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Climate Risk Polycentricity and the IAD Framework

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Abstract

Climate change is commonly cast as a significant governance challenge demanding national and international actions. Subsequently, political science research tends to focus on the policy and politics of nation-states, their domestic institutions, and/or their interplay in international venues. However, thousands of industrial facilities and hundreds of subnational US governments are active in American climate risk governance. Therefore, we argue that more research should attend to climate governance's subnational policy and politics, their promise, and their performance. In the vacuum of national policies to mitigate and adapt to climate-change, subnational arrangements offer an ideal opportunity to study not only the spontaneity of polycentrism, but whether or not it is leading to better environmental outcomes. This paper integrates polycentric theory and the environmental performance dilemma within the Institutional Analysis and Development (IAD) framework to guide the analysis of the multilevel comparative policy setting of U.S. environmental federalism. State and local government initiatives, or lack thereof, on climate change offer a quasi-experimental setting to examine the detailed decision-making and the role of information within polycentric governance arrangements. This paper adapts Ostrom's IAD framework for this task and presents hypotheses to explore: (1) institutional diversity; (2) multilevel institutional nesting; (3) analytic deliberation; and their relation to (4) Greenhouse Gas Emission (GHG) reduction performance. The research design developed in this paper advances theory development and environmental policy analysis with the IAD framework to clarify key conceptual and methodological issues that enables the investigation and diagnosis of the institutions and interactions driving U.S. climate risk governance with both large and small-N studies.

Polycentric Climate Risk Governance

Global climate change and its risks pose significant governance dilemmas. Greenhouse gas (GHG) emissions are changing the planet's climate and, if ignored, will cost the U.S. economy hundreds of billions of dollars annually (Jorgenson et al. 2004; Sussman et al. 2013), increase morbidity and mortality rates (Barreca 2012; Tagaris et al. 2009), and pose multiple threats to the national security of the United States (Smith 2011; U.S. Department of Defense 2010). Conventional wisdom holds that a problem of this magnitude - a global scale problem - must be addressed by a coordinated international response (Aldy and Stavins 2009; Biermann et al. 2010; Victor 2011), but such an approach remains elusive. Instead, within the United States, subnational governments have been considerably more active in developing climate change mitigations and adaptations compared to their federal counterparts (Betsill 2001; Rabe 2004, 2008, 2010, 2011; Sharp, Daley and Lynch 2011). Many states and localities are bearing the costs of addressing climate change, while the benefits of curtailing GHG emissions cross

political boundaries. Conventional logic holds that the combination of concentrated costs and spillover benefits creates a considerable hurdle that should impede subnational policy making. Yet, several state and local governments have opted to pursue climate mitigation and adaptation policies.

Scholars have examined this trend to better understand the determinants of policy adoptions under these circumstances (for example, see Krause 2011, 2012; Lutsey and Sperling 2008; Rabe 2004; 2007; 2010; and Sharp, Daley and Lynch 2011). But far less attention has been directed to comprehensively examining the nature of these governance arrangements and how their variation may predict GHG emission reduction performance across the states. In large part, this shortcoming stems from data restrictions; there has been no feasible approach to systematically examine the ways in which state and local governance arrangements influence actual GHG emissions. The proposed research framework capitalizes on a new nationwide GHG emissions reporting program. Additionally, by explicitly considering environmental outcomes, this framework clarifies theories frequently used to understand environmental decision-making.

In 2009, the US Environmental Protection Agency (EPA) announced the first facility level regulatory program addressing climate change when it issued the Mandatory Reporting of Greenhouse Gases (GHGs) rule. Facilities surpassing an emissions threshold of 25,000 metric tons are now required to annually estimate and report their GHG volume to the EPA. Prior to collecting this facility level information, since 1990, the EPA has estimated GHG emissions on a national and, to some extent sectoral level, in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. But this was a top down approach and a coarse resolution of data that provided limited information for domestic policy making. While the Energy Information Administration (EIA) has tracked energy related facility CO_2 emissions since 1990, EPA's newly created emission inventory provides a comprehensive bottom up, facility level emission inventory of multiple GHG emissions. This allows the empirical testing of how different

multilevel governance arrangements translate into effective climate risk governance performance. Facility level data for 2010, 2011 and 2012 are available with the 2013 dataset to be released in October 2014.

Research Objectives

This research framework responds to Dietz, Ostrom, and Stern's (2003) call for systematic research on multi-scale environmental resource governance and climate governance in particular (Arvai et al. 2006; Ostrom 2009a, 2010). Our climate risk governance framework contributes to a more fully conceptualized theory of polycentricity[1] within the Institutional Analysis and Development framework and proposes to test the implications of this merging in a multilevel comparative state setting. Future research based on this framework will systematically examine what types of institutional arrangements lend themselves to effective climate risk governance performance in a complex and fragmented political system. Research to date has largely focused on exploring the occurrence of multilevel policy activity for climate change mitigation (Amundsen et al. 2010; Betsill and Bulkeley 2006; Betsill and Rabe 2009; Corfee-Morlot et al. 2011; Dilling 2007; Rabe 2007, 2008) or adaptation (Adger, Arnell, and Tompkins 2005; Hunt and Watkiss 2011; Mazmanian, Jurewitz, and Nelson 2013), as opposed to examining the consequences of that policy activity - actual changes in environmental performance by GHG emitters.

Moreover, meaningfully incorporating environmental outcomes remains a central challenge in environmental policy research and must be tackled to allow for clearer tests of our theoretical expectations (Koontz and Thomas 2006; Niles and Lubell 2012; Ostrom 2007a, 2009c). State and local government initiatives on climate change, or lack thereof, offer a natural experiment to examine the

[1] Polycentricity can be understood as a "system of governance in which authorities from overlapping jurisdictions (or centers of authority) interact to determine the conditions under which these authorities, as well as the citizens subject to these jurisdictional units, are authorized to act as well as the constraints put upon their activities for public purposes" (McGinnis 2011, p. 171).

detailed decision-making that occurs within polycentric governance arrangements. Some state and local governments have been active in climate governance - developing a range of mitigation and adaptation initiatives - for over a decade, providing an opportunity to test established theories predicting the performance of environmental resource protection using quantitative and qualitative evidence, and in doing so, expand our understanding of climate risk governance to better inform GHG reduction strategies.

