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THE SCOPE OF POLYCENTRIC GOVERNANCE ANALYSIS AND RESULTING CHALLENGES

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ABSTRACT. Literature on environmental governance has shown renewed interest in polycentricity and polycentric governance. This paper is to provide greater clarity to the recent discussions of polycentricity by introducing the polycentricity approach based on the different roles that the concepts of polycentricity and polycentric governance and associated theoretical claims adopt. After revisiting the early writings on polycentricity, I distinguish between its use as "ontological," "operationalizing" and "sensitizing" concept, as normative and positive theory, and as analytical framework. I use these perspectives to review the literature on environmental governance that relates to polycentric governance. Thirty six papers had been identified for this review covering the period since the beginning of the nineties. The distinction of uses of polycentricity proves helpful to organize the literature and uncover research gaps. Emerging gaps are: the role of constitutional rules and social problem characteristics for polycentric governance; ways to distinguish the domain of overarching rules and the domain of polycentric governance, specifically in relation to issues of distribution; the way polycentric governance shapes public agents' behavior in acts of public service provision, and the relation between constitutional rules, polycentric governance structures and innovative criteria to evaluate social-ecological system performance such as robustness, resilience, etc.
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1. Introduction

The terms polycentricity and polycentric governance[1] were introduced and elaborated by Vincent and Elinor Ostrom in the sixties and seventies of the last century, representing an analytical concept that has been around for a long time but whose understanding has only partially been enhanced (Aligica, 2014). Using these terms, research concerning the way nested sets of institutions (i.e. rules in use that describe regularized ways of behavior of actors) shape the behavior of interdependent actors and its performance has been developed. Specifically, those that first coined the terms, the Ostroms and what is now sometimes called the "Bloomington school of Political Economy" (Cole, 2015), set out to test this theory in the sixties and seventies through work on the structures shaping local public economies and metropolitan governance, and, more specifically, policing (cf. Parks and Oakerson, 2000).

The initial contribution by Ostrom, Tiebout, and Warren (1961: 831) defines polycentric governance as follows:

> polycentric connotes many centers of decision-making which are formally independent of each other.… To the extent that they take each other into account in competitive relationships, …[they]… enter into various contractual and cooperative undertakings or have recourse to central mechanisms to resolve conflicts…, the various political jurisdictions in a [functionally interlinked] …area may function in a coherent manner with consistent and predictable patterns of interacting behaviour. To the extent that this is said to be so, they may be said to function as a 'system.'

To provide an empirical illustration of a system like this, some argue that the way the American federal state was set up is probably closest to the kind of polycentric society that the authors had in mind. I take this idea to connote the understanding of polycentricity as a descriptive concept (see below). Its key proponents later developed it into additional understandings of polycentricity as normative and positive theory and as analytical framework (see also the elaboration on these terms below). Based on this definition of polycentric governance, the overall polycentricity approach, which comprises of multiple perspectives on polycentricity, portrays a functionalist, ahistorical perspective on governance. It aims at theory building similar to fiscal federalism (Oates, 1972), polyarchy (Dahl, 1984), and functionalist approaches to the analysis of multi-level governance (Hooghe and Marks, 2004) and the explanation of its development (Putnam, 1988; Scharpf, 1997). This contrasts with analysts that investigate what makes specific kinds of governance emerge in particular historic constellations and what determines their functioning, performance and evolution (cf. Rhodes, 1995). What in this paper we call the polycentricity approach also goes beyond just mentioned functionalist alternatives because

it proposes a more comprehensive perspective on the determining factors of governance and its performance. Similar to a very recent contribution by McGinnis (2016) we seek to remind researchers of environmental governance of the depth of thinking that the Ostroms associated with polycentricity. As also McGinnis seems to indicate, it is as much a (normative) utopia of how to democratically and efficiently organize a social order (in the best sense) as it is a lifelong and community wide research quest with many unresolved conceptual as well as empirical issues.

Recently, polycentricity seems to experience renewed interest. A brief review through Scopus and Web of Science confirms that since the beginning of the last decade its application has been increasing. Use of the concept is most prominent in planning studies addressing metropolitan areas and network types of governance. In these types of studies polycentricity refers to spatialized urban development and governance (models) in metropolitan areas (Giffinger and Suitner, 2014). This is followed by environmental social sciences with the most prominent representative being Elinor Ostrom (Ostrom, 2010c). Her much praised work on local common pool resource management is deeply grounded in the polycentricity approach.

The polycentricity approach comprises of three distinct but interlinked elements. It is constituted by the descriptive concept of polycentric governance, a normative theory concerning what leads to polycentric governance which is considered desirable on the whole, a positive theory that hypothesizes what elements determine specific types of governance, and an analytical framework that aims to examine the explanatory and normative claims of positive and normative polycentricity theory. The overarching research interest of the approach, the interaction between institutions, behavior of interdependent actors and its performance and methodological individualism provide the common core of the approach. These tenets are also shared by the successful IAD (Institutional Analysis and Development) framework addressing local collective action that Elinor Ostrom and colleagues built and applied extensively (Oakerson and Parks, 2011).

McGinnis and Ostrom (2012) reconstruct the development and basic theoretical tenets of the polycentricity approach and the way it departed from its public choice origins. Key features of the approach are the possibility of multiple rationalities of action, normative orientations and perceptions of agents, the role of entrepreneurship within a well-structured normative constitutional order, the balanced treatment of interrelated public and private economic and political spheres, and analysis of a multiplicity of governance arrangements and actors involved. The approach is of outstanding importance to the analysis of environmental and social-ecological systems, i.e. non-linear systems intricately linking social and ecological systems (Anderies et al., 2004). For either, polycentric governance is widely considered to be

desirable, making social-ecological systems more resilient, adaptive and sustainable (Huitema et al., 2009). According to Schoon et al. (2015), the polycentricity concept provides opportunities for enhanced learning and experimentation, it enables broader levels of participation, it improves connectivity across governance scales, it creates possibilities for response diversity and builds in redundance that can minimize and correct errors in governance. Even in policy-making circles polycentric governance is increasingly being advocated – however, oftentimes it remains unclear what exactly the concept stands for in these discourses, and why it should be considered desirable.

By relying on what in this paper I call the "polycentricity approach" I aim to present a more differentiated understanding of the way research grapples with polycentric governance. I see this as important because, alternatively, we risk to miss out on the essential dynamics inherent in polycentric systems and fall short of scrutinizing what are preconditions and determinants of their functioning. First, I pursue the question what the different roles are that polycentricity adopts in research on environmental governance, if they can be connected to each other, and what research ensues from such an overarching review. I structure this exposition through an understanding of the terms concept, normative and positive theory and analytical framework. Second, in order to examine this operationalization of the polycentricity approach, I review literature addressing environmental governance that refers to the term polycentricity, and examine how it relates to the components of the polycentricity approach. This step helps us to identify avenues for future research on environmental governance from the perspective of the polycentricity approach.

