded and static action situations where individuals are the primary actors (Ostrom, 2011), despite recent efforts to conceptualize PG as comprising multiple, interconnected action situations (e.g., Kimmich, 2013, 2023; McGinnis, 2011).

Finally, most studies in our sample had a temporal length of 2 years or less, providing a very limited snapshot of governance systems. As the number of PG studies has increased, we have seen an uptick in studies with a temporal period of 10 years or more (Figure 6).

Synthesis of findings about PG performance

We turn now to a more in-depth synthesis of findings from the 112 articles that analyzed PG empirically. We start with findings about PG performance and then move on to discuss findings that provide empirical evidence for or against the positive and negative features of PG summarized in Table 2.
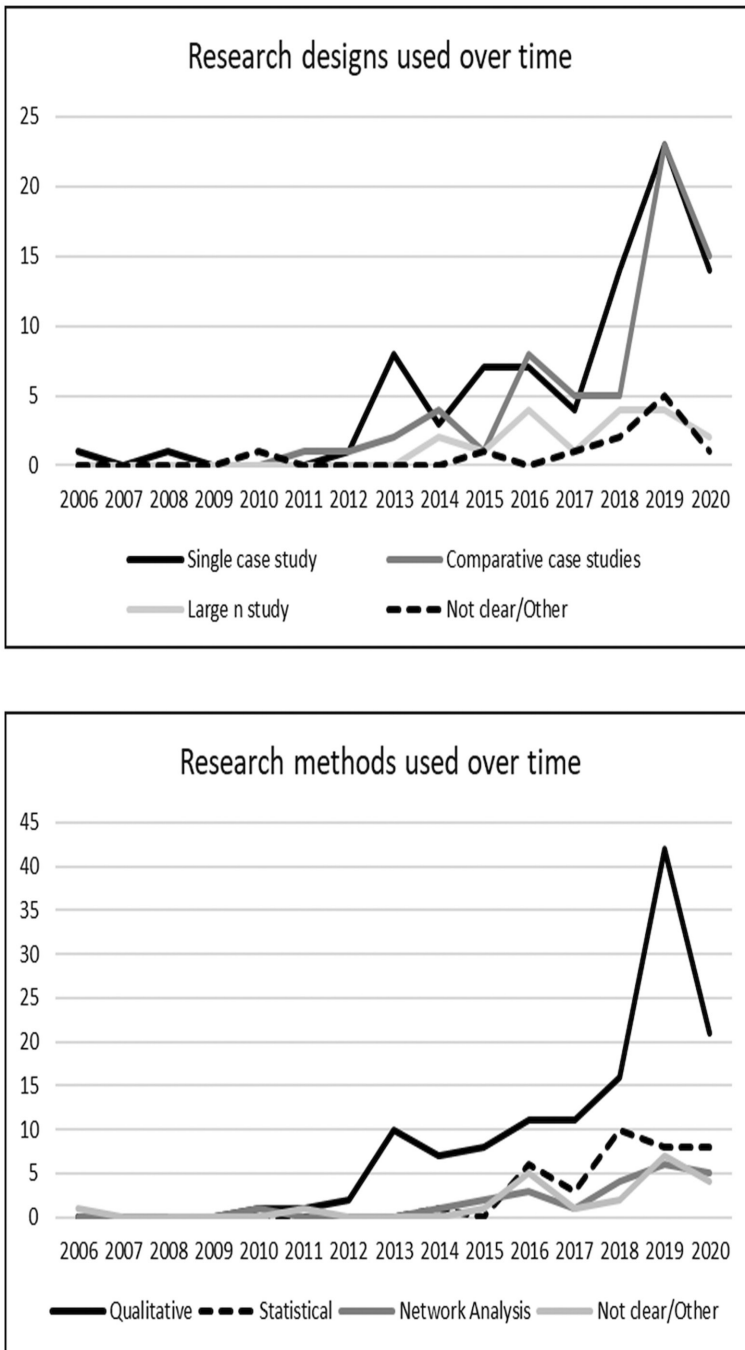
FIGURE 5   Research designs and methods used over time.

Findings about PG performance

About half of the studies in our sample assessed the relationship between PG and outcomes, effectiveness, or performance, often defining performance in terms of adaptive capacity, resilience, or sustainable resource use (e.g., Pahl-Wostl et al., 2012). Across multiple natural resource governance settings, many case studies found that "structurally" PG arrangements can improve sustainable resource use
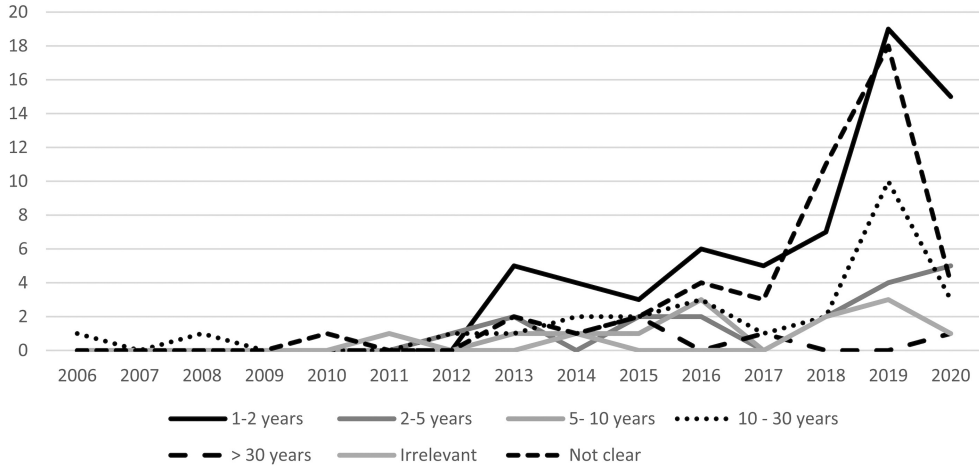
FIGURE 6   Study temporal length over time.

and/or adaptive capacity, although performance may be partial or conditional on the availability of multiple, effective coordination mechanisms (Baldwin et al., 2018; Baltutis & Moore, 2019; Biddle & Baehler, 2019; Bissonnette et al., 2018; Carlisle & Gruby, 2018; Kelly et al., 2019; Pahl-Wostl et al., 2012; Pahl-Wostl & Knieper, 2014; Sandström, Söderberg, & Nilsson, 2020; da Silveira & Richards, 2013; Sixt et al., 2019; Thiel, 2015; Vaas et al., 2017; Wit & Freitas, 2019a, 2019b).