Our climate risk governance research program has three main objectives:

1. To advance theory development and policy analysis with the Institutional Analysis and Development (IAD) framework and better understand how polycentricity -- through nesting, institutional diversity and analytic deliberation -- affects climate risk governance performance. This investigation will empirically test how state-level variations in polycentricity correlate with climate governance performance in reducing facility-level GHG emissions while controlling for other factors.
2. To qualitatively analyze state-level institutional arrangements, policy community attributes, and action situations in order to better understand the micro-processes that link polycentric governance factors with climate risk governance and performance. Research based on the climate risk governance framework will utilize institutional environmental policy analysis to better understand the specific processes of cooperation, conflict, and deliberation in a nested and fragmented political system.
3. To contribute to a productive dialogue on climate risk governance approaches among policy leaders, practitioners and students in the environmental field.

Climate Risk Governance and the IAD Framework

Climate change represents one of the most challenging commons dilemmas facing governments, markets, and communities. Because of the broad uncertainties underlying climate change, this research framework also situates this issue within the field of risk decision-making (Corfee-Morlot et al. 2011; De Marchi 2003; Deere and Birkbeck 2009; Klinke and Renn 2012; Renn 2008, 2011) and as an important topic for risk research (Keeney and McDaniels 2001; Lorenzoni et al. 2005; Pidgeon and Butler 2009). Moreover, climate risk governance, as Ostrom (2009a) observed, is “potentially the largest [collective action] dilemma the world has ever knowingly faced” (p. 5). But most conventional policy prescriptions

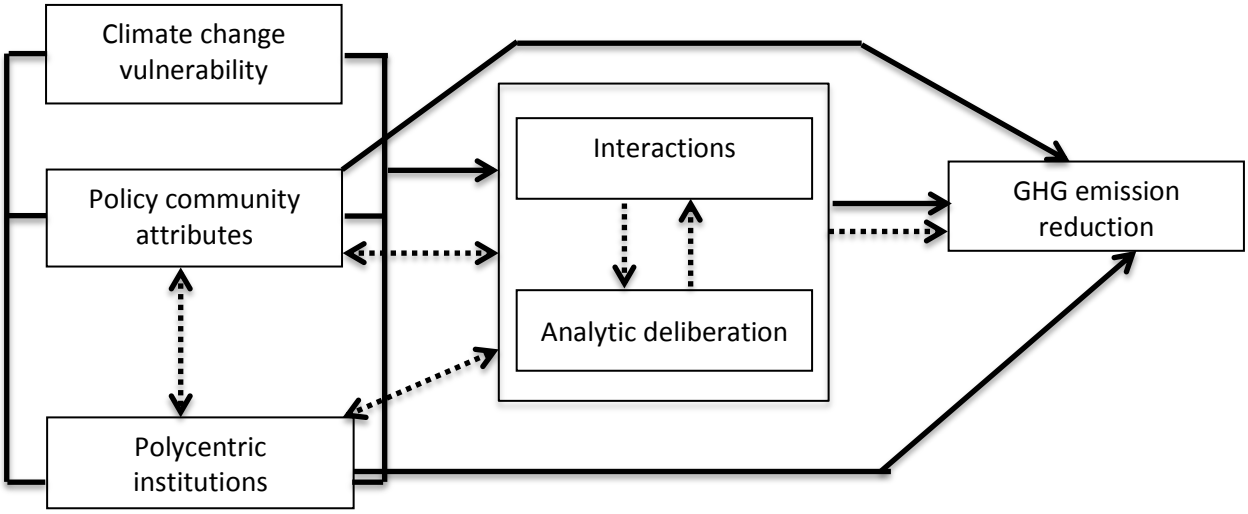
for national and international collective action problems are informed by this famous characterization: "Freedom in a commons brings ruin to all" (Hardin 1968, 1244).

A rich body of work challenges the rational-choice presumption that actors faced with an environmental dilemma will always succumb to the commons tragedy. In particular, as developed mainly by Elinor Ostrom (1986, 1990, 2007b, 2009b, 2010a), most researchers have used the Institutional Analysis and Development (IAD) framework to study the resolution of localized natural resource conservation dilemmas around the world (Basurto 2013; Becker and Ostrom 1995, Benjamin et al. 1994; Bollman and Hardy 2012; Imperial 1999; Imperial and Yandle 2005; Joshi et al. 2000; Lam 1998; Lubell et al. 2002; McGinley and Cubbage 2011; Ostrom et. al 1994; Schlager 2002; Tang 1992; Tucker 2008). Numerous scholars have called for widening the application of IAD and its Institutional Rational Choice (IRC) theory (Blomquist and de Leon 2011). According to Schlager and Blomquist (1996), applications of the IRC framework ". . . fail to account for institutional complexity created by constitutional-level arrangements such as separation of powers and federalism. . ." (667). Likewise, Lubell et al. (2010) noted the limited attention of the IRC to ". . . the existence of multiple institutions in a policy arena" (287). Most recently, Rosenbaum (2012) concluded that a remaining challenge for the IAD framework is its relevance for explaining ". . . governance models for management of much larger, globally pervasive common resources. . ." such as the earth's climate (148). State-level climate risk governance in the U.S. offers an ideal context for answering these research challenges.

A behavioral (Ostrom 1991, 1998), or institutional rational choice theory (Ostrom 2007b; Sabatier 1991) lies at the heart of the IAD framework where individual choices are not tragedies occurring in vacuums, but within action situations (interactions and outcomes, see Ostrom 2007a, 2009c) shaped by human designed and nested arrangements of multilevel institutions. These decision situations are also nested within a system of inputs and outputs (Kiser and Ostrom 2000; Ostrom 2009b, 2010a, 2011).

Individual decision makers in an action situation are surrounded by four contexts that influence their choices: (1) the biophysical world; (2) a community the individual is embedded in; (3) sets of institutional rules that incentivize or constrain certain actions; and (4) group interactions (Koontz 2005; Ostrom 2011.).

Figure 1. State climate policy action situations. Adapted from Ostrom (2009b, 2009c).



Note: Dotted arrows represent where we will be able to use qualitative data and methods. Solid arrows represent where we will be able to use quantitative data and methods.