2. A Framework for Discussing Literature on Polycentric Governance

To structure the discussion, I use three instruments of social science research: concept, analytical framework and theory. Following Blaikie (2000: 129), a concept expresses an idea in words (or symbols) that is used as building block in social science theories. "If the concept is clear as to what it refers, then sure identification of the empirical instances may be made" (Blumer, 1969: 143, quoted by Blaikie, 2000: 129). Blaikie distinguishes three roles of concepts: a) the ontological tradition associates concepts with a community of social scientists and identifies basic features of the social world, i.e. we understand this as statements about observable categories that need to be researched in order to come to an understanding of particular phenomena; b) the operationalizing tradition turns concepts into variables in order to define them and develop ways of measuring them; c) the sensitizing use holds that

concepts provide suggestions about what to look for and to search for commonalities between observations (Blaikie, 2000: 130–140).

As second class of social science instruments, analytical frameworks consist of a family of theories that adhere to common underlying assumptions, making them internally consistent (Blaikie, 2000). An example of this understanding is Ostrom's Institutional Analysis and Development (IAD) framework which provides a precursor to the application of game theoretical analysis of complex settings. The IAD and game theory therefore share methodological individualism as a core tenet. Schlager (1999: 234) writes that such "[f]rameworks bound inquiry and direct attention of the analyst to critical features of the social and physical landscape. […] [T]hey specify classes of variables and general relationships among them, that is, how the general classes of variables loosely fit together into a coherent structure." In this paper, the term analytical framework will be used where frameworks provide (constraining) cognitive (ontological) maps (Aligica, 2006) but also adopt a sensitizing role.

Theories and frameworks are two interrelated but distinct instruments in social science. For the purpose of this paper, I adopt the understanding of theories of the Bloomington school. It holds that "explanation and prediction lie in the realm of theories" (Schlager, 1999: 234; Ostrom, 2005). Theories "place value (only) on some of the variables identified as important in a framework, posit relationships among the variables, and make predictions about likely outcomes" (Schlager, 1999: 240). I distinguish between normative theories that make hypothetical, value-laden statements about ways in which societies organize themselves in order to comply with certain performance criteria that are considered desirable, and positive theories that explain societal phenomena and performance. Below, this distinction is used in order to characterize different aspects of the polycentricity approach.

In the following review of the way polycentricity and polycentric governance were portrayed by the Ostroms and the way they were used in literature on environmental governance, I will make use of the above-introduced perspectives. I will argue that it is useful to identify these different uses of the term polycentricity and to consider the interrelations between them in order to systematize work on polycentricity and grasp the polycentricity approach. To summarize, the paper distinguishes the following use of the terms in relation to polycentricity:

a) *The concepts of polycentricity of governance or polycentric governance* describe (polycentricity-related) structural features of static governance arrangements. These terms may be used in an ontological (what exists), operationalizing (how to measure what is assumed to exist) or sensitizing tradition (what may be interesting aspects to address in research).

b) *The normative theory of polycentricity* refers to propositions about the interrelations between a set of conceptualized, presumed variables and their effect upon a specific, desirable outcome. The normative theory is based on the first publication on the subject by Ostrom, Tiebout, and Warren (1961). It is not fully accepted or corroborated. This posits polycentricity as an endeavor in *positive, explanatory theory development* on environmental governance.

c) *The polycentricity framework* describes an analytical framework that consists of the conceptual building blocks that polycentric governance and its desired/hypothetical performance are embedded in. Broad, causal relations and what are dependent and independent variables in the polycentricity framework are highly aggregated. However, I distinguish these causal relations from proper theories because they operate at a highly abstract level. I also call this perspective the polycentricity lens because research needs to zoom in on specific components of overarching, positive polycentricity theory.

In what follows, I want elaborate on these components of the polycentricity approach and how they interrelate before I utilize this structure to review recent literature on environmental governance.

3. The Concept of Polycentric Governance

In its use as a concept, polycentric governance describes a specific, configuration of governance that is predominantly observed from a static perspective. McGinnis (2016) calls this a structural perspective on polycentricity. It is probably best captured through the original definition of polycentricity by Ostrom, Tiebout, and Warren (1961: 831) which was presented above. This definition aims to provide clues about whether a specific configuration of governance was polycentric or not. It is less interested in the dynamics of how it emerged, sustains or outlives itself.

Van Zeben (2013) shows the multi-dimensionality of the concept. She describes its dimensions of multi-actor, cross-level and cross-sectoral relations between functionally interrelated ways of resolving coordination and conflict for multiple purposes. She highlights that these institutionalized modes of interrelation are nested in an overarching structure of institutions. Due to its multi-dimensionality, the concept of structural (static) polycentricity equates often only with a subset of the dimensions referred to above. Thus, governance configurations are usually considered polycentric when multiple, independent autonomous but interrelated actors are involved. Still, this does not necessarily mean that the corresponding governance configuration also involves multiple levels and sectors. Also, it does not say anything about the relations between actors. Hence, academics struggle with comprehensively operation-

alizing the concept and measuring it (Aligica and Tarko, 2012) because of its multi-dimensionality.[2] For example, Pahl-Wostl and Knieper (2014), informed also by other authors, break polycentric governance down in a way that many authors would follow nowadays: "Polycentric regimes combine distribution of power and authority with effective coordination among various centres and across spatial levels" (see also Ostrom, 2010a; Folke et al., 2005). While such an approach is useful because it makes it operationalizable for comparative work, it leaves out dimensions, such as the role of overarching rules, or multiple rationalities and purposes of actors and entrepreneurship. Also, many would argue that coordination is not necessarily a feature of a polycentricity (cf. Marshall, 2015)

Further, the original publication of 1961 by Vincent Ostrom and colleagues posited that polycentric governance and its underlying conditions emerge somehow on the same level as decisions about provision and production. Thus, the causal structure underlying polycentric governance and its linkages to performance were not made explicit. For example, they overlooked that polycentric governance would itself depend on constitutional and collective choice rules. Only later did the Ostroms disentangle preconditions of polycentricity, what drives it on the one hand and its output and outcomes on the other (Ostrom, 1999c). As a result, a comprehensive picture of what I want to call "positive and normative polycentricity theory" emerged.