But other studies found that PG approaches were simply ineffective, maladaptive, or generated negative externalities (Lieberman, 2011; Morrison, 2017; Ros-Tonen et al., 2014; Sovacool & Van de Graaf, 2018; Sunderlin et al., 2015; Wyborn, 2015). A significant number of studies conducted in the global South raised deeper concerns that PG-oriented reforms may undermine or crowd out local resource users' authority (Aswani et al., 2017; Carlisle & Gruby, 2018; Gruby & Basurto, 2013; Komakech & van der Zaag, 2013; Müller & Chaliganti, 2016; Nyaupane et al., 2022; Ringel, 2018). A handful of studies, all focused on European water governance, identified tradeoffs: PG can increase diverse actors' engagement with PG and improve legitimacy, but in doing so may also introduce transaction costs and delays (Juerges et al., 2018; Newig et al., 2016; Schröder, 2018).

Findings about the positive and negative features of PG

Given the mixed and contradictory findings about PG performance, we dig deeper to explore whether the literature provides more nuanced evidence about why some PG cases exhibit the positive features described in Table 2, while other cases exhibit the negative features. Few studies explicitly tested these theoretical features from the literature: only thirty-three studies provided explicit hypotheses or propositions, and even fewer hypothesized about the positive and negative features of PG summarized in Table 2 (exceptions include Carlisle & Gruby, 2018; Fisher & Leifeld, 2019; Gallemore, 2017; Kellner et al., 2019; McCord et al., 2017; Newig et al., 2016; Pahl-Wostl & Knieper, 2014; Shawoo & McDermott, 2020; Wit & Freitas, 2019a, 2019b). Below, we synthesize findings about the positive and negative features of PG in the cases studied.

Findings about the positive features of PG

Table 2 identified six potentially positive features of PG: flexibility to match local circumstances; opportunities for experimentation and learning; resilience to exogenous shocks; perceived legitimacy of outcomes; identification of trustworthy collaborators; and long-term accumulation of successful

adjustments providing lots of options for problem-solving. Below we summarize the study findings on these themes.

Several studies found that PG provided the flexibility to meet local circumstances. At least three studies found that PG was effective or partially effective in allowing local users to devise locally appropriate rules for the governance of water (Baldwin et al., 2016), forests (Nagendra & Ostrom, 2012), and marine areas (Carlisle & Gruby, 2018).

And several more studies found that PG improved resilience to exogenous shocks. Across multiple countries, forests that combined fragmented authority with effective coordination mechanisms were better able to manage climate-related challenges (Pahl-Wostl et al., 2012; Pahl-Wostl & Knieper, 2014). Other studies found that PG was generally adaptive in the face of ecological change, conditional on the presence of effective systems for coordination and information exchange (Becker et al., 2015; Bissonnette et al., 2018); without such mechanisms, dispersed authority was not adaptive (da Silveira & Richards, 2013).

Nearly a dozen studies found that PG provided opportunities for experimentation and learning, making this a more frequent theme in the literature (Bixler, 2014; McCord et al., 2017; Méndez-Medina et al., 2020; Sandström, Söderberg, Lundmark, et al., 2020; Sixt et al., 2019; Wit & Freitas, 2019a, 2019b). PG often allowed policy actors to create new institutional arrangements to address emergent problems or fill existing gaps in the governance system – for example, by creating local associations that could bridge gaps between governments and local resource users (Favero et al., 2016; Juerges et al., 2018; Nagendra & Ostrom, 2012), or that could improve coordination between actors at multiple levels in global governance systems (Ahlström & Cornell, 2018; Livingston et al., 2018). In some instances, PG itself was seen as the innovation and was identified as being more likely to emerge in contexts where authority is less centralized (Baltutis & Moore, 2019; Long et al., 2018), or in response to exogenous shock (McCord et al., 2017). At least five studies were careful to note, however, that experimentation is not automatic in PG (Carlisle & Gruby, 2018; Ros-Tonen et al., 2014; da Silveira & Richards, 2013), but is conditional on interactions and linkages between actors in the system (Fisher & Leifeld, 2019; Wyborn, 2015).

Several studies found that PG improved the perceived legitimacy of outcomes. Two studies (both of the same case) found that PG helped improve public acceptance of a dam in Switzerland (Kellner, 2019; Kellner et al., 2019), and others found that in their studies of PG the public generally perceived decision-making processes to be effective, conditional on sufficient local involvement (Baldwin et al., 2018; Juerges et al., 2018; Newig et al., 2016).

While no studies directly addressed the claim that PG helps participants identify trustworthy collaborators, several social network analyses explored the presence and prevalence of "bonding" structures, which indicate that actors participate jointly in multiple forums (e.g., Berardo & Lubell, 2016). And a number of studies find that PG helps to build trust among interdependent actors (Aude et al., 2019; Baldwin et al., 2018; Nagendra & Ostrom, 2012; Wit & Freitas, 2019a, 2019b). No studies directly addressed the claim that the long-term accumulation of successful adjustments provides lots of options for long-term problem-solving.

Findings about the negative features of PG

Table 2 also identified potentially negative features of PG: high-transaction costs; weakened democratic accountability; exclusion of marginalized groups; manipulation by powerful actors for private gain; overwhelming complexity that reinforces status quo conditions; veto points, holdouts, or intractable conflicts that prevent coordinated responses to problems; and negative externalities may spread across forums. As with the positive features of PG, most studies did not address these negative features explicitly, but many studies provided evidence that these negative features are common in cases of PG.