Following the logic of the IAD framework, this proposed research program will investigate the relationships between a group of exogenous variables (climate change vulnerability, the policy community's attributes, and state-level polycentric institutional arrangements), state policy action situations, and their impact on facility-level outcomes on GHG emissions (see Figure 1 above). These

interrelationships will be examined with both qualitative and quantitative data and methods represented by dotted and solid arrows respectively in Figure 1.

Climate Change Vulnerability

Research in the IAD framework has traditionally focused on biophysical conditions of common pool resource systems commensurate in size to a localized community and several conditions amenable to successful management. As one researcher summarized: (1) the resource's spatial extent should be small enough for users or appropriators to comprehend the boundaries; (2) the resource's ecological dynamics should be relatively predictable; (3) there are good indicators of the resource's conditions; and (4) the resource can feasibly be improved (Schlager 2004, 152). None of these conditions are met in the climate resource case. However, a review of the commons research field identified an important role for contingencies or moderator variables. "These are factors that are out of the practical control of short-run policy interventions but that may determine how an intervention affects an outcome" according to Stern et al. (2002, 453). Measures of climate change risk (Brody et al. 2008; Zahran et al. 2008) and social vulnerability to environmental hazards (Cutter 1996; Morrow 1999) represent these kinds of factors. A state-level index of climate vulnerability will be developed that builds on climate risk and the county level Social Vulnerability Index (SOVI; see Cutter, Boruff, and Shirley 2003) leading to the first hypothesis. C*limate vulnerability is expected to shape the context within which a state's policy and institutional interventions develop and in turn, influence GHG reduction performance.*

State Climate Policy Community Attributes

Within the IAD framework, the second exogenous variable represents a set of attributes for a community where actors are located. The relevant attributes are levels of trust among members, reciprocity, cooperation, shared values and goals, social capital, and repertoires of deliberative processes (McGinnis 2011a). Numerous studies have found many of these attributes among individuals

who have experienced a history of cooperation in various resource management settings (Beierle and Konisky 2005; Leach and Sabatier 2005; Lubell et al. 2002; Weber 1998); also sometimes referred to as a policy community (Dowding 1995; Jordan 1990; Lubell 2004; Marsh and Rhodes 1992; Schneider et al. 2003; Scholz, Berardo, and Kile 2008). For instance, "rules, norms, and shared strategies are constituted and reconstituted by human interaction in frequently occurring or repetitive situations" (Crawford and Ostrom 1995, 582). In experimental settings, researchers have found that positive interactions in collective action simulations result in players learning to trust one another and tend to be reinforcing (Lubell and Scholz 2001; Ostrom 2000). In the adaptation of the IAD framework in the figure above, a double-arrow depicts this interaction between the policy community's attributes and action situations and produces our second hypothesis. *Some types of action situations generate and sustain trust, cooperation and shared goals among climate policy community stakeholders, and in turn, influence GHG reduction performance.*

Polycentric Institutions

The IAD framework grew in part from the Ostroms' research on polycentrism (V. Ostrom, Tiebout, and Warren 1961; McGinnis 1999; Ostrom 2010a, 2010b, 2012); a concept exemplified by American federalism. Consistent evidence highlighted the surprising finding that distributed and interdependent (nested) decision making centers in municipal settings were related to more efficient public service provisions. And while notions of polycentrism remain important in IAD applications, more recent research has focused on localized common pool resources and a series of eight institutional design principles associated with successful governance. Three of those principles are especially applicable at larger ecological scales where nonlocal forces are influential (Dietz, Ostrom, and Stern 2003).

First, governance should involve the distribution of authority at multiple levels. Very few comparative state environmental studies have considered "within" state polycentrism, or nested

institutional arrangements, as both an investigative topic and as a variable. American climate risk governance has emerged at both the substate and regional level. On the former, a growing literature examines city-level climate initiatives (Betsill 2001; Brody et al. 2008; Krause 2011, 2012a, 2012b; Sharp, Daley, and Lynch 2011; Tang et al. 2010; Zahran et al. 2008) that can inform the construction of a state-level index of localities pursuing GHG reduction efforts. Likewise, researchers have also explored the use of interstate climate compacts in the US (Engel 2006; Selin and VanDeveer 2011) which offer another component of polycentric climate risk governance. The project's third and fourth hypotheses address these vertical and horizontal arrangements. *Better GHG emission reduction performance is expected in states where a greater proportion of local governments are involved in climate protection programs. Likewise, better GHG emission reduction performance is expected in states participating in inter-state climate compacts.*

Second, as Dietz, Ostrom, and Stern (2003) and McGinnis (2011a) observed, polycentric governance is characterized by not just multi-level units (local, provincial, regional), but also: (1) multi-type units (markets, hierarchies, community self-governance), (2) multi-sector activities (built environment, energy, transportation), and (3) multi-functional rule structures (regulation, incentives, monitoring, sanctioning, and dispute resolution). For instance, mitigation strategies are now joined by adaptation policies as several states commit to a more diverse portfolio of climate change policy tools. A rich source of institutional diversity data became available in 2011 with the Center for Climate and Energy Solutions (C2ES) publication of an inventory of state actions by sector (energy, transportation, and building), function, and type (emission standards and caps, reporting, financial incentives, etc.) totaling more than 30 categories and informs a fifth hypothesis. *Better GHG reduction performance is expected in states with more diverse institutional arrangements.*

However, beyond the hypothesis testing specified above, we also believe that more should be done for the theoretical understanding of polycentricity. Concepts related to polycentricity need to be expanded to better acknowledge that state and local governments have both a hierarchical *and* networked relationship. We attempt some work in this area below.