4. Polycentricity Theory

4.1. Normative polycentricity theory

What I want to call normative polycentricity theory suggests what ideally needs to be in place for polycentric governance to emerge and what the virtues of polycentric governance are. In their first, seminal publication on polycentricity, Ostrom, Tiebout, and Warren (1961) emphasized the structuralist (static) understanding of polycentric governance and postulated that it would lead to second best efficient production of public goods and/or exploiting economies of scale as a result of flexible, adaptive self-organization among jurisdictions. The understanding implied: a) constant negotiation between efficiency in production and alternative, normative values concerning provision and production of public goods, such as clean water, public safety, or the like; b) control, i.e. the determination of boundaries, so that the political jurisdiction includes the relevant set of events to be controlled; c) political representation, so that appropriate political interests are represented in decision-making arrangements; and d) that public enterprises will be controlled by the decisions of its constituents.

Vincent Ostrom's approach to polycentricity illustrates a meta-theory, distant from specific cases. The specific shape of governance he developed throughout later publications depends upon contingent, emergent dynamics and features of the setting. Whether or not polycentric governance emerges depends upon fulfillment of constitutional choice level conditions. Hereby following the understandings of the Bloomington School, constitutional level rules are defined as those rules that determine who in a community is eligible to make choices about who is entitled to make the rules according to which the community lives (Ostrom, 2005). In what follows I describe a) V. Ostrom's normative assumptions concerning constitutional rules and overarching institutional framework, and how they combine with b) the Ostroms' ontological position concerning the characteristics of social problems and aspects of governance. These can be considered *foundational* for polycentric governance (0 and 4.1.2).

To get to the elements of what I want to call normative polycentricity theory, governance needs to be embedded as follows: Precursors to the development of polycentric governance are compliance with specific constitutional prescriptions and overarching, non-polycentric rules (see table 1) and variability of social problem characteristics. Embedded in that way, polycentric governance will lead to tension where several performance criteria (a) efficiency, b) control, c) political representation, d) accountability) are continuously being traded off (see section 0; see figure 1). In such contexts, provision and/ or production of public and common pool goods and services that do not satisfy expectations of consumers would be punished because actors could exit from the corresponding consumption-provision relation, or they could switch to or establish alternative organizations or voice their concerns. If consumers were to self-organize this would bring spontaneous self-organization to the fore (i.e. what Ostrom, 1980, has called public and private entrepreneur- or artisanship). That way, previous providers would be punished through decrease in membership and/or (tax-like) contributions to the provision of public goods or services. Implicitly, at this early moment, Ostrom seems to presume intendedly rational actors (consumers and producers) (Simon, 1962: 16, quoted by Williamson, 1985: 45), and it is only later that the Ostroms make behavioral responses to institutions an object of their research (Ostrom and Ostrom, 1999a: 107). Therefore, I separately elaborate on this perspective below.

The normative theory of polycentricity emphasizes the competitive evolutionary selection of forms of organization for the provision and production of public goods and services as a result of (perceived) variations in characteristics of social problems and underlying constitutional (and meta-constitutional) conditions. McGinnis (2005: 13) aptly describes the resulting dynamic when he writes that "[a]s long as a polycentric system is in

operation we should expect to observe unending processes of change and re-negotiation, as new collective entities are formed, old ones dissolve, and new bargains are arrived at to deal with an unending series of new issues of public policy. If this can be said to be an equilibrium, it is a radically dynamic one with nothing fixed except the underlying complexity of the system as a whole" fixed by the constitutional rules named below as underlying conditions of polycentric governance.

4.1.1. The ontological conditions at the origin of polycentric governance

An ontological position describes what theorists presume to exist. Correspondingly, Vincent Ostrom holds that characteristics of societal problems greatly differ among each other, which make them the root cause of polycentric governance because adequately solving different problems obviously requires variable governance arrangements. Against this background, we would argue, one role of analysts is to uncover how specific characteristics of social problems shape the way they are best addressed. For example, Ostrom, Tiebout, and Warren (1961) singled out characteristics of public goods along which goods and services vary and which, from a welfarist perspective, can make provision and production a social problem. They address subtractable and non-subtractable goods (i.e., common pool resources and pure public goods) (Ostrom and Ostrom, 1999b; Ostrom, 2003; 2010a). These goods are characterized by externalities because of undue costs of excluding others from their effects, the spatial scale and associated (part of a) jurisdiction/subset of a community across which these positive or negative externalities extend, and the packageability of the goods, and difficulties to measure input-output relations. As a result, public goods need to be financed through taxes to overcome the freerider problem (cf. Ostrom, Tiebout, and Warren, 1961: 832ff.). This brings us to the second ontological position, social heterogeneity, whose relevance has recently been re-emphasized by Aligica in his insightful treatment of the theoretical work of the Ostroms (Aligica, 2014: 4ff). He sees the Ostroms' work to be crucially influenced by their attempt to devise a theoretical approach focusing on collectives that allow dealing with social heterogeneity: heterogeneity in capabilities, preferences, beliefs and information around which collective action may be organized, all of which also result in a variety of forms of governance for specific social problems, which, as such, are also more likely to represent a polycentric system. Such reasoning directly relates to Malik's (2013) emphasis of the role of diverse social covenants in collective action, which he sees as devices instrumental to the formation of collectives. The third ontological position refers to governance. Ostrom, Tiebout, and Warren (1961) introduce the notion of what was later called "governance functions." These authors consider governance functions to be divisible among each other (McGinnis,

2011; Oakerson and Parks, 2011). The presumption is that aspects of governance such as provision (monitoring, and conflict resolution) and its various components, production, and consumption, can be spread out across different levels and actors in public economies. Even if we presumed embeddedness into equal constitutional conditions, as a result of the first and second ontological conditions (differences in social problem characteristics and social heterogeneity), we expect the way governance is organized to show great variations across cases.