At least a dozen studies associated PG with increased transaction costs, due to the presence of multiple actors, institutional diversity, and high coordination needs (Newig et al., 2016; Sovacool & Van de Graaf, 2018; Wyborn, 2015). Other studies, however, suggested that PG can *reduce* transaction costs, for example, by connecting government agencies' technical expertise with local user groups' local knowledge

and proximity to conditions on the ground (Nagendra & Ostrom, 2012, 2014). Most studies, however, addressed transaction costs not at the system level, but from the perspective of the individual. Participating in PG generally involves high transaction costs for participants (Gallemore, 2017; Gallemore et al., 2015; McAllister et al., 2017), suggesting that the perceived benefits must outweigh those costs if actors are to participate (Hileman & Bodin, 2019). The effects of transaction costs are heterogeneous across actors and governance levels (Lubell et al., 2020). Over time, the costs of participation may decrease as actors gain experience with one another (Hamilton & Lubell, 2019; Hileman & Bodin, 2019).

At least eight studies identified weak accountability as a problem in PG (Caron & Fenner, 2017; Greer et al., 2018; Lieberman, 2011; Thiel & Moser, 2018; Wit & Freitas, 2019a, 2019b). PG can diffuse responsibility, encouraging free riding (Lieberman, 2011), or dilute the powers of locally accountable institutions (Greer et al., 2018; Müller & Chaliganti, 2016). PG may suffer from a lack of transparency (Monios, 2019), which limits actors' ability to assess and contest outcomes (Thiel & Moser-Preiwich, 2019). Weak accountability is not inherent in all PG but depends on whether and how new institutions are embedded in existing governance structures (Aswani et al., 2017).

At least seven studies highlighted the potential for PG to exclude marginalized groups. Several studies focused on innovative, participatory institutions developed in the global South, and noted that these new institutions can ignore, crowd out, or undermine local communities or traditional authorities (Carlisle & Gruby, 2018; Ebel, 2020; Komakech & van der Zaag, 2013), particularly when innovations are proposed by outsiders, such as donors and international NGOs (Aswani et al., 2017; Carlisle & Gruby, 2019; Komakech & van der Zaag, 2013). Even outside the global South, heterogeneity in transaction costs can lead to the under-representation of local actors or those with limited capacity to engage (Lubell et al., 2020), echoing broader concerns in the literature about whose interests are served by complex PG arrangements (Thiel & Swyngedouw, 2019).

At least four studies found that PG is potentially vulnerable to manipulation by powerful actors for private gain (Biddle & Baehler, 2019; Gorris et al., 2019; Greer et al., 2018; Libman & Obydenkova, 2014). Without additional support, local decision centers may lack the capacity or political will to avoid capture by industrial interests (Libman & Obydenkova, 2014). Conversely, however, at least two studies discussed the possibility that PG helps to align diverse actors' interests, avoiding this kind of capture (Baldwin et al., 2018; Favero et al., 2016).

Several studies described cases where governance complexity undermined change or prompted reversion to the status quo (Ng et al., 2019). In a study of historic PG water governance arrangements, Mostert (2015) found that change is complex and difficult in PG, particularly if there are multiple, vested interests in the system. PG can create a "joint decision-making trap" where multiple veto points slow decisions (Fisher & Leifeld, 2019; Juerges et al., 2018). Conversely, PG might help *overcome* blockaged progress, if multiple actors and diverse institutions help overcome stalemate (Gillard et al., 2017).

No study findings provided evidence that PG may lead to hidden or intractable conflicts, although at least two studies found that institutional externalities are common in PG (Greer et al., 2018; Mewhirter et al., 2018).

Remaining gaps

The literature reviewed above demonstrates the breadth and depth of PG studies, shows that PG has been studied in a wide range of cases, and provides empirical evidence to show that both the positive and negative features of PG occur in practice. But the literature has done little to cumulate generalizable knowledge about why some cases exhibit the positive features of PG while others exhibit the negative features – a critical question, particularly given the tendency for many scholars and practitioners to call for more PG in practice.

Given the large and growing number of studies, why have we failed to cumulate generalizable knowledge about when and why PG is likely to work well? This may be partly due to the lack of a shared language on PG – e.g., shared and clearly defined terms and concepts – that would enable cross-case comparison. It may also be partly due to selection bias: the studies in our sample reflect cases that

scholars found interesting, rather than the full universe of possible cases, and within individual cases, authors highlight some features of interest while ignoring others. But we argue that a bigger limitation is the literature's general inattention to two aspects of PG that are fundamental to our understanding of the concept as described in our overview of the conceptual history of PG. These are: (a) limited attention to the underlying context shaping the process-related performance of PG; and (b) limited attention to the way that PG evolve and changes over time, and its longer-term effect on process-related performance and sustainability.

Context as an important but often overlooked factor shaping PG

Taken as a whole, the literature has yet to devote systematic attention to the underlying context in which PG occurs, despite the fact that much of this literature at least makes reference to frameworks that emphasize the importance of context - e.g., the Institutional Analysis and Development (IAD) and Social-Ecological Systems (SES) frameworks (Schlager & Cox, 2018). We define "context" to include factors that exist independent from the specific geographic or policy setting where PG occurs. Consistent with the IAD and SES frameworks, we include factors such as political regimes, systems of property rights, basic features of the socio-ecological problem, and historical culture and norms among social groups. Often, contextual factors were not part of a study's initial research question or hypothesis but emerged as an ad-hoc explanation of why PG failed to perform well. The studies that did address contextual factors tended to focus on how context affects the performance of PG, but often overlooked important questions about how context shapes the basic form of PG. Below, we summarize the main contextual factors that studies identified as important to the form or functioning of PG.

First, several studies focused on the underlying problem context. In a comparative study across the energy-water nexus, Villamayor-Tomas (2018) finds that PG was more adaptive to changes in water conditions than to changes in energy prices. Sandström, Söderberg, & Nilsson, (2020) find that PG works well for problems characterized by vertical policy incoherence across governance levels, but less so for problems that span jurisdictions at the same governance level. Greer and Scott (2020) suggest that performance may be conditional on the nature of actors' interdependence. And Knieper and Pahl-Wostl (2016) find PG performance may be conditional on the underlying problem severity.