State climate policy action situations

Dietz, Ostrom, and Stern (2003) use the concept of "analytic deliberation" to describe the third scalable design principle that defines one kind of outcome in an action situation. It has been described as ". . . the social space where individuals with diverse preferences interact, exchange goods and services, solve problems, dominate one another, or fight" (Ostrom 2009b, 14). The more recent conceptualizations of the action situation consisting of interactions and outcomes inform this proposed project (Ostrom 2007a, 2009). A critical outcome for nonlocal environmental governance dilemmas is a "well-structured dialogue involving scientists, resource users, and interested publics, and informed by analysis of key information about environmental and human-environment systems. . ." (Dietz, Ostrom, and Stern 2003, 1910). However, national US environmental policy and attempts to address climate change within this system rarely have been described as analytic or deliberative. Adversarial legalism (Kagan 1991, 1998) is the more common characterization as the dominant action situation is often described as "heavily bureaucratic, prescriptive, fragmented in purpose, and adversarial in nature" (Durant, Fiorino, and O'Leary 2004, 1). U.S. environmental policy's gridlocked action ". . . has channeled tremendous political energies down other policymaking pathways, creating considerable instability in policy as policymakers and interest groups have pursued their agendas—sometimes momentous policy shifts—in other venues" (Klyza and Sousa 2013, 10). The states are one of those venues or, an alternative action situation that climate change programs have been channeled through in the historical absence of federal activity on climate risk governance. This leads to the proposed project's sixth

hypothesis. *Better GHG reduction performance is therefore expected in states where actors have developed action situations that foster analytic deliberation.*

Polycentricity and U.S. State Actors

Recently, polycentricity has received new attention from scholars. Our integration of these different strands of theory and empirical work are what drive some new theorizing about the interactions of U.S. state actors with local actors. First, some of Elinor Ostrom's contributions of the last decade (Ostrom 2009a; Dietz, Ostrom, Stern 2003), before her death, have included linkages between polycentricity and climate governance. She saw a role for theory related to polycentricity in wider climate change policy research. Second, in an in-depth analysis of polycentricity, Aligica and Tarko (2012) pointed out some critical questions left unanswered about the relationship between polycentricity and monocentricy. The two are not divorced from each other in many cases. Finally, others have noticed overlap in theorizing between work on polycentricity, network theory, and collaborative public management (Rogers 2014). Our integration of these ideas suggests to us a need to further articulate the complex interactions between different actors within, and between, action situations.

Though polycentricity is at the center of our understanding of the IAD framework, scholars who use the framework acknowledge that polycentric systems can have monocentric "elements" within them (Ostrom 1972 in McGinnis 1999, 52). We would go a step farther and say that within polycentric systems there can be interactions between levels in the system that are hierarchical and therefore can be characterized as monocentric interactions. Our particular focus here is the multi-level relationship between local governments and the state government within which those localities are found – the nested interactions. Importantly, these different levels of government have the ability to work together

in horizontal and collaborative ways AND relate to each other in vertical ways (both coercive and non-coercive).[2]

Local policy actors and state actors can be understood, under certain circumstances, to be participating in the same action situation (see Figure 1 above). At other times state actors can be understood as "rule enforcers" (Aligica and Tarko 2012, 256) or capacity builders (Corfee-Morlot et al 2011, 179) – outsiders whose actions arise from collective choices at the state level (or at the national level). The collective choice sits outside an action situation where an operational choice plays out (McGinnis 2011). As Aligica and Tarko state, "In a polycentric system, one may be an outsider to a unit but insider to another and thus, ultimately, part of the overarching system" (255). In effect this means that state actors can be understood to act at two levels of nested institutional arrangements. They can join a variety of sub-state actors (e.g., general purpose local governments, special districts, non-governmental organizations) within one level of a polycentric system while also acting at another higher level in a different capacity.[3]

State Actors in their Horizontal Capacity

The idea of state actors acting alongside a number of local actors in a metropolitan region goes back to the theoretical beginnings of the use of polycentricity in a governance context (Ostrom et al. 1961). In response to a standard argument of the time that metropolitan regions were chaotic and inefficient because of the numerous governmental units (including state agencies), Ostrom and Ostrom (1965) argued that such separate (but overlapping) units might be the best choice under certain conditions. These numerous governmental units, each with their own jurisdiction, and therefore distinct center of

[2] The arguments made below are assumed to apply across purpose, sector, and function.

[3] To be clear, a specific participant in a particular position within an action situation is not necessarily going to be the same participant in a particular position at another level of the system. But both of these participants may come from the same state agency or department and may work on the same policy issue but in different institutional roles.

power, can be understood as a coherent system. Rather than a hierarchical structure (monocentricity), such a system could perform the same public functions but do so in a way where power is shared in a horizontal form (polycentricity).

This idea of horizontal interactions can be found in scholarly literatures beyond the institutional choice literature. For example, in public management this idea of polycentricity is akin to ideas of collaborative public management (Agranoff and McGuire 2004). Collaborative public management involves both governmental units and non-governmental actors in the provision of public services. Rather than focusing on hierarchy, the desire is to study and better understand the "transactions between formal entities" (Agranoff and McGuire 2004, vii).

From policy theory come ideas such as policy networks and partnerships that reflect the mutuality of decision-making authority for both collective and operational choices (Bevir 2008; Klijn and Koppenjan 2000). Policy networks are understood to be horizontal interactions, with each node having the potential to be connected to every other node in a non-hierarchical form. Partnerships, by very definition, are understood to involve two or more autonomous actors who have the authority to join with others on a common project.

Our sense of the two basic types of horizontal collaborative interactions includes the following: (1) State and local actors are involved together in both collective choices AND operational choices, and (2) State and local actors are involved together in operational choices where the collective choice has come from above.

State Actors in their Vertical Coercive Capacity

In key respects the idea of state actors relating to local governments in a hierarchical form is a conceptual default for intergovernmental relations in the late 20th century. As Agranoff (2001) argues, federalism from the 1970s through the 1990s had a stronger hierarchical bent, with federal laws strictly

specifying what must be done at the state and local level. States too used a stronger regulatory hand in this period. To be clear the idea of monocentric control as described here is relative. We are not talking about a unitary state. But neither are we talking about the decentered decision-making of polycentricity as it could occur for both collective and operational choices. Rather, we are talking about federalism on a continuum from coercive to cooperative to collaborative (Agranoff 2001).

Our sense of the two basic types of vertical coercive interactions includes the following: (1) State actors set up regulations but allow significant discretion at the local level, ensuring local autonomy in the means of implementation, and (2) State actors use strong regulatory language and limit significantly the discretion of local actors to make operational choices.

State Actors in their Vertical Non-Coercive Capacity

Key to the idea of a vertical, non-coercive interaction is that states sometimes work with localities on issues where the state doesn't regulate local governmental behavior but instead acts to incentivize or subsidize local actions. In such cases state actors neither act as regulators nor as collaborators, but rather they work as facilitators and capacity builders.