4.1.2. The normative constitutional conditions underlying polycentric governance

The normative position refers to an idealized perspective on a social system which considers polycentric governance as desirable for the performance features described above. Its emergence depends on particular, idealized constitutional conditions which allow polycentric governance to emerge and which are addressed in this section (see also table 1). These relate to the formal and informal, constitutional, collective choice and meta-constitutional rules within which society organizes governance. In the initial publication by V. Ostrom, Tiebout, and Warren (1961), these were only mentioned implicitly, and the underlying causal structure was not made explicit. Later on, Ostrom detailed ideas about normative assumptions or preconditions for polycentric governance to emerge. In this regard, he largely relies on the work of Polanyi (1953) (V. Ostrom, 1999b). Aligica and Tarko (2012) reduce these constitutional rules to the enabling conditions for spontaneous self-organization in the sense of freedom to organize, to enter into an organization or to leave it, and to voice contestation. Such prescriptions are to insure that public administrators' actions and decisions are subject to legitimization by those that benefit from and pay for services (consumers, taxpayers). Concerning the overarching level into which polycentric governance is embedded, Ostrom et al. further state that "[g]overnments […] provide an appropriate institutional framework for the maintenance of polycentricity in various sectors of society (Ostrom, Tiebout, and Warren, 1961: 63). An issues that may be part of such overarching rules may be what Hooghe and Marks, for example, describe as distributional tasks and provision of non-excludable public goods that would be best fulfilled by national-level, multi-purpose governance arrangements (Hooghe and Marks, 2004). A constitutional provision underlying that polycentricity was not limited to provision of public goods and services, but that it was also maintained in other spheres of societal organization and functions such as the judicial system, constitutional rule, selection of political leadership and organization of political coalitions. If the constitutional provisions for polycentricity in any of these spheres was incomplete, polycentricity would not emerge or continue to exist because the tendency for evolutionary

self-correction and self-regulation would be disturbed (Ostrom, Tiebout, and, Warren, 1961; van Zeben, 2013). Further, important underlying meta-constitutional rules are incentives that make members of a society enforce general rules, which frame the polycentric order.

Table 1 Categories derived from the normative theory of polycentricity to characterize the polity

Overarching constitutional rules
Existence of "constitutional law" that implies that no unit of government has unlimited authority as precondition of symmetrical relationships between actors
Knowable and autonomous division of authority across making, enforcing and applying the law – as ways to assign veto powers among each other to authority holders – purpose here is to establish the conditions for a loose equilibrium among veto points (Ostrom, 2008)
Freedom of speech, press and association which are upheld independently from government
Independence of diverse decision-making units is upheld. Constitutional changes subject to extra-ordinary decision-making procedures.
Concurrent regimes with overlapping jurisdictions must exist and constitutional limitations must be imposed upon governmental authorities. Possibility to share authority across decision-making centres and organizations must be given
Multiple organizational forms as channels for articulation of preferences must be admissible
Overarching rules to resolve conflicts between organizations
Polycentricity in the political, legal, economic and meta-constitutional sphere
Meta-norms
Shared community of understanding about basic normative and explanatory considerations as a result of similitude in human nature, thoughts and passion ("eternal order" as basis for "covenantal order," Ostrom, 2008), particularly in regard to what it means to be free and grant others the opportunity to be free and what it means to be just under conditions of humans' fallible judgment.
Community values – and that actors behave entrepreneurially in regard to acting collectively
Incentives for all members of a society to enforce general rules that frame the polycentric order.
Normative orientations, where constitutional laws are violated, citizens must be willing to exercise civil disobedience.
Legal and constitutional framework
Market sphere
Secure property rights and market orders (contract law, in the terms of Williamson, 1985) that sanction contractual agreements.
Judicial sphere
Enforceable law must embody common understandings
Legal concepts and terms must be knowable, reliable public, and intersubjectively (including government) applicable. Operable basis for judgment and principles for legal reasoning must be laid out. Interpretation of law must be subject to "contention among autonomous colleagues who are learned in the law" (Ostrom et al., 1961: 62).
Political sphere
Party system allows emergence of political entrepreneurs and provide incentives to reformers of party politics.
Need for a culture of learning and entrepreneurship among political actors.
Election laws need to be intact and existence of multiple constitutional decision rules in relation to selection of different actors.
Enable citizens' participation in government – through elections and direct participation
Critical scrutiny of laws and processes by political scientists

Source: own, based on Ostrom, Tiebout, and Warren, 1961; Ostrom, 2008; van Zeben, 2013; Aligica and Tarko, 2012; McGinnis, 2005.

4.2. Positive polycentricity theory and the polycentricity framework

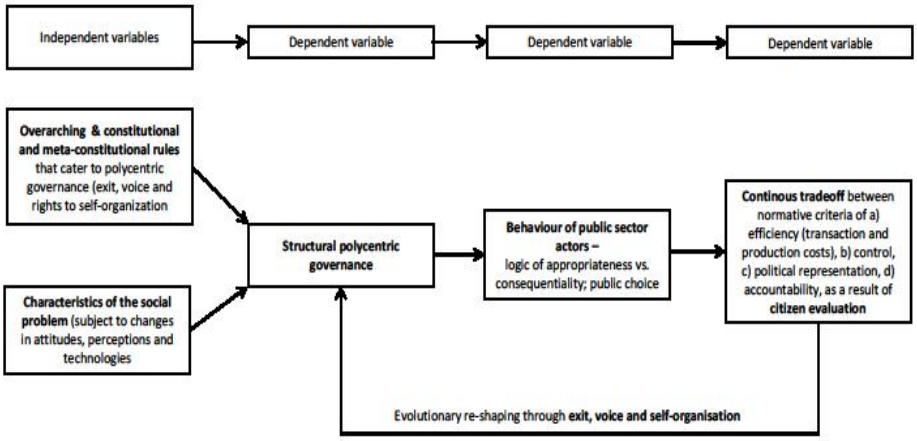
Positive polycentricity theory is based on the normative theory as described above. Instead of normative claims it posits causal structures that underlie governance, actors' behavior and resulting performance of governance. For example, it aims to empirically test the claims normative polycentricity theory makes. Examining the complex interrelations that normative polycentricity theory posits is challenging. Thus, only few aspects have been addressed so far. The Ostroms themselves set out to test this theory in the sixties and seventies through work on local public economies, metropolitan governance and, more specifically, policing (cf. Parks and Oakerson, 2000).

The most prominent outflow of the research program on polycentric governance is the work concerning local collective action in the context of common pool resource management. It started to address the behavioral dimension only after the first publications on polycentric governance. Ostrom (1999c: 124) specifies: "[T]he critical variables [to understand behavior] of concern to scholars in the polycentric tradition include (1) individuals; (2) decision rules; (3) sets of events; (4) outcomes; and (5) measures of performance." Openness with regards to motivations and behavior is also expressed by Ostrom (1999c: 125)[3] in claiming that "[o]nce we can conceptualize how individuals will choose strategies in light of the opportunities available to them in differently structured events with reference to different sets of decision rules, we can begin to specify the consequences for each set of permutations. We then have the necessary foundation for specifying the behavioral characteristics for aggregations of individuals who are organized into different types of collectivities." There can be little doubt that later development and work on the behavioral dimensions of the IAD followed from this kind of reasoning. The common underlying core of the IAD framework and polycentric governance relates to assumptions of purposive actors, their capacity to restructure institutions and methodological individualism. As a result, I also include this behavioral dimension into polycentricity theory (figure 1). Work on the IAD leads to the identification of design principles and further factors influencing collective action in local common pool resource settings (Ostrom, 1990; 2005; 2007). With its focus on local CPRs and addressing polycentricity through the design principle of nested institutions, it can be considered an operationalization of polycentricity for local common pool resources. Still, polycentricity opens up further research avenues. The resultant research program comprised of polycentricity addresses vertically and horizontally interlinked, autonomous, but interrelated, actors (Schoon et al., 2015). Coupled with the conditions underlying the emergence of polycentric governance and its implications for performance of governance, a rich research agenda emerges (see figure 1). The corresponding figure can be read as normative and positive, highly aggregated theory underpinning

the analysis of polycentric governance. It suggests an analytical framework that aims at corroborating and further developing either theory.