Second, community attributes also shape PG. Several studies found that low funding levels affect PG performance (Carlisle & Gruby, 2018; Sovacool & Van de Graaf, 2018; Vaas et al., 2017). The capacity of local actors may matter, since some PG arrangements are vulnerable to actors with an incentive to exploit resources for their own gain (Biddle & Baehler, 2019; Gorris et al., 2019; Libman & Obydenkova, 2014). Cultural norms and political support within the community may also shape the effectiveness of PG (Biddle & Baehler, 2019; Omori & Tesorero, 2020; Sunderlin et al., 2015). The past history of interactions, stability, conflict, trust, and cooperation may affect how actors engage in the process (Lubell et al., 2020).

Finally, the national institutional context can be a key factor. Aswani et al. (2017) find that the institutions around land tenure that helped Fiji develop successful polycentric reforms would be unlikely to work in the Solomon Islands or Vanuatu, where land tenure is different. Incoherent policy can also undermine effectiveness (Schroder et al., 2020). And in contexts where authority is centralized or where local actors lack autonomy, PG is likely to emerge slowly and take time (Baltutis & Moore, 2019).

Limited attention to emergence, feedback, and change over time to PG systems

Few studies in our sample took a longitudinal approach that examines how governance systems emerge, change, and evolve over time. However, we consider it of core importance to understand whether and how contextual characteristics affect PG, and whether the resulting PG is capable of maintaining sustainable production of collective goods over longer periods of time even as contextual conditions change. Thus, given that PG is theorized to change dynamically over time in response to changing conditions and citizens'

demands, as well as the prevalent discussions of PG's potential adaptiveness and resilience, it is surprising that so little research has paid explicit attention to dynamic institutional change over time. While the literature on PG tends to emphasize policy learning and improved governance over time as part of the PG process, relatively few studies examined this process empirically. As noted earlier in our findings about the positive and negative features of PG above, many studies highlighted the creation of new policy venues or other institutional forms to fill existing coordination gaps; but relatively few explored how these institutions emerged and what contextual influences prompted changes to these institutions over time.

Notable exceptions illustrate the potential insights that can come from taking a longer-term view. For example, Biddle and Baehler (2019) engage in a comparative case study of two water systems over several decades and find that over time, the attitudes and behaviors of political elites can reshape institutions to have either positive or negative long-term effects. In another study, Kellner et al. (2019) found that the rules of engagement in a hydroelectric dam concession process had been changed in an explicit attempt to encourage more negotiation about a conflictual trade-off situation between the production of renewable energy and environmental protection. In another study, Barnett and Anderies (2014) compared the evolution of two lobster fisheries over time, finding that Maine's fishery included stronger feedback systems where fishers were allowed to modify rules based on their experience with outcomes; in Nova Scotia, where such feedbacks were weaker, the governance system declined over time (ibid.). And in a study of Australia's Great Barrier Reef, Morrison (2017) finds that PG has produced incremental, unintended, and maladaptive changes to the governance system (Morrison, 2017). Considerable insight could be gleaned from further studies that examine how governance arrangements change, how those changes affect the system's ability to function, and what possible safeguards might help ensure that change is adaptive, rather than maladaptive, over time.

A META-THEORETICAL FRAMEWORK FOR ANALYZING PG

Rationale for a framework

One surprising finding in our review is that relatively few PG studies have made explicit use of traditional tools like the IAD and SES frameworks to guide their analyses. These frameworks provide insights and concepts that are designed to facilitate cross-case comparison, but our review suggests that scholars either do not see utility in applying these frameworks to PG or may find it challenging to apply the IAD framework – which is oriented around the individual action situation – to cases of PG, which by definition will comprise a great many individual action situations and capture interrelations between and among them. The conceptual framework that we introduce in this section includes many of the basic components found in the IAD and SES frameworks but scales up the level of analysis for application to cases of PG. In doing so, we draw explicit attention to PG as process-based, embedded in context, and subject to dynamic long-term change.

We start by identifying a few key differences between PG and the governance settings where the IAD and SES frameworks have been most commonly applied. First, while the IAD and SES frameworks were designed to address *individual* action situations, PG by its very definition comprises multiple, interdependent action situations and their interrelations. Second, the IAD and SES frameworks are often used to reconstruct local collective action situations where individual agents are the key actors and take on critical roles in the governance system. In contrast, in PG, actors are often organizations or other collectives of individuals. The nestedness of decision-making in PG thus requires analysts to scale up from individual actors within action situations (in the original IAD) to organizational actors interacting within complex or emergent policy venues and other settings (to study PG). Third and perhaps most crucial, the IAD is conventionally used to analyze the performance of collective action problems as if they were static.[v] In our view, it is important to understand and assess PG performance as a dynamic process.

If we want to understand and observe PG performance in the medium to long term, we need to conceptualize and empirically observe how PG changes over time to produce (and re-produce) outcomes

of interest. And because any empirically observed form of PG will be uniquely embedded within its social–ecological context, understanding medium to long-term performance also requires us to examine how the social-ecological context affects the way PG changes over time. In relation to the latter, we identify particularly important pathways where we might expect dynamic change over time – such as the influence of context on PG processes of coordination and contestation, the influence of PG outcomes on underlying contextual conditions, or the way that PG outcomes may influence policy actors' preferences, demands, and behaviors over time. Studying dynamic changes may not have been central for many analyses using the IAD or SES frameworks, but they are critical for the study of PG because we expect PG to adopt diverse forms, and to be shaped and re-shaped by contextual factors. Thus, specific contextual conditions help to determine PG's form, maintain or modify it over time, and shape its performance in desirable ways (or not) (Thiel, Pacheco-Vega, & Baldwin, 2019). We also highlight several important, dynamic aspects of the socio-ecological context that condition sustainable PG, such as the importance of "enabling conditions" including overarching rules and cross-scale coordination (Carlisle & Gruby, 2019).