This idea of a vertical, non-coercive interaction has been studied in multiple areas of public policy (including educational, energy, and public health), though its fullest articulation has been in the area of environmental policy (Andrews 1999; Durant et al 2004; Kraft et al 2011). A variety of non-regulatory programs, including market-based incentives, voluntary programs, information disclosure programs, and technical assistance programs, are meant to spur local governments to do more than they already are doing. Such programs may be created by state legislatures or from within state agencies.

Our sense of the one basic type of vertical non-coercive interaction includes the following: (1) State actors make collective choices and send them down to the local level, allowing complete discretion at the local level.

These different conceptions of the interactions between state and local actors will inform our analyses of both our quantitative and quality data.

Research Methods

To better understand the complex relationship between multi-level governance and environmental performance, the project will rely upon small N case study research and large N statistical modeling including a web-based survey of key stakeholders. There are no methodological "panaceas" for the institutional analysis of actors and context (Basurto and Ostrom 2009; Poteete, Janssen, and Ostrom 2010; Stern et al. 2002) therefore, We will utilize multiple methods. This multi-method approach is appropriate because the research problem is complex, longitudinal, and multilevel. A growing literature on integrating qualitative and quantitative methods guides the project's hybrid research design (Brady and Collier 2010; Coppedge 1999; King, Keohane, and Verba 1994; Lieberman 2005; McGinnis 2000; Ragin 1987; Tarrow 1995). Specifically, the project employs a nested mixed method comparative analysis (Coppedge 2001; Lieberman 2005; Seawright 2010a) combining qualitative and quantitative data collection and analysis techniques. *Included here are just some of the details about our qualitative and quantitative methods. Further details are available upon request.*

Qualitative Data Collection

We will use a Small-N case study methodology and collect data in the first and third years of the research timeline. In the first year, initial case study work will continue a three-state convenience sample (Kansas, Washington State, and Oregon) already being developed. In the third year, three additional cases will be selected consistent with a "Model-testing Small-N Analysis" (Mt-SNA) or a "Model-building Small-N Analysis" (Mb-SNA) informed by variations in our quantitative analysis (Lieberman 2005, 444-448). Six different kinds of qualitative evidence lead to six different collection procedures in case study analysis (Yin 1989) but this investigation focuses on three: interviews,

documentation, and archival records. First, we anticipate conducting 15 to 20 semi-structured in person interviews per case. ECOS regional representatives and key policy elites identified with snowball sampling and in newspaper articles and organizational websites will compose the sample of respondents for case study interviews. Policy and political documentation will be obtained from climate plans collected from the International Council for Local Environmental Initiatives (ICLEI) database of local climate action, C2Es' database of local adaptation plans, state climate policy program archives or officials, Georgetown Climate Center's "Adaptation Clearinghouse," organizational websites, state legislative databases, and the National Conference of State Legislatures' (NCSL) Bill Information Service.

The relevant case studies will have two levels of analysis corresponding with two separate units of analysis (Poteete, Janssen and Ostrom 2010). First, comparative case studies will be structured around state policy jurisdictions as a unit of analysis. Oregon and Washington offer well developed climate risk governance cases while Kansas is relatively underdeveloped. The initial case studies will also help construct the sampling frame for the three additional state case studies and within-case data sources. Quantitative research in year 1 and 2 will help identify a well developed state case, an underdeveloped case, and a "deviant" case in year three (Lieberman 2005). Second, within-case analysis across the six states involves a social group unit of analysis, or the groups engaged with the climate policy action situation in a state and their institutional statements. These units of analysis are the most relevant for diagnosing collective action prospects (see Poteete et al. 2010, 66-67). For within-case analysis, we will rely on a minimum of 30 observations (20 interviews and 10 documents for example) resulting in a minimum of 180 observations across the six case studies.

Qualitative Analysis

The comparative case analysis in the first year will inform the conceptualization and operationalization (indexes and scales) of variables for subsequent quantitative work. Conversely, within case-analysis in the third year allows us to diagnose the causal and complex processes operating

between policy community attributes, institutional arrangements, and action situations. Moreover, Causal Process Observations (CPOs) will inform the diagnosis of Data Process Observations (DPOs) from the quantitative analysis (see Brady, Collier, and Seawright 2010b). The qualitative analysis will also illuminate important theoretical anomalies that can advance the field of governance studies. Comparisons of multiple cases allow for a more refined understanding of micro-processes within different institutional settings that complements the quantitative methods (Brady and Collier 2010; Koontz 2005; Poteete, Janssen, and Ostrom 2010).

In particular, the interactions and outcomes of state climate policy action situations will be the focus of qualitative analysis. First, we will use the Institutional Grammar Tool (Crawford and Ostrom 1995) and its recent variants (Basurto et al. 2010; Crawford and Ostrom 2005; Siddiki et al. 2011) to code within-case conditions that may lead to deliberative and cooperative outcomes instead of conflict and mistrust. This will involve coding interview responses and individual climate action plans or other relevant institutional statements (statues, executive orders, agency strategies) as written rules with the following grammatical components: (1) the attribute or subject of the rule; (2) the deontic or prescription type; (3) the aim or prescribed action; (4) the conditions on how the rule must be followed; and (5) an "or else" consequence. Three types of institutional statements observable in climate action situations are: strategies, obligations, and rules (Crawford and Ostrom 1995, 2005). For instance, shared strategies in a policy statement would include only Attributes, aIms, and Conditions (AIC) while climate plans establishing obligations or a norm would also include a Deonitc (ADIC) signaled with statements that connotate what is obliged, permitted, or forbidden. Finally, "Or else" phrasings signal a more traditional command and control kind of rule (ADICO). Our goal for intercoder reliability is 80 percent agreement levels (see Basurto et al. 2010).

The IGT analysis builds the empirical foundation for examining two "pragmatic" issues according Crawford and Ostrom (1995). First, analysts can assess the consistency and completeness of the

institutional statements in the action situation of interest. Second, the effects of institutional statement configurations can be examined. In this project, we will organize and examine the institutional configurations in relation to the analytic deliberation exhibited in different state climate action situations. Such analysis will employ Qualitative Comparative Analysis (QCA); a middle pathway between qualitative and statistical analysis (Ragin 2008). Fuzzy Set QCA relies on set theory and Boolean algebra to systematize qualitative comparisons. Moreover, QCA is well suited for small to intermediate samples sizes (N = 5-65, see Ragin 1987, 2000).