To summarize this section, functionalist, polycentric governance in this paper is conceptualized as a static structural description of governance. It is embedded in the polycentricity approach which highlights the foundational causes and normative preconditions for polycentric governance to emerge and the performance features that make it desirable (normative polycentricity theory), and the explanatory dimensions of (polycentric) governance (positive polycentricity theory). As neither the normative nor the positive theory have been sufficiently corroborated by empirical studies, the elements that are part of polycentricity theory are suggested as components of an analytical framework guiding future research. In what follows, I review how, over the last 15 years of research, in relation to the proposed distinction of uses of the term polycentricity, the term polycentric governance has been used in the literature and what the principal findings were.

Figure 1 The polycentricity approach entailing a normative and a positive theory and an analytical framework embedding polycentric governance



Source: own, after Ostrom, 1999c; Ostrom, Tiebout, and Warren, 1961; Ostrom, 1999b; McGinnis, 2005.

5. Mapping the Last Fifteen Years of Research on Environmental Governance and Its Relation to the Polycentricity Approach

In the following, I revisit published work that relates to the polycentricity approach. Particularly, I selected work that makes use of the terms polycentricity or polycentric governance in studies on environmental governance. Articles have been sought through Web of Science and Scopus for title, abstract or keywords, covering the years 1999 to 2017. I selected one hundred

and twenty papers, most of which focus on theoretical elaboration or metropolitan governance. Thirty six papers actually address environmental governance and relate it to the terms polycentricity or polycentric governance.

Articles that explicitly related to environmental governance were reviewed applying a loose meta-analysis. The review was structured with reference to the "conceptual instruments" of social science research introduced above. Hence, the question was, whether and how work related to polycentricity or polycentric governance as a concept – as theory or as framework. At the same time, I evaluated the outcomes of research in relation to polycentric governance on the level of the aggregate causal connections proposed by the analytical framework described above and identified some gaps.

5.1. Polycentric governance as ontological, operationalizing, and sensitizing concept

The majority of the papers reviewed rely on polycentric governance as a background concept, based on the same ontological presumptions concerning the way relations within society are ordered as conceptualized by the polycentricity approach. Ontological acceptance of polycentric ordering of societal relations comes along with the recognition of the impossibility to do justice to the concomitant complexity in empirical research. Therefore, papers focus on particular aspects of polycentricity. In relation to the above-described ways of engaging with concepts, I would describe this as an ontological and sensitizing use of the concept of polycentricity.

Heikkila et al. (2011) address the role of specific types of cross-scale or cross-level linkages between two or more actors in transboundary watershed management. Nagendra and Ostrom (2012) similarly address the interaction between actors at different levels of governance. They look at variation in management of forests. Marshall (2009) couches his analysis of conservation within the notion of polycentricity when he analyzes relations between communities of farmers and public agencies at lower levels. Basurto (2013) studies how multi-level institutional linkages (for example, employment, membership, or different kinds of partnership) affect processes of local institutional change. Galaz et al. (2012, see also Vousden, 2016, and Abe et al., 2016) analyze marine governance. They specifically aim to conceptualize and uncover the content of relations in polycentric orders of governance in the international realm.

In addition to an ontological and sensitizing use of the concept of polycentricity, some of the above papers extend use of the concept in an operationalizing fashion. Andersson and Ostrom (2008) operationalized vertical interlinkages of three types: frequency of interaction between local resource users and local governments, financial transfers between central and local governments, and upward political pressure for explaining commitment

of local actors to invest into the governance of natural resources. Their results corroborate that a polycentric approach that enhances interactions and cross-level incentives between actors is an important determinant of local government interest in natural resource governance. Political as well as financial incentives seem to be of relevance in this regard. Heikkila et al. (2011) operationalize types of functional interlinkages in polycentric governance relying on Ostrom's design principles. The resulting categorization shows similarities with what the Ostroms called governance functions (Ostrom, Tiebout, and Warren, 1961; McGinnis, 2011). They count occurrence of types of horizontal interlinkages and their relevance to governance functions and kinds of institutions (constitutional, collective choice, operational). They qualify the corresponding results by discussing relative importance of specific types of linkages, such as allocation, collective choice and monitoring rules. Sarker et al. (2014) do not explicitly address polycentricity but argue for an inclusion of state actors, multiple modes of governance and divergent policies into IAD analysis at the local level. Thus, they extend the IAD in conformance with the ontology of polycentricity. Galaz et al. (2012) address polycentricity from a network perspective. They characterize connections between actors at the international level through their degree of communication, formalization and network structures. For the international realm they highlight that connections are not only to serve coordination between actors but also to enable political influence.

To summarize this section, we can say that polycentric governance is mostly used as a concept to frame and sensitize research. Along with such use goes the analysts' subscription to its ontological presumptions (variability of social problems and concomitant governance structures, heterogeneity of social collectives). Where analysts directly research polycentric governance, they predominantly address different types of horizontal and vertical interlinkages between actors intervening in governance, relating the analysis of networks to the analysis of polycentricity.