Introduction to the context-operations-outcomes-feedbacks (COOF) framework

In the tradition of the Bloomington School of Political Economy, we base our framework on the fundamental building blocks of the Institutional Analysis and Development (IAD) framework (Cole & McGinnis, 2017; Ostrom, 2005). Our framework, presented in Figure 7, has four main components, several of which are drawn directly from the IAD: (a) contextual characteristics; (b) operational arrangements; (c) outcomes of the governance system; and (d) feedback pathways and adjustment mechanisms whereby outcomes may generate or drive changes in contextual or operational parts of the system. Temporal sequences and causal connections are denoted as moving (during time period t) from left to right in Figure 7, showing that contextual factors shape governance arrangements, and governance arrangements produce outcomes. These outcomes are important in their own right, but if they generate feedback effects, they can also have longer-term effects on contextual conditions, PG structure, and PG process. Feedback pathways that may lead to changes in contextual conditions or governance arrangements over time are denoted by dotted lines in the figure moving from right to left (e.g., at time $t + n$).

We continue to follow the standard IAD assumption that humans act as imperfectly rational actors, cognitively constrained by self-interest and preconceived notions and yet capable of cooperation and
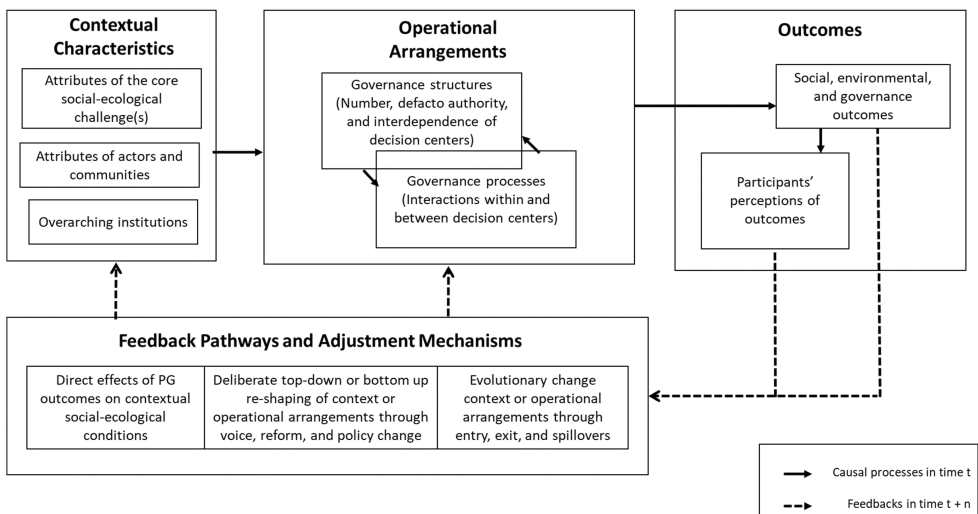

FIGURE 7 The Context-Operations-Outcomes-Feedbacks (COOFs) framework for analysis of polycentric governance.

learning (Ostrom, 1998). Actors in PG are presumed to act as public entrepreneurs, fallible but boundedly rational learners who aim to improve their well-being (Ostrom, 1980). Here, "rationality" implies that humans will generally work to pursue their self-interest, which can include altruism, social status, and cultural recognition, and can serve as an inspiration for the cooperative collective action needed for a group to realize shared goals. "Boundedly rational" implies that there are limits to human knowledge and that humans are potentially fallible, and capable of making mistakes. At the same time, we assume that humans are inherently capable of engaging in learning and collaborative problem-solving – although whether they succeed in doing so is an empirical question.

Elements of the context-operations-outcomes-feedbacks (COOF) framework

Contextual characteristics

The term PG refers to decision centers and their interactions, and these decision centers and their interactions always occur in and are structured by their broader context. Contextual characteristics include the core attributes of the social-ecological challenge, as well as the legal, political, cultural, and socio-economic setting in which governance occurs. Drawing on the IAD and SES frameworks, we identified three main types of contextual factors. First, *attributes of the core social-ecological problem* describe the socio-economic and biophysical dimensions of the collective action dilemma (Schlager et al., 1994; Thiel & Moser-Preiwich, 2019). Second, *attributes of actors and communities* describe the social setting in which governance occurs, including demographic factors, cultural norms, resources and capabilities of individuals, their distribution across a community, and their history of social relations (Aligica & Tarko, 2013). Finally, *overarching institutions* refer to the relevant formal or informal rules and norms about decision centers' abilities to form, self-govern, and engage in the contestation and transformation of governance, sometimes referred to as "constitutional level" rules (Ostrom, 2011). These can include legal attributes of the governance system at the national level (or similarly "higher" governance level), such as political regime type, systems of property rights, formal or informal rules about which actors have power over others (Bushouse, 2011), and formal or informal rules about decision centers' abilities to form, self-govern, contest and negotiate governance sytems (Ostrom, 2011; Thiel, 2017). These constitutional-level rules refer to OTW (1961)'s concept of an "overarching system of rules" in PG, and can be conceptually distinguished from the operational-level institutions that delineate structure and shape processes of governance arrangements in a more day-to-day fashion.

Operational arrangements

Here, we draw on the IAD framework, but rather than positing a single "action situation" as the focal unit of analysis, we draw attention to operational arrangements that include multiple action situations and the interplay between them. At the operational level, structural dimensions include the number of decision centers that have formed or decided to participate in governance (e.g. pursuant to constitutional level rules), as well as the operational-level institutions that establish each decision center's scope of authority, allocate authority or delineate formal relationships between decision centers, and determine which actors can participate and how decisions will be made. Processual dimensions include the range of cooperative, competitive, conflictual, or hierarchical relationships between and among decision centers, including any efforts to address externalities that arise from overlap and interdependence among decision centers. Taken together, these structural and processual dimensions organize the multifaceted activities related to the provision and production of specific collective goods across multiple jurisdictions and decision centers. Conceptually, we can distinguish between structural and processual dimensions, but in practice, it may be difficult – and possibly unnecessary – to disentangle the two, and

we present both dimensions as intertwined in Figure 7. Theory suggests that in order to be effective, PG needs to operate in a coordinated manner as a "system", where ideally, incentives are aligned, information is widely shared and emerging patterns of interaction are predictable (Stephan et al., 2019).