QCA questions are usually framed as "under what conditions" instead of "by how much" allowing us to examine configurations of causal conditions and outcomes. For instance, biophysical conditions, community attributes, and institutional arrangements are expected to be related to analytic deliberation. Moreover, analytic deliberation conditions are expected to be related to state-level GHG reduction performance. Different climate plan configurations will be operationalized as a degree of membership falling between 0 and 1 in a category's full set (Ragin 2008) and the calibration of our qualitative variables will follow the six steps outlined by Basurto and Speer (2012). We will utilize the fuzzy extension to STATA (Longset and Vaisey 2008) for the qualitative data analysis.

Quantitative Data Collection

We plan to collect and merge an array of secondary data to better understand how climate risk governance with a particular focus on state level analytical deliberation, nested institutional arrangements, and institutional diversity affects GHG reduction performance. We will utilize EPA's GHGRP to develop measures of GHG reduction performance. Currently, there are three years of facility level emissions data available from the GHGRP (2010-2012). Two more years of emissions data will become available over the course of the proposed research project. This reporting program includes nine reporting sectors: Power Plants; Refineries; Chemical Manufacturing; Other Industrial; Landfills; Metals; Minerals; Pulp and Paper; and Government and Commercial. We have already collected the

available emissions data from EPA's GHGRP. For facilities that have been reporting since 2010 we will create a panel dataset and develop absolute and relative measures of change in emissions over time, using both as a dependent variable. We will use this data to test the effects of climate risk governance on both overall emission changes in a facility and emission changes normalized per unit production. Whenever possible, the researchers will generate emission changes per unit produced in facilities. Currently, this is only possible for the power sector by merging production data from EPA's Clean Air Markets dataset.

The structure of the GHGRP data allows us to build a unique clustered data set and use it to statistically estimate how both facility and state level characteristics affect change in emissions over our three to five year time period. Systematically comparing emission profiles of similar facilities that operate in different state environments is particularly important given the wide range of climate risk governance across states. Each facility in the database contains several geographic identifiers (e.g., state, city, county, zip code and full mailing address). We will merge a range of state, local and even facility characteristics to each facility in the GHGRP. In addition, we will conduct a web-based survey of state government personnel and key stakeholders to determine how trust, cooperation and shared goals influence GHG emission reduction performance. Table 1 highlights the variables needed for the quantitative analysis. Secondary data collection effort is currently underway with several variables already collected and merged into a panel dataset where the unit of analysis is "facility_state_year" with more than 3,000 observations per year. We will rely on information from the Center for Climate and Energy Solutions (C2ES; formerly the Pew Center on Global Climate Change), ICLEI, ESRI's Business Analyst, and other secondary data sources to better understand what elements of climate risk governance result in improved environmental performance.

Table 1 - Variable Description

Concept of Interest	Operationalization	Source
GHG Emission Reduction Performance		
	Change in GHG Emission by facility (both absolute and percentage change). Emissions data are available at the facility level over three years.	EPA GHGRP*
	Per unit change in GHG emissions in Power Sector. This information is not publicly available for the other sectors of the GHGRP.	EPA GHGRP* and Clean Air Markets
Climate Change Vulnerability		
- Biophysical Vulnerability	Hazard causalities measured as the sum of deaths and injuries from weather related extreme events for the last decade.	Spatial Hazards Events & Losses Database for the U.S. (1960-2012)*
	Percentage of Coastal Areas at or below sea level.	NOAA, Sea Level Rise and Coastal Flooding.
- Social Vulnerability	Social Vulnerability Index to Environmental Hazards (2006-2010).	Hazards and Vulnerability Research Instit. *
State Policy Community Attributes		
- Trust, Cooperation, & Shared Goals	State decision makers and key stakeholders' perceptions/evaluations of trust, cooperation, and shared goals within the state in relationship to climate risk governance.	Proposed Web-based survey
Polycentric Institutions: Nested Arrangements		
- Vertical Nesting	Multiple measures of vertical nesting will be constructed. (1) The proportion of local governments within a state that have developed climate adaptation plans. (2) Proportion of local governments who have joined ICLEI's climate protection initiative and or climate resilient communities; and (3) The proportion of U.S. Conference of Mayor Climate Protection Agreement signatories within a state.	C2ES*, ICLEI USA & US Conference of Mayors & Census of Government*
- Horizontal Nesting	Inter-state nesting will be measured by constructing a variable noting if the state participates in any regional climate protection initiatives.	C2ES*
Polycentric Institutions: Diverse Arrangements		
- Institutional Diversity	Three different variables will be created based on C2ES' classification of climate related policy activity within states (and cross-checked using information in Georgetown's Climate Center): (1) an index score noting the diversity of approaches used in decision making venues (markets, hierarchies, self governance); (2) a variable measuring the number of climate policy activities across multiple sectors; and (3) a count of the number of policy tools such as regulations, incentives, and dispute resolution, used across sectors.	C2ES* & Georgetown Climate Center: A Leading Resource for State and Federal Policy

State Climate Policy Action Situations		
- Analytical Deliberation	At least four variables will represent analytical deliberation. (1) A binary variable indicating if state has a climate change commission or advisory board. (2) Code the diversity of the advisory board's membership. (3) Categorize each the level of activity of each advisory board. (4) And evaluate state involvement in NA2050.	C2ES*
Controls		
- Facility Level	Employees Per facility	ESRI's Business Analyst
	Environmental Compliance includes a variable noting if the facility has been in "Significant Non-Compliance" with the Clean Air Act, Clean Water Act or the Resource Conservation and Recovery Act prior to reporting of GHG emissions.	EPA's ECHO Database**
	GHG Reporting Sector.	EPA GHGRP*
- State level	Experience – the length of time a state has been engaged in climate governance.	C2ES*

* = This information has been collected.