5.2. Polycentric governance as positive, explanatory, or normative, value-laden theory

In this section, I will first look at publications that employed versions of what I call the polycentricity approach as positive, explanatory theories before I look at authors that employed it as normative, value-laden point of reference for evaluating the performance of environmental governance. Authors that employ polycentricity as positive theory usually explain governance without being very explicit about the causal relationships at play. Schlager and Blomquist (2008), for example, observe polycentric governance. They see it as result of overlapping arrangements where on the one hand, management units whose boundaries have been drawn in a technocratic manner are

coupled with emerging forms of representation and on the other in which communities invest into additional fora to articulate and protect their values and interests. Thiel (2013; 2015; Thiel and Egerton, 2011) explains how constitutional state structures, as expressed in different roles of subnational units in either federal or unitary states, shape governance of marine resources and watersheds. Explaining the emergence of polycentric governance are also McCord et al. (2016) which reconstruct how governmental deliberate reform in Kenya at what we would call the constitutional level led to emergence of polycentric governance. In another paper, some of the same authors connect the emergence of polycentric water governance in a newly established constitutional context to the variable social and ecological conditions (Baldwin et al., 2016). What is missing however is the analysis of principles underlying the logic of self-organization that shaped the newly emerging configuration. Other authors couple the explanatory clout of theories they associate with polycentricity with critical approaches. Gruby and Basurto (2014) discuss the usefulness of complementing the polycentricity approach with approaches derived from critical human geography that address the politics of scale. Armitage's work (2008) looks at polycentricity and discusses the way normative principles derived from work on the commons and resilient governance become eventually operationalized in multi-level contexts of environmental governance ridden by power, discourses and diversity of knowledge about valuations and distributional implications. A similar conceptual ambition has been expressed by the work of Clement (2013).

As examples of an application of normative polycentricity theory I would consider claims about the role of polycentric governance for adaptive management, resilience and robustness (Anderies, Janssen, and Ostrom, 2004). Pahl-Wostl (2008: 1) define adaptive management as "a systematic process for improving management policies and practices by learning from the outcomes of implemented management strategies" (cf. Folke et al., 2005: 447). The underlying normative assumption is that polycentric governance allows for flexible coping with external drivers and that rapid change is enhanced by systems of governance that exist at multiple levels with some degree of autonomy, complemented by modest overlaps in authority and capability" (Folke et al., 2005: 460). Nagendra and Ostrom (2012: 115) go further in their normative claims when they write that "polycentric governance tends to reduce opportunistic behavior in forested and urban settings because the complexity of many natural resources requires sophisticated multitier or polycentric governance systems rather than a reliance on a single type or level of governance" (McGinnis, 1999, quoted by Nagendra and Ostrom, 2012). Ostrom becomes even more explicit about the virtues of polycentric governance when she discusses climate mitigation. She states polycentric gover-

nance "tend[s] to enhance innovation, learning, adaptation, trustworthiness, levels of cooperation of participants and the achievement of more effective, equitable, and sustainable outcomes at multiple scales…" (2010c: 511; cf. Rayner and Jordan, 2013; Sovacool, 2011; da Silveira and Richards, 2013). It helps to overcome opportunistic behavior, enhances face-to-face communication, and matching of ecosystem, institutional and social scales. Other authors raise claims that polycentric governance is more robust (Anderies and Janssen, 2013), resilient (Garmestani and Benson, 2013) and less vulnerable because of high degrees of overlaps and redundancy (Gupta et al., 2010).

Sensitized by the normative propositions on polycentricity some authors try to measure the performance of governance that varies in relation to the degree of polycentricity. Da Silveira and Richards (2013), for example, look at what aspects of polycentricity make it beneficial to adaptive capacity. For the cases of the Rhine (Europe) and Pearl River (China) these authors conclude that internal power dynamics, competitive and collaborative patterns of interaction between multiple centers and emergence of functional and operational linkages among them are key to explain adaptive capacity. Similarly, Pahl-Wostl and Knieper (2014) examine the causal proposition that polycentricity renders governance more flexible and adaptive. From a QCA-based multiple comparative case study, they conclude that polycentric governance regimes are more responsive to climate change than centralized or even fragmented types of governance arrangements. Furthermore, they discuss the role of external conditions such as economic performance for adaptive capacity. Often polycentricity is equated with the design principle of nested institutions (Huntjens et al., 2012; Heikkila, Schlager, and Davis, 2011) among Ostrom's eight design principles (Ostrom, 2007). Corroborating such ideas, in their examination of adaptive capacity of watershed management in relation to climate change, Huntjens et al. (2012) found that adaptation to climate change relies on polycentric institutions which they consider crucial. More recently, McCord et al. (2016) evaluate the benefits of polycentric governance for water management in Kenya. They found that experimentation with new approaches emerged and that this correlated with an improved water situation locally. However, they also expressed fears that in the medium to long-term governance may become overly complex as a result. Knieper and Pahl-Wostl (2016) depart from a definition of polycentricity with coordination as component part. While their multiple case study confirms that polycentricity contributes positively to water governance, they also identify overall environmental pressure as most important determinant of management performance. Newig et al. (2016) examine polycentricity in relation to the challenges scale posits for effectiveness of participation and find that effectiveness of participation varies across governance functions

(planning and implementation) but they consider it helpful in overcoming misalignment of scales of governance and social problems.

More speculative concerning the potential of polycentric governance are recent works by Marshall et al. (2016) that advocate ordered and facilitated self-organization by farmer to address invasive species more effectively. A veritable debate on the potentials of polycentric governance has been unleashed in relation to climate change policies. The debate, largely launched by above-cited contribution by Lin Ostrom (2010) sees polycentric governance as at least complementary if not alternative to global level efforts of climate change mitigation. In relation to the potential of insurances and other innovative ways of introducing climate change mitigation aspects into private decision-making Spreng et al. (2016) include polycentricity into a set of reasoned recommendations for addressing climate change more effectively. A somewhat more skeptical evaluation is provided by Cole (2015) who on the one hand argues for the corroborated virtues of polycentricity (enhanced opportunities for learning and experimentation) but also points to the robust finding that trust, of which he see a prominent lack in climate governance, was essential for collective action at any level to emerge. Finally, another prominent contribution to this debate was coined by Jordan et al. (2015). These authors caution against too much hope on polycentric governance of climate change mitigation because it is still largely unclear how relations between state-centered approaches, international approaches and polycentric approaches will play out on the whole. Implicitly, these authors argue climate change governance will only be effective if described governance approaches complement each other in a synergistic way. That way, similar to our argument these authors state that polycentric governance needs to be social-ecologically embedded.

Nevertheless, while the literature concludes with the many virtues of polycentric governance, also some drawbacks are mentioned. Thus, it is argued that distribution of governance functions across multiple decision-making centers decreases possibilities to realize economies of scale and scope in governance, making polycentric governance subject to high transaction costs (cf. McGinnis, 2005). Schoon et al. (2015) equate this with the need to balance redundancy and experimentation with concomitant inefficiencies and heightened transaction costs. Similarly, loss of democratic accountability of governance is expected not least because of the complexity of decision-making processes (Lieberman, 2011), which may lead to advantages for powerful actors that successfully navigate the complexities of polycentric governance. Furthermore, polycentric governance focuses on static structures of governance without giving much emphasis to the way they are enacted. The latter, however, may be decisive for performance of governance (Schoon et al., 2015). More fundamental, systemic critique is raised by Harvey (2010)

who wonders about the way polycentric governance would address questions of redistribution.