Meaningful cross-case comparison of PG will require that authors further unpack the "black box" of governance arrangements, identify the horizontal, vertical, or other features of PG that might affect a system's "fit" with the core socio-ecological challenges, and develop ways to compare those features across cases. Readers who are interested in exploring ways to empirically "unpack" complex governance systems may wish to refer to related literature that provide guidance about how to empirically observe PG via "networks of action situations" (Kimmich, 2013; Kimmich, 2023; McGinnis, 2011) or via "ecologies of games" (Berardo & Lubell, 2019; Lubell, 2013).

Outcomes

Each governance system produces some set of social, environmental, and governance outcomes. Theory suggests that polycentricity should be particularly beneficial for improving adaptive capacity, and many studies either defined performance in terms of adaptive capacity or otherwise sought to assess how PG affected the adaptive capacity of the system (e.g., Wyborn, 2015). The literature also suggests a wide range of other potentially important outcomes of PG, including resource users' livelihoods (e.g., Bixler, 2014), equitable access to natural resources (e.g., Bennett et al., 2018), ecological conditions in forests, fisheries, and rivers (e.g., Knieper & Pahl-Wostl, 2016), and stakeholders' perceptions about the legitimacy of a governance system (e.g., Newig et al., 2016). Several studies also discussed the possibility of externalities or unintended consequences, although only one study measured this directly as an outcome variable (Greer et al., 2018).

Nearly all of the studies we reviewed measured outcomes at a single moment in time. But outcomes also recur over time, and some outcomes associated with PG are best observed as patterns over time. From this longer-term perspective, outcomes and contextual factors are closely related. The outcomes of PG observed in time t will become part of the context in time $t + n$. For purposes of framing the full context-operations-outputs-feedbacks sequence of PG, Figure 7 creates separate boxes for outputs and context. But in practice, there may be instances where the outputs observed are identical to at least some of the contextual factors that the analyst deems relevant.

Our figure also draws a distinction between outcomes and participants' perception of outcomes. The two are clearly related, but the distinction is important because PG theory presumes that those who are affected by outcomes have some ability to affect future operations. As a result, participants' perspectives and their change are a key driver of responses and change in PG systems, even if their practical ability to respond may be constrained.

Feedback pathways and adjustment mechanisms

In response to the lack of empirical attention to evolution and change over time in PG, we draw particular attention to dynamic change in the system. In the original IAD framework, feedback arrows showed connections between the core action situation and outcomes of that action situation, and then from those outcomes back to the contextual characteristics that shape the core action situation. The subsequent literature has done little to explore these connections. Here, we identify and discuss particular "feedback pathways" that connect outcomes to other elements of the framework. Within each feedback pathway, we also identify potential "adjustment mechanisms" where actors observe and adjust to outcomes in ways that induce change to PG. Intentionally, we define these concepts somewhat loosely; rather than comprehensively describe phenomena about which we currently know little, our goal is to draw on the existing policy feedbacks literature (Béland & Schlager, 2019; Pierson, 1993) to identify potential starting points for empirical analysis of feedbacks and change in PG.

Before describing feedback pathways and adjustment mechanisms in more detail, we note a few characteristics of feedbacks and change in PG systems more generally. First, we present these feedback pathways as a heuristic to describe a much more complex empirical reality. For example, while we posit three separate feedback pathways, it may be impractical to distinguish them in practice. All three feedback pathways may operate simultaneously or sequentially; and feedback pathways may induce change at all governance levels, or affect spatial or temporal conditions well beyond the analyst's study boundaries (OTW, 1961). Second, we note that while change is common in instances of PG, adjustment mechanisms are not automatic. Our framework makes explicit the fact that outcomes are dynamic over time and that these changes have an influence on contextual conditions and operational aspects of PG. The specific details about *how* dynamic outcomes prompt change to PG depend on how actors within the system adjust (or do not adjust) to these changes. Finally, the effect of feedback (pathways) is contingent upon and conditioned by the particular social–ecological context, such that similar feedback pathways may have different effects in different cases.

The first feedback pathway connects outcomes back to the attributes of the core socio-ecological challenge, including the resources, capabilities, knowledge, and experiences that actors bring to bear on these challenges. The dynamic relationship between socio-ecological outcomes in time t and contextual conditions in time $t+1$ is widely recognized in the literature on common pool resources, implicitly if not explicitly (Cole et al., 2019). When governance systems produce a sustainable supply of resources, for example, this provides actors with sustainable livelihoods; but when resources become depleted, livelihoods become more difficult, reshaping social conditions among actors and their communities.

Although this pathway may not always produce immediate adjustments, it may facilitate significant long-term effects on governance contexts, operations, and outcomes. For example, interactions with public officials can prompt individual citizens to adjust their perceived autonomy, self-worth, or ability to influence policymakers (Béland & Schlager, 2019). Also, it is well known that existing policies can provide unequal resources to different groups in society in ways that shape their political preferences and expectations (e.g., Pierson, 1993). Even slow or nearly imperceptible changes in governance operations and outcomes can shape the capabilities and experiences of policy actors in ways that might further entrench existing power relationships, or alternatively, might redistribute power more equitably among actors (Béland et al., 2022; Jacobs, 2016). For example, actors that participate in PG may gain knowledge about other participants, their interests, and the governance process itself which lead to policy learning and improved capacity for collective action over time; if marginalized groups are systematically excluded from PG, they will be excluded from this kind of learning and capacity building.