** = This information has been collected and merged with the GHGRP data.

Climate Change Vulnerability. To better understand how climate change vulnerability shapes GHG emission reduction performance we will develop two measures of vulnerability: biophysical and social. Using previous research as a guide (Brody et al. 2008; Zahran et al. 2008), we will include a state level variable reporting the cumulative number of deaths and injuries from extreme weather related in the decade prior to the GHG emissions data. A second biophysical variable noting the percentage of coastal areas within a state that are at or below sea level will also be included. Recent scholarship highlights that social vulnerability to climate change is critically important in understanding and measuring climate vulnerability (Altizer et al. 2013; Lafferty 2009; and Cutter et al. 2008). Therefore, we will also create a state level social vulnerability index patterned off the current county level measure publically available from the Hazards and Vulnerability Research Institute.

Attributes of State Climate Policy Community. Across the fifty states, the policy community attributes for climate mitigation and adaptation action varies considerably. IAD theorists note that

within any policy community, the level of trust among actors, cooperation and shared goals are critical in shaping behavior. Because this type of information is not readily available in existing secondary data sets, we propose a web-based survey of state environmental agency personnel and elected officials active on environmental policy legislative committees. This survey will also be distributed to key stakeholders from the for-profit and nonprofit sectors. Data from the survey will be aggregated to measure overall levels of trust within the climate policy community and also provide an indication of the extent of cooperation and shared goals about climate change and appropriate public actions in response to climate change.

Several sources will be used to develop a sampling frame for the web-based survey. Information on state civil servants and elected officials is publically available. Moreover, the collaborative relationship with the Environmental Council of State Governments (ECOS) will be invaluable to ensure adequate contact information. This survey will also be distributed to key stakeholders representing a range of interests in climate governance. Relying upon the "Encyclopedia of Associations: National Organizations of the U.S" and "Encyclopedia of Associations: Regional, State and Local Organization" available through WWU's library, we will develop a sampling frame that includes individuals representing non-profit organization that are linked to the nine sectors required to report under the GHGRP, such as the National Association of Manufacturers, or the Independent Petroleum Association of America. These two databases provide electronic contact information for individuals within organizations. In addition to surveying membership organizations directly connected to the nine sectors covered by the GHGRP, we will also use these databases to augment the sampling frame of key stakeholder by including representatives of chamber of commerce organizations and environmental advocacy groups. We will randomly sample 600 individuals from these stakeholders. Finally, to ensure that the web-based survey includes perspectives from the regulated community, we will include a stratified random sample of GHG emitters. Using the three sectors with the largest number of reporters as a starting point (power plants,

petroleum and natural gas systems, and waste), we will use the most recent reporting year and divide facilities into small, medium, and large emitters. Once stratified, 75 facilities within each size range and sector will be randomly sampled for a total of 675 emitters.

This approach will allow us to survey public and private decision-makers to determine how levels of trust, cooperation and shared goals influence GHG reduction performance. In previous research all three researchers have developed surveys for policy elites that focus on these issues (Daley 2009; Kraft, Stephan, and Abel 2011). In total, we anticipate surveying more than 1000 key stakeholders using this approach. The University of Kansas uses Qualtrics to develop and implement web-based surveys. We will rely upon a variant of the "Tailored Design Method" (Dillman, Smyth and Christian 2000) to guide survey development and implementation. Once the sample for the survey has been finalized, an email will be sent to all participants notifying them of their inclusion in the survey and highlighting the importance of their participation. Following this, the electronic survey will be administered, with weekly follow up prompts to non-respondents occurring weekly for up to four weeks. After the third reminder prompt, non-respondents will be contacted by phone in an effort to maximize the response rate.

Polycentric Institutions: Nested Arrangements. This research design acknowledges that multiple and overlapping institutional designs exist in climate risk governance and our empirical approach will evaluate the impact of several forms of polycentrism. First, we have started to collect a range of data that indicate if a local government is activity pursuing climate mitigation or adaptation policies. Information on local government activity will come from several publicly available sources, including C2ES, ICLEI, and Georgetown Climate Center. Using this information, we will construct a variable noting the proportion of local governments within a state that are actively engaged in climate risk governance. The denominator for this measure, total number of local governments, is publically available via the Census of Governments. The second measure of polycentrism focuses on inter-state nesting. Using data

collected by C2ES, we will develop a measure noting if the state participates in any regional climate initiatives.

Polycentric Institutions: Diverse Arrangements. C2ES reports a range of state climate related activities. Using this information and cross-checking it with state documents and other organizations that track state policy activity, such as the Georgetown Climate Center, We will create an index score noting the diversity of state approaches, along with measuring policy activity across multiple sectors. Finally, we will create a measure based on the range of policy tools used by state governments. This measure will capture creative financing programs, incentives and regulations for carbon capture and sequestration, and low carbon fuel standards among others. We expect systematic emission reductions to occur in states that are engaged in a range of climate risk governance. An important aspect of measuring institutional diversity includes understanding or controlling for the length of time a state has been activity pursuing climate change policy. For those states with active climate change initiatives, we will rely upon C2ES data that highlights the passage of key policy initiatives to measure their experience in this area. This indicator of experience can be used to develop more detailed measures of the institutional diversity. Interacting institutional diversity with experience may provide a more valid operationalization of institutional diversity while also potentially highlighting critical mechanisms of climate risk governance.

State Climate Policy Action Situations. This research will measure the extent to which states have created alternative action situations that rely upon analytical deliberation to address the challenges associated with climate change. A range of research highlights the importance of collaborative forums and their role in improved decision-making. We have collected data from C2ES that provides considerable detail on the twenty-five states that have active legislative and executive climate advisory boards. This allows the researchers to create variables noting their presence, coding the diversity of

their membership to understand the range of sectors and stakeholders represented, and categorizing their activity in terms of meetings, document writing, and outreach. In states without active climate risk governance, we will examine state environmental agency websites and state documents such as legislative and executive reports and issue briefs, in order to determine if climate advisory panels have been formed or if there is an appropriate counterpart in these states. There is a distinct need for more systematic research that considers what forces shape both the promotion and opposition to climate governance (Selin and Vandeveer 2013). We also have collected data on which states are involved with North American 2050 (NA2050), a forum committed to identify the range of policies needed to move their states to a low-carbon economy. This information will be used as an additional indicator of an alternative action situation.