5.3. Polycentric governance as analytical framework

In the ontological and sensitizing tradition of the use of concepts, polycentricity has been used as an implicit framework in all above-cited studies. While Gruby and Basurto (2014: 50) explicitly referred to polycentricity as a "framework for analysis," they did not spell out what the elements of such a framework would be. As a matter of fact, different frames of reference have been devised for analyzing aspects of polycentric governance, without precisely showing how these relate to the overarching polycentricity theory and framework, which this paper derived from the theoretical writings on the subject. Also, the IAD can be considered to be a framework analyzing particularly self-organization at the local level, a key component of polycentric governance. Similarly, Lubell situates his work on the Ecology of Games in-between a framework and a positive theory inspired by and consistent with polycentricity and the IAD framework (Lubell, 2013; Lubell, Henry, and McCoy, 2010). He writes "the EG [Ecology of Games] framework intends to produce empirically testable hypotheses about structure and function of complex adaptive governance systems, analyze the causal processes driving individual behavior and institutional change and ultimately understand how different types of institutional arrangements are linked to policy outputs and outcomes…" (Lubell, 2013: 513). It considers the role of cooperation, distribution and learning processes in governance which involve "multiple policy games operating simultaneously within a geographically defined policy arena, where a policy game consists of a set of policy actors participating in a rule-governed, collective decision making process" (Lubell, 2013: 538). Applications of the EG approach (Lubell, Henry, and McCoy, 2010; Smaldino and Lubell, 2011; Lubell, Robins, and Wang, 2011; Berardo and Scholz, 2010) focus on conceptualizing the internal workings and determinants of interdependent but autonomous actor constellations. More recently, their system-level approach was applied to comparative work on water management in different basins. The authors found that the shape and inclusiveness of networks was a function of institutional development in a social-ecological system (Berardo and Lubell, 2016). This posits the question what kinds of relations we need to include into the analysis of social relations in polycentric governance. They end on the question of the role of macro institutions and political orders for governance of water systems.

Further, the Network's of Adjacent Action Situations (NAAS) approach, developed by McGinnis (2011) seeks to connect analyses of specific policy games or action situations using the IAD to the complexity within which they are situated from the perspective of polycentricity. It goes beyond the EG

approach by referring to the dynamics between different levels of institutional analysis and governance functions and raises interest in the connections between the focal action situation and its context (McGinnis, 2011: 58). McGinnis himself illustrates how the approach helps to focus on key processes that determine outcomes. A first operationalization and detailing of linkages and their roles for focal action situations has been provided by Kimmich (2013) who studied the NAAS established by the role of energy (and its governance) for irrigation in Andhra Pradesh, India.

The frameworks discussed seem to confirm the emphasis of above cited studies inspired by an ontological understanding of polycentricity that focuses on cross-scalar and horizontal interlinkages between actors. They emphasize particular elements that establish structural, static polycentricity and as analytical frameworks they operationalize polycentricity differently. In what follows, I want to use the analytical framework developed in the section above in order to identify some of the most prominent conceptual, methodological and knowledge gaps in research whose elaboration promises useful to expand and in that way deepen our understanding of environmental governance.

On the whole, summarizing this section, we can observe that work on the use of polycentric governance for explaining change of institutions and governance relates to processes and channels of deliberation and acting upon providers and producers of collective goods. Actors use these channels in order to make their preferences heard. However, relatively little work has been done concerning which kinds of processes lead to polycentric governance in this regard and of what nature underlying conditions are. Value-driven (normative) statements about polycentric governance are abundant in the literature. Many have neither been substantiated for specific case studies nor on a more general level (Huitema et al., 2009; Anderies and Janssen, 2013). Careful work in this regard is highly challenging. It highlights the need for an operationalization of types of polycentric governance which allows measuring performance (Schoon et al., 2015). Disentangling causalities is specifically complex because of the comprehensiveness of Vincent Ostrom's suggestions of what polycentric governance builds on and entails. In order to build a comprehensive research program, in this paper it is considered useful to view polycentric governance as a meta-analytical, highly abstract analytical framework. It helps to connect theories and analytical frameworks that subscribe to related core assumptions of intended rationality oriented by perceived costs and benefits inscribed into the incentives posited by institutions and their analysis relying on methodological individualism. However, polycentricity analysis necessarily relies on several theories related to these core assumptions.

6. Discussion and Conclusions: Developing Research Based on an Understanding of Polycentric Governance as Analytical Framework

With regard to conceptual advances, the differentiation of structural polycentric governance has been developed furthest, specifically in respect of horizontal and vertical interlinkages. This becomes specifically clear when we look at the various conceptualizations of polycentricity as networks and interconnected games.

Empirical knowledge creation and operationalization focuses on the way a polycentric ordering of public service entities influences the performance of overall governance. Research on co-management and co-production (Verschuere, Brandsen, and Pestoff, 2012), the Ecology of Games (Lubell, 2013: 513), Institutional Collective Action (Feiock, 2013) and the Network of Adjacent Action Situations (NAAS) illustrate ongoing developments in this field. Nevertheless, these significant advances, with regard to the study of the polycentric governance structures, require further differentiation as also confirmed by above-mentioned authors working on this understanding of polycentricity. Of particular importance seems to be how polycentric governance relates to other types of governance, often associated with different scales, such as the state or international regimes.

Further, the broader polycentricity framework (figure 1) helps us to diagnose important research gaps in relation to the above-described foundational elements of polycentricity: 1. constitutional rules, and 2. characteristics of social problems. With regard to constitutional rules, this refers to the operationalization of constitutionally catered opportunities regarding voice, exit and self-organization, and overarching rules within which polycentric governance is to develop (cf. McGinnis, 2016). Focusing on a) operationalizing constitutional and meta-constitutional rules underlying polycentric governance as well as b) spelling out their effects in specific constellations, both offer an exciting agenda for the study of (natural resource) governance.

The relevance of such research becomes clear when we reflect on numerous comparative case studies of natural resource governance that include countries whose underlying constitutions largely differ. Illustrative in this regard is the study by da Silveira and Richards (2013) who discuss polycentricity of water governance in the cases of China and the EU. Questions also relate to studies that discuss polycentricity in international marine and natural resource governance (Gruby and Basurto, 2014). At the very least, the question emerges how we should further develop and operationalize the constitutional conditions suggested by Vincent Ostrom over 40 years ago. For example, where formal rules significantly differ from the initial, normative propositions of the Ostroms, but where we can still

observe polycentric, functional operation of governance, certain kinds of meta-constitutional, informal rules may lead to polycentric governance.