The remaining two pathways designate feedback pathways that do not operate with a *direct* effect on governance contexts but instead involve processes of evaluation and adjustment undertaken by individuals, groups, or formal organizations. Under the second feedback pathway, actors' experiences, perceptions, and subjective evaluations of governance outcomes may prompt them to engage in behaviors that cause structural changes such as legal reform, policy change, or reconsideration of the responsibilities assigned to specific public authorities or private organizations. Political scientists tend to focus on one specific adjustment mechanism within this pathway, where satisfaction or dissatisfaction with policy outcomes may prompt citizens to exercise their voice by voting elected officials in or out of office (Oakerson & Parks, 1988). This feedback pathway could also include a number of other potential adjustment mechanism where citizens or elites exercise their voice in an attempt to change policy. It can include bottom-up action, such as when actors respond to emergent problems and insufficient existing governance structures by mobilizing to revise the goals or the jurisdiction of existing organizations, or to create, change, or dissolve existing policy venues. It can also include top-down changes, where government officials and other elite actors evaluate policy outcomes as a precursor to proposing policy reforms (e.g., Baldwin et al., 2016; Kellner, 2019), or where public entrepreneurs propose new reforms (Oakerson & Parks, 1988).

A third feedback pathway prompts changes to the PG process – e.g., the way that decision centers interact with one another in the system. The Tiebout model identifies one potential mechanism within this pathway, where citizens dissatisfied with local public goods can "vote with their feet" by exiting the

local jurisdiction and entering one with a better basket of goods and services (Tiebout, 1956). Within PG, actors can often choose whether or not to participate in particular policy venues for collective action, or how to engage with other actors in those policy venues. Extending the Tiebout model to PG, there may be mechanisms by which actors' satisfaction with PG or assessment of the costs of participation in time t will shape their choices about whether and how to participate in subsequent time periods. Over time, these choices about whether and how to participate can lead to evolution in the basic processes of PG – expanding or contracting the relative authority of state-controlled policy venues (Béland et al., 2022), shaping which actors exercise the most influence in the way that collective problems are addressed, or shifting from cooperative to conflictual interrelations between decision centers.

Mechanisms within this third feedback pathway can also include spillover effects and behavior responses. Several of the social network analyses that we reviewed had moved in this direction, assessing how individuals' perceptions and past experiences shaped their interactions in the system (e.g., Berardo & Lubell, 2016). Another study assessed spillovers within a PG system, exploring how interactions in one set of venues affected problem severity for others (Greer et al., 2018). To our knowledge, no such studies have repeated over time to track longer-term feedbacks between outcomes, actors' choices about whether, where, and how to participate, and positive and negative spillovers that may occur because of these choices.

Utility of the framework

In essence, our framework bridges the gap between the IAD and SES frameworks' emphasis on case-specific contextual characteristics and the practical challenges of "scaling up" these frameworks for application to PG. To do so, we replace the IAD's focal Action Situation with our own empirical understanding of PG as a dynamic, process-based system of governance, where operational arrangements are situated within a particular context and are subject to dynamic change through particular feedback pathways. We hope that it will help guide empirical research that fills the gaps identified in our systematic literature review.

Our framework is also intended, much as the IAD was, to improve cross-case comparison by offering a shared conceptual language to analyze how PG is embedded within its context and to ensure that analysts do not overlook important categories of variables. In our literature review, many otherwise excellent papers did little to describe the underlying context, describe the governance system itself in meaningful detail, or recognize the possible feedbacks that might be at play. The literature has not yet advanced to the point where the most relevant contextual factors, governance arrangements, outcomes, feedback pathways, and adjustment mechanisms are well-identified, and we do not attempt here to introduce comprehensive lists of variables for which analysts might want to collect data. Instead, we encourage analysts to pay greater attention to the kinds of variables that are already identified in the existing IAD and SES frameworks, and to make use of those variables and variable categories when selecting cases, collecting data, and engaging in cross-case comparison. At the same time, however, analysts should pay attention to the fact that PG operates at the scale of multiple, nested action situations in which collective actors operate and interrelate. The ability to compare across cases will be particularly critical to begin to cumulate knowledge about the particular socio-ecological problems and contexts where PG is most likely to work well, as well as to identify key aspects of governance arrangements that may be influential in shaping outcomes.

Finally, we hope that our framework will help empirical researchers move beyond asking narrow questions about *whether* PG worked well in a particular case, and instead start building more generalizable knowledge by testing hypotheses about what types of PG work well and under what conditions. Similar to the IAD, our framework does not propose any particular theories about when, why, or what types of PG might work well to solve collective action problems, but it can be used to structure empirical tests of multiple existing theories. For example, Carlisle and Gruby (2019) offer a set of theoretical propositions about "enabling conditions" that are necessary for PG to produce

particular benefits. Some of these enabling conditions describe contextual conditions, such as the presence of generally applicable rules that govern a system. Other enabling conditions describe processual characteristics of PG, such as decision centers' participation in cross-scale venues for deliberation and learning. Empirical researchers who wish to test Carlisle & Gruby's propositions can locate their enabling conditions within our framework, posit specific hypotheses about how these conditions lead to particular outcomes, and do so in a way that facilitates comparison over time with other empirical cases.

DISCUSSION AND DIRECTIONS FOR FUTURE RESEARCH

The broader PG research agenda has enormous potential to help researchers better understand how communities can respond effectively to the socio-ecological changes and challenges of the 21st century. In our review, we initially sought to answer an important question about why PG is effective in some cases and not in others by synthesizing the existing literature on PG. But our review highlighted that there are critical barriers that prevent meaningful synthesis across this broad literature. Our review and framework suggest several key directions that could help the research community overcome these barriers.

First, we call for more research on how PG evolves and changes over time. Our framework identifies three potential feedback pathways, each of which suggests new or considerably expanded lines of research about the multiple mechanisms prompting change within PG. Within feedback pathway A, for example, are there particular governance arrangements that improve marginalized communities' capacity to engage with policymakers? In pathway B, when will current participants seek out information from other affected parties, rather than continuing to focus on their own interests and their own sources of information? What kinds of emerging problems are most likely to convince them to establish new policy venues or to engage in new modes of collaboration? To what extent are external effects on other actors or inadvertent spillovers into other policy domains taken into account in actors' evaluative deliberations?

Although we argue that for some analytical purposes, it is useful to distinguish among these three feedback pathways, in practical situations many adjustment mechanisms will draw upon information transmitted through more than one of these pathways. For example, one study from our sample (Barnett & Anderies, 2014) explicitly compared two cases where the actors who were directly affected by (and knowledgeable about) resource availability had different levels of authority to make changes to the system's operational level rules. More generally, as individuals, organizations, and communities gain experience interacting with others in diverse policy settings, they will learn that they need to construct and maintain institutional mechanisms that can help them make effective use of information transmitted through all three feedback paths, and use that information in ways that lead to improved governance structures, processes, and outcomes. Systematic research about how PG changes over time can lead to important insights about how to design and encourage wide participation in governance systems capable of adapting to the challenges of the 21st century.

Second, we call for greater attention to developing and testing hypotheses about what kinds of PG arrangements work well for particular kinds of collective action problems. Much of the literature we reviewed spent little time systematically describing the governance arrangements in their cases; often, authors simply noted that their case was "polycentric" and then moved on to assessing governance outcomes. Carlisle and Gruby (2019)'s theoretical model draws attention to a wide range of PG attributes and enabling conditions that they theorize should lead to particular benefits, but their model has not yet been widely tested in the literature. Another handful of studies that we identified distinguished between "horizontal" and "vertical" PG (Bolognesi & Pflieger, 2019; Ringel, 2018; Sandström, Söderberg, Lundmark, et al., 2020; Sandström, Söderberg, & Nilsson, 2020; Schröder, 2018), theorizing that the characteristics of the underlying socio-ecological problem determine which approach is a better "fit" (Sandström, Söderberg, & Nilsson, 2020; Young, 2002).

Research on social–ecological systems has generally established that governance systems should "fit" the spatial and social extent of the problems that they are meant to address (Epstein et al., 2015; Thiel, 2016). But this concept has not yet been fully explored in the context of PG, where overlapping authority can, at least potentially, encourage decision centers to collaborate in ways that meet the socio-ecological challenge at hand. Which decision centers affect and are affected by a socio–ecological problem, and do the governance arrangements include them? Which arrangements – horizontal, vertical, both – work best to include them? How divergent are the decision centers' interests, and do the collaborative arrangements at play help to balance them? The literature as a whole would benefit from more work that develops theory and hypotheses about how different aspects of PG help address different types of collective action problems. While our framework does not posit any specific hypotheses, we believe that it can guide such hypotheses testing in a way that facilitates cross-case comparison and cumulation of generalizable knowledge.

Third, we note that thus far, PG research has focused primarily on Western democracies, with relatively few studies in the global South. In our view, this is a missed opportunity to study dynamic governance changes in diverse constitutional and meta-constitutional contexts. In recent decades, many countries globally have experimented with constitutional reforms; devolution of various forms of authority to lower levels of government; changing relationships with donors, corporations, and civil society; and increased emphasis on democracy and democratic accountability. Often, these reforms fall short of expectations, at least in the short term. By studying these governance changes through the lens of PG, we may be able to build knowledge about when and how this kind of reform helps improve actors' long-term ability to address collective action problems.

Finally, our review also shows that while many PG studies have focused on local or sub-national dynamics, national and international-scale studies can also be fruitful, particularly for problems like global climate change that cannot be resolved at the local or even national level. Global and transboundary studies were relatively rare before 2016, but have increased rapidly since then, reflecting increased interest in applying PG to global problems like climate change. More research is needed to assess how PG operates at the national and global scale, and PG presents a particularly useful lens for understanding governance at the international level, where governance is not the purview of a single state but by necessity involves mutual adjustment and coordination across a wide range of actors at multiple levels.

The literature review shows that PG is not a panacea – it works well under some, but not all, conditions. PG can have both positive and negative outcomes, sometimes simultaneously. Despite this growing volume of research, it is difficult to draw generalizable conclusions about whether, when, and why PG is (or is not) effective. There are several reasons why it is difficult to accumulate generalizable knowledge from the current work on PG. Few studies pay explicit attention to the role of context in shaping governance arrangements and their outcomes. Without a guiding framework, analysts choose variables and research designs that maximize their studies' internal validity, but at the expense of cross-case comparison and the ability to accumulate knowledge. Other studies focus on a single moment in time and thus do not investigate the dynamic, evolutionary aspects of PG. The literature in general has paid limited attention to process-based factors, particularly the long-term feedbacks by which PG changes over time. If we want to build an understanding about how PG systems operate, we need more work that pays attention to context and dynamic change, as well as more work that engages in comparison across cases.

One goal of this article was to improve the research community's ability to build durable, generalizable knowledge about PG. We propose the COOF framework to guide future empirical research on PG, and we hope that both our literature review and this framework will encourage scholarship that more fully develops and tests theories about the dynamic relationships among contextual factors, operational arrangements, outcomes, feedback pathways, and adjustment mechanisms. We urge the research community to do so in ways that facilitate cross-case comparison and knowledge cumulation, as well as practical application to real-world policy problems.

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ENDNOTES

[1] Our review focuses on articles that use the terms "polycentricity" or "polycentric governance" and omits many articles that examine similar phenomena using different terms. While we expect that a more expansive review might identify more areas of knowledge cumulation, we found that it was impractical to conduct a literature review that was both systematic and inclusive of all of the many terms (multi-level governance, network governance, etc.) by which scholars study complex governance.

[2] Drawing on the work of Vincent Ostrom, some scholars identify norms or meta-constitutional rules of "respectful contestation" as critical for PG performance (McGinnis et al., 2020).

[3] We use the term "interrelations" to describe the repeated interactions between decision centers within polycentric governance.

[4] We did not include a starting date, but we found no empirical articles using the term "polycentric governance" before 2006. Empirical research prior to 2006 may have investigated similar phenomena using different terms like public choice, local public economies, or political economy, terms whose meaning has changed over time. For practical reasons, we focus explicitly on the term "polycentricity" and its variants, which excludes these early studies from our review.

[5] The IAD framework itself does recognize feedback arrows between outcomes and starting conditions relative to a given action situation (D. Cole et al., 2019), but these dynamic relationships have received limited theoretical or empirical attention.

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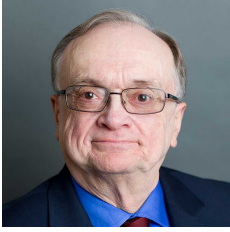
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