Controls. Finally, because a range of factors influences GHG emissions, appropriate control variables will be included. Using a facility's address, we will merge facility level information from ESRI's Business Analyst database available through WWU's library. This will allow a control for facility size by including variables like the number of employees in a facility. We have tested this merging approach on a small number of facilities to ensure its accuracy. Additionally, we have already merged facility-based information from EPA's Enforcement and Compliance History Online database. This includes information on any regulated environmental emissions, along with a wide range of compliance and enforcement information. We will include a variable noting if a facility has been in "significant non-compliance" with major environmental legislation five years prior to reporting GHG emissions. With this secondary data assembled, we will be in a position to simultaneously examine the impact of state climate risk governance and facility level factors on GHG emissions.

Quantitative Analysis

After collecting and merging the full range of secondary data described above, along with primary data collection using the web-based survey, we will rely upon multivariate statistical techniques that allow for the estimation of relationships while accounting for the clustered nature of the data. Doing so will enable the research team to understand how climate risk governance within states affect facility level GHG emissions. A panel data set will be constructed to analyze the relative effect of nested and diverse institutional arrangements and analytical deliberation on emissions, controlling for a range of other factors likely to influence emissions. We will utilize random effects multilevel modeling (MLM) using Stata. A dynamic higher-level model with nested random effects will capitalize on the data structure: clusters, nested within super clusters (Rabe-Hesketh and Skrondal 2012). This will allow We to examine how both facility and state level factors predict change in emissions over time (Deleeuw and Kreft 1986; Rabe-Hesketh and Skrondal 2012). MLM is increasingly being used in social science research (Djupe and Olson 2010; Smith and Walker 2013; Raudenbush and Bryk 2002; Steenbergen and Jones 2002) to better understand how characteristics or variables grouped at different levels influence a range of outcomes. One of the challenges in using this methodological approach includes the need for clear theoretical expectations that correspond to the relevant levels of analysis (Blalock 1984; Diez-Roux 2000; Gamoran 1992). In this respect the IAD and polycentric governance provide an excellent theoretical approach with clear expectations that apply to different analytical levels.

We will model emission changes - both absolute and percentage change in emission - as a function facility level characteristics (number of employees, previous environmental performance) and climate risk governance factors (vertical and horizontal nesting within the state; measures of institutional diversity, and upon completion of the web based survey, assessment of trust, cooperation and shared goals within the policy community). The models will include controls for climate change vulnerability

within a state along with facility level controls for different GHGRP sectors. In the power sector, production data are available via EPA's Clean Air Markets data. Therefore, for this sector We will be in a position to estimate the same model described above on change in emission per unit production (or power generated for this sector. The sub analysis for this important sector will allow the inclusion of additional policy context, such as incentives for renewable energy generation, that may influence environmental performance.

A random effects MLM is appropriate for our data structure and allows us to evaluate the effect of both within and across level interactions. With MLM the sample or population size of the second level – state level in this case – is critical to consider when constructing models (Stegmueller 2013). While there is no consensus about how many observations are needed at the second level of analysis, it is generally desirable to sample thirty or more at the second level (Deleeuw and Kreft 1995; Hox and Kreft 1994) and some suggest that the second level of analysis needs more than fifty observations to guard against biased estimates (Maas and Hox 2005). Because there are three years of GHGRP data, we will be able to measure emission *changes* in all states over two time periods, using the first round of data to gauge absolute and relative emission changes. Therefore, there will be 100 observations at the second level of analysis. While all of We have significant empirical modeling experience, the research team will work closely with quantitative methodologists from the University of Kansas' Center for Research Methods & Data Analysis (CRMDA) to ensure that our analytical approach is appropriate and the inferences drawn from our data are replicable.

We will model GHG emission reduction performance using the full panel of facilities along with examining change from 2011-2012. There are approximately 3,000 facilities that have reported across all three years of the GHGRP. But EPA has also added source categories that increase the number of facilities that must now report under this program. The 2012 GHGRP data had more than 8000 facilities. For the larger subset of facilities that reported both in 2011 and 2012, we will replicate the analysis -

measuring absolute and relative emission changes across one time period - to determine if the patterns hold when more emitters are included in the data. If the same patterns exist, we will have more confidence in the relationships that emerge.

Causal inference is always a challenge in studies relying on observational data. Whenever possible we will validate the statistical analysis using proxy indicators of environmental performance, thus limiting potential endogenity issues. State level action on climate change has been differential across space and time. While implementation scholars suggest this is a strength of the proposed research design because it generally takes at least a decade to see changes "on the ground" (Mazmanian and Sabatier 1989), we recognize that some GHG emission reductions could have occurred before the GHGRP. Therefore, as a robustness check, we will examine aggregate state level CO_2 emissions from 2000 – 2010 recently released by the US Energy Information Administration (EIA). While this is a limited subsection of GHG emissions from energy related activities, it provides a reasonable proxy to examine emissions levels directly before and after a range of state policy activity. As a follow up robustness check we will examine a second proxy indicator for GHG emission, per capita hazardous air pollutants (HAP). Prior research has relied in this as a proxy indicator for CO_2 emission, noting that HAP emissions are highly correlated to estimated CO_2 emissions from fossil fuel combustion (Brody et al. 2008). Time variant HAP data are available from the EPA and therefore will allow us to examine emission patterns before and after a range of climate policy activity across the states. This type of follow-up analysis provides additional confidence in any results and can help support causal inferences.

Conclusion

The proposed research program offers the first systematic attention and evaluation of America's subnational climate risk governance. More than a decade ago, the National Academy of Public Administration's (NAPA 2000) panel of experts advocated for the use of non-regulatory environmental

policies. Likewise, an earlier NAPA (1995) study found that the EPA was failing to leverage the problem-solving capacity of firms, cities, and states effectively. The results from this research will inform this ongoing debate both for climate risk and environmental governance more broadly.

In diverse and complex institutional settings, thousands of industrial facilities and hundreds of subnational US governments are at the forefront of American climate risk governance. The research program proposed here offers a framework to examine whether and how subnational governance arrangements affect GHG emission trends. Informed by this climate risk governance framework, future empirical work will investigate the institutional factors, policy community attributes, and interactions that most significantly facilitate or impede subnational climate risk governance and performance. In the vacuum of national policies to mitigate and adapt to climate-change, subnational governance arrangements offer an ideal opportunity to study not only the spontaneity of polycentrism, but whether or not it is leading to better environmental outcomes.

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