Furthermore, as regards overarching rules within which polycentric governance is supposed to develop, the question emerges what aspects and governance functions need to be regulated potentially at the overarching or possibly constitutional level, and what aspects can be organized in a polycentric fashion. Specifically, in my view such a focus may also need to elaborate the role of distributional aspects of governmental tasks in relation to polycentricity. Similarly, other systemic tendencies of polycentric systems may need to be addressed at this level (McGinnis (2016) for example points towards structural inequities, incremental bias, high complexity, deep structural fissures, and coordination failures). More research also needs to be invested into the role of characteristics of social problems for potentials of polycentric governance. As a matter of fact, the characteristics of social problems are hardly addressed in research on natural resource governance although research on local common pool resource management that has been developed by the Ostrom School has pointed out for long that the characteristics of resource systems and units largely differ and lead to a differentiated way in which they are addressed (Schlager and Blomquist, 2008; Schlager, Blomquist, and Tang, 1994; Hagedorn, Arzt, and Peters, 2002; Agrawal, 2001; Ostrom, 2009). Recently, this agenda has been detailed by institutional economists that transposed transaction cost economics to the analysis of what can be called nature-related transactions (Hagedorn, 2008, see also Bougherara, Grolleau, and Mzoughi, 2005; McCann, 2013, Thiel et al., 2016). Previous research addressed the role of characteristics of social problems such as mobility (Schlager and Ostrom, 1992; Thiel, Schleyer, and Plieninger, 2012), jointness (Falconer, 2002), care intensity (Birner and Wittmer, 2004) and the like. However, their impact on polycentric governance has not been addressed in a systematic fashion yet.

Moving on along the polycentricity framework it becomes clear that, similarly, the link between polycentric governance structures and behavior of (public) agents has hardly been addressed thus far. However, reading Skelcher (2005) and going back to the Ostroms (1999c) illustrates the relevance of such work. According to Skelcher (2005), the normative theory of polycentricity aims to introduce the behavioral logic of consequentiality into provision of public goods and services. It entails that "action arises from a calculation of expectations in relation to preferences" (Skelcher, 2005: 102). Bureaucrats' preferences may be related to policy output or outcomes in relation to a welfarist, societal perspective, or they may be directed at personal gain (Niskanen, 1994; Mueller, 2003). In contrast, specifically in the public sector, many analysts consider the logic of appropriateness to dominate, i.e. behavior that is oriented by rules, roles and tasks, rather than

by outcomes (March and Olsen, 1989; 2004; Cohen, Olsen, and March, 1972). Skelcher continues to write that "[t]he design of governance institutions for collective decisions in a polycentric environment needs to accommodate this tension" (Skelcher, 2005: 102). He sees it as a result of the co-existence of general purpose and problem-oriented, specific purpose administrations within polycentric systems that, for functional reasons, need to relate to each other. Thus, also in polycentric systems it becomes necessary to balance the general interest reflected in administrative rule-following which is not contestable by individual consumers or members with interests of efficient provision articulated by purpose-oriented jurisdictions where under- or over-provision can be punished. Corresponding governance structures need "to be able to resolve collective action problems, to reflect and protect particular interest as well as the general will and not to necessitate a hierarchical equivalence of spatially defined jurisdictions" (Skelcher, 2005: 104). As becomes evident from this elaboration, a rich research agenda couched in the polycentricity framework may address the way governance structures and their underlying foundations shape behavior of actors involved in governance. Such work could be developed through behavioral economic approaches which examine the behavioral effects of different types of polycentric governance structures.

Another research focus that the polycentricity framework points at and that has also already been alluded to above concerns the performance of polycentric governance structures in relation to specific performance criteria. McGinnis argues that inherent dynamics in polycentric governance optimize in relation to economies of scale. However, similarly, he does not preclude that other performance criteria are evaluated against polycentric governance, many of which have been declared virtues of polycentric governance in recent years (McGinnis, 2016). This becomes important because a multitude of new, sustainability-related performance criteria have been introduced such as robustness, resilience, flexibility, or vulnerability. The corresponding causal relations are theoretically and empirically unclear (cf. Anderies and Janssen, 2013; Lubell, 2013; Huitema et al., 2009). Detailed research on the effects of polycentric governance on each of them is missing thus far.

Finally, I would suggest that we can also use polycentricity theory as a framework for focusing on causal relations between aggregate aspects. Hence, an interesting question concerns the role of specific sets of constitutional and meta-constitutional rules (e.g., varieties of political orders or capitalism) for innovative performance criteria concerning social-ecological systems such as, for example, resilience or robustness, or for the behavioral dimension of polycentric governance.

7. Summary

In this paper, I have re-visited the original writings of the Ostroms on functionalist, polycentric governance and ordered them in relation to social scientific tools of research such as ontological, operationalizing and sensitizing concepts, as normative and positive theories, and as conceptual framework providing innovative outlooks on research. I demarcated related research that adopts an institutionalist perspective, that investigates actors from a methodological individualist perspective and that models actors as driven by instrumental (but bounded) rationality and perceptions of costs and benefits. Starting from the original normative theory of polycentricity, I suggest we understand polycentricity also as a research framework (or lens) on environmental governance which aims at providing a coherent understanding of the ontological and normative conditions underlying polycentricity and their implications for behavior of public service providers, and categories such as transactions costs, user satisfaction, efficiency or even resilience. A review of the literature on environmental governance that relates to polycentric governance proved that a distinction of the ways the term polycentricity is used helps to structure and interrelate research work related to polycentric governance. Further, understanding polycentric governance as an overarching analytical framework led to the identification of several research gaps: the operationalization and differentiation of a structural understanding of polycentric governance, the role of constitutional and meta-constitutional rules and social problem characteristics for polycentric governance, ways to distinguish the domain of overarching rules and the domain of polycentric governance, the way polycentric governance shapes agents' behavior in acts of public service provision, and the relation between constitutional rules, polycentric governance structures and innovative criteria to evaluate social-ecological system performance. In the context of this assessment, recently renewed interest in polycentricity of environmental governance is welcome and promises exciting research.

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NOTES

1. In this paper I use polycentricity and polycentric governance as synonymous.

2. It seems that most of the environmental management related literature we found throughout an extensive review of peer-reviewed literature, uses a reduced set of dimensions of the static structural concept of polycentricity either in an ontological, operationalizing or sensitizing way (cf. da Silveira and Richards, 2013; Galaz et al., 2012; Gruby and Basurto, 2014; Ostrom, 2012; Sproule-Jones, 2002).

3. Initially published 1972.